Faculty of Science & Technology
Banasthali Vidyapith

Minutes of the meeting of the **Faculty of Science & Technology** held on **6 April, 2012** at **10.00 a.m.** in the **Conference Hall, Vidya Mandir**, Banasthali Vidyapith.

P r e s e n t

Prof. H.D. Kumar	External Member
Prof. Gursharn S. Randhawa	External Member
Prof. Dharma Kishore	Internal Member
Prof. Sudha Shastri	,,
Prof. R.P. Vaid	,,
Prof. Veena Garg	,,
Dr. Veena Sharma	,,
Dr. Gyan Singh Shekhawat	,,
Dr. Nilima Kumari	,,
Dr. Anubhuti Sharma	,,
Dr. Suphia Khan	,,
Dr. Jaya Dwivwdi	,,
Dr. Bhawani Singh	,,
Dr. Dinesh Kumar	,,
Dr. Rashmi Sharma	,,
Shri. Vinay Shankar Prasad Sinha	,,
Dr. Nidhi Srivastava	,,
Dr. Suman Gupta	,,
Shri. Chandra Kant Sharma	,,
Dr. Dipjyoti Chakraborty	,,
Dr. Renu Bist	,,
Dr. Jyoti Srivastava	,,
Ms. Tripti Sharma	,,
Dr. Shrilekha Sharma	,,
Dr. Manu Sharma	,,
Dr. Rajani Chauhan	,,
Shri. Swapnil Sharma	,,
Ms. Yashumati Ratan	,,
Smt. Divya Yadav	,,
Dr. Rakesh Yadav	,,
Dr. Sumitra Nair	,,
Dr. Sudhanshu Sharma	,,
Prof. Vinay Sharma	Convenor

Note: Prof. Virinder Singh Parmar, Dr. Shailendra Saraf, External Members and Dr. Sarvesh Paliwal, Internal Member could not attend the meeting.

The Convener accorded a cordial welcome to all the old and new members who were present in the meeting.

1. The minutes of its last meeting of the Faculty of Science and Technology held on 30 December, 2010 were confirmed.

2. The Faculty considered and approved the policy framework to better manage multi-section courses of the Vidyapith as proposed except that for better teacher student coordination, provision of one common hour can be kept for interaction fortnightly rather than weekly, either through a common period or after the scheduled time table has been over, i.e. at 5/ 6 pm as applicable. Annexure I

3. To the faculty considered the possibility of adopting grading system in the Vidyapith. The members including the external experts were of the view that the grading system will work well provided there is 100% internal evaluation system. The faculty resolved to recoomend that the present examination format followed for various courses in the Vidyapith has a well balanced combination of external and internal evaluation which is not conducive to the grading system and thus the existing system may be continued as such.

4. The faculty considered suggestions for further improvement of the 'BLISS Commitment form and BLISS Appraisal and Accomplishment form' and resolved to recommend as follows:

   - The workshop/ training/ refresher /orientation courses be included in the BLISS format as under:

     Less than one week: 2 points

     One-two weeks: 5 points

     More than 2 weeks: 10 points

   - Duties in practical examination should be included in BLISS proforma and be treated at par with theory invigilation duties.

5. The faculty extensively discussed the issues related to the improvement in the standards of day-to-day teaching learning process. After a thorough discussion and suggestions by various faculty members, the faculty recommended that in order to

bring about overall improvement in quality, specifically, the following steps need to be undertaken:

- There should be better utilization of the e-resourses by the teachers and the students
- Greater emphasis need to be made on imparting practical training to the students
- Guest lectures by eminent subject experts need to be more frequently organized
- Workshops for teachers focused on teaching-learning methods be organized
- Subject workshops with student participation be organized.
- The maximum teacher student ratio for specific courses should not exceed as follows:

  M. Tech. 1:20; Other P.G. courses 1:40; U.G. courses 1:60

6. The faculty considered the suggestions to prepare guidelines to improve quality of question papers and was of the view that that standard of the question papers of the examinations conducted by the Vidyapith are high as reported in the BOS of the different Science and Technology Departments and as such did not require any radical modification. The faculty also noted that in cases of sub-standard question papers, the reason seems to be inadequate attention by the paper setter or at times, improper selection of examiners. In such cases, the examiner may need to be changed. Thus overall the issue of sub-standard papers has to be addressed case by case. Hence, the faculty resolved to recommend that as such there is not need to change the current format of the question papers.

7. The faculty considered the recommendations of the **Board of Studies in Bio-Science & Biotechnology** made at its meeting held on 15 March, 2012 and resolved that the recommendations of the Board be accepted. The salient features are as noted below:

7.1 The faculty approved the syllabi for Ph.D. Entrance Examination for Banasthali Research Entrance Test (BRET) in Bioscience and Biotechnology as recommened by the board **Appendix – I** (pages 6-10 of BOS minutes).

7.2 The faculty approved the verified list of degrees offered by Dept of Bioscience and Biotechnology as recommended by the board.

7.3 The faculty approved the course structure and recurring, non-recurring requirements of M. Tech. (Biotechnology) Program and recommended that the program may begin from 2013-14 as proposed by the board. The details are included in **Appendix II** (pages 11-15 of BOS minutes).

7.4 The faculty approved the course codes of all ongoing programmes in Bioscience and Biotechnology as recommended by the board. A list of the modified and corrected course codes is included as **Appendix – III** (pages 16-46 of BOS minutes).

7.5 The faculty approved a sample model handout recommended by the Board in view of the decision of the Academic Council to make course 'Handout' mandatory for every course offered by the Vidyapith with effect from July, 2012. A copy of the Handout approved by the faculty is included in **Appendix – IV** (page 47 of BOS minutes).

7.6 The faculty approved the recommendations of the Board to strengthening continuous assessment policy. The faculty endorsed the view of the Board that the existing policy is adequate to assess the students and resolved to recommend the continuation of the existing policy with the incorporation of quiz, group discussion, surprise test, dictating a technical paragraph based on the course and checking the same for spelling mistakes etc.

7.7 The faculty approved the list additional text book(s) for the under-graduate programmes, by the board. A list is included as **Appendix – V** (pages 48-57 of BOS minutes).

7.8 The faculty approved minor changes in BTech practical course 1.6/ 2.6 to be implemented from the session 2012-13 (**Appendix VI A,** page 58 of BOS minutes). Further, modifications in the B.Sc. Zoology and M.Sc. Bioscience (Animal Science) in consideration of UGC guidelines for gradually phasing out dissections oriented practicals as proposed by the Board was approved. The modified course structure to be implemented w.e.f. session 2012-13 is enclosed as **Appendix VI B** (pages 59-64 of BOS minutes) for B.Sc. Bioscience – Zoology course and **Appendix VI C** (pages 65-66 of BOS minutes) for M.Sc. Bioscience (Animal Science) courses.

7.9 The faculty endorsed the view of the board regarding the reports of examiners in various examinations of 2010-2011. Most of the examiners found the content of answers satisfactory or good and overall were quite satisfied with the performance of the students. The faculty approved the recommendation of the Board unanimously that the supplementary copies in final/ term examinations be discontinued and if the need be, the number of pages in the main copy may be increased accordingly.

7.10 The faculty approved the recommendations of Board concerning the analysis of the question papers for the year 2010-2011 and noted that all the papers were well balanced. The analysis of the question papers summarized in **Appendix VIIA** (pages 67-68 of BOS minutes) and details given in various tables and figures Appendix VIIB

(UG, page 69-93 of BOS minutes), (B.Tech. Biotechnology, pages 94-103 of BOS minutes) and (PG, pages 104-118 of BOS minutes).

8. The faculty considered the recommendations of the **Board of Studies in Chemistry** made at its meeting held on 14 March, 2012 and resolved that the recommendations of the Board be accepted. The salient features are as noted below:

8.1 The faculty approved the syllabi for Ph.D. Entrance Examination for Banasthali Research Entrance Test (BRET) in Chemistry as recommened by the board **Annexure – I** (pages 5-6 of BOS minutes).

8.2 The faculty approved weitage of marks in Question Bank whereby, 70 % weightage for the knowledge of the subject and 30% weightage for the knowledge general aptitude. The 70% is subdivided as 20% (Inorganic Chemistry, 20% Organic Chemistry, 20% Physical Chemistry and 10% Analytical Chemistry for Ph.D. Entrance Examination for Banasthali Research Entrance Test (BRET) in Chemistry.

8.3 The faculty approved the verified list of degrees offered by Dept. of Chemistry as recommended by the Board.

8.4 The faculty approved the course codes as recommended by the board. The details are given in **Annexure 2 (**pages 7-9 of BOS minutes)

8.5 The recommendation of the faculty for Handouts as given in the section 7.4 above was approved.

8.6 The faculty approved the list of additional text books recommended by the Board.

8.7 The faculty approved the recommendations of the Board regarding the Courses of Study, Curricula and Scheme of Examinations of the following undergraduate and postgraduate examinations of Chemistry given as below:

(I) Bachelor of Science (B. Sc.) Examinations:

The faculty approved the changes made in the syllabus of Physical Chemistry.

Annexure-4 (pages 11 to 13 of BOS minutes**)**

(II) Master of Science (M. Sc.) Chemistry Examination:

Scheme of Examinations (Existing and Modified Schemes of Sem. Exam)

Annexure-5 (pages 14 to 15 of BOS minutes)

Syllabi (Existing and Modified Syllabi of Semester Examinations)

Annexure-6 (pages 16 to 28 of BOS minutes)

Further, the faculty approved the boards recommendation that Paper-V (a) CH-415(a) on Mathematics for Chemists of the M. Sc. I semester be run as a compulsory paper as **Paper-V: Mathematics for Chemists** [instead of optional as (a) Mathematics for Chemists (b) Biology for Chemists (c) Research Methodology and Technical Writing and (d) Green Chemistry]. The faculty approved the boards recasting of course content of Mathematics for Chemists.

8.8 The faculty endorsed the view of the board regarding the reports of examiners in various examinations of 2010-2011.

8.9 The faculty approved the recommendations of Board regarding the analysis of the question papers for the year 2010-2011 and noted that all the papers were well balanced. The outcome of the analysis of the papers of year 2010-2011 is shown in the **Annexure-7 (p**ages 29 of BOS minutes**)**.

9. The faculty considered the recommendations of the **Board of Studies in Pharmacy** made at its meeting held on 15 March, 2012 and resolved that the recommendations of the Board be accepted. The salient features are as noted below:

9.1 The faculty approved the syllabus for Ph.D. entrance examination as recommended by the board (**Annexure-I** page no. 9 of BOS minutes).

9.2 The faculty approved the verified list of degrees offered by Dept of Pharmacy as recommended by the board.

9.3 The faculty approved the proposal of the board to start the M.Pharm. (Pharmaceutics) course w.e.f. the academic session 2013-14 and recommended that the proposed courses of study, curricula and scheme of examinations be implemented. **Annexure-IIA** (Page no. 10-12 of BOS minutes): M.Pharm.-Pharmaceutics (Proposed scheme of semester examination); **Annexure-IIB** (Page no. 13-30 of BOS minutes): M.Pharm.-Pharmaceutics (Proposed syllabi of M.Pharm. examination).

9.4 The faculty approved the course list of UG and PG programmes of the department.

9.5 The recommendation of the faculty for Handouts as given in the section 7.4 above was approved.

9.6 The faculty approved the recommendations of the board for strengthening the mode of evaluation for continuous assessment in the curriculum. The details are given in **Annexure-IV** (page 32 of BOS minutes).

9.7 The faculty approved the recommendations of the board regarding the courses of study, curricula and scheme of examinations of the following undergraduate and postgraduate examinations: -

Details of the scheme of examinations and the syllabi of different courses are given in the following annexure **Annexure-V to VI** (of BOS minutes):

(A) Bachelor of Pharmacy (B. Pharm.) Examination:

Annexure-VA (pages 33-37 of BOS minutes)**:** B. Pharm. (Existing and modified Scheme of Semester Examinations)

Annexure-VB (pages 38-44 of BOS minutes)**:** B. Pharm. (Existing and modified Syllabi of Semester Examinations)

(B) Master of Pharmacy (M.Pharm.) Pharm. Chemistry Examination:

Annexure-VIA (pages 45-47 of BOS minutes)**:** M. Pharm. (Pharm. Chemistry) (Existing Scheme of Semester Examinations)

Annexure-VIB (pages 48-50 of BOS minutes)**:** M. Pharm. (Pharm. Chemistry) (Existing and Modified Syllabi of Semester Examinations)

9.8 The faculty board endorsed the view of the board regarding the reports of examiners in various examinations of 2010-2011.

9.9 The faculty approved the recommendations of Board concerning the analysis of the question papers for the year 2010-2011 that the number of analytical, application and information based questions should be increased in the question papers. The outcome of the analysis of the papers of year 2010-11 is shown in **Annexure-VII** (pages 51-55 of BOS minutes).

10. The faculty considered the recommendations of the **Board of Studies in B.Tech. Chemical Engineering** made at its meeting held on 10 March, 2012 and resolved that the recommendations of the Board be accepted.

10.1 The faculty approved the amendment of the board for item-5 of the minutes of the previous held on 29 September 2010 BOS which recommended introduction of a summer training program after B.Tech. (CE) VI Semester Examination instead of a VII Semester Industrial/institute-linkage Project. It was pointed out that this decision was not implemented for the current final year batch in their VII Semester because of administrative reasons. As an amendment, the BOS decided to introduce the summer training program after B.Tech. (CE) VI Semester Examination as an additional

optional component rather than an alternative component to the VII Semester Industrial/institute-linkage Project which was approved by the faculty.

10.2 The faculty approved the syllabi for Ph.D. Entrance Examination in Chemical Engineering recommended by the board. The details are given in **Annexure-I** (of BOS minutes)

10.3 The faculty approved the course codes of the programs relevant to the Chemical Engineering department verified by the board and the course structure of B.Tech. (Chemical Engineering) program **Annexure-III (**of BOS minutes**).**

10.4 The recommendation of the faculty for Handouts as given in the section 7.4 above was approved.

10.5 The faculty approved the continuous assessment policy consisting of one class test plus one periodical test plus one quiz spaced equally over the semester as recommended by the board.

10.6 The faculty approved the revised list of text books for all courses where syllabi had been modified as recommended by the board (**Annexure-V** of BOS minutes).

10.7 The faculty approved the recommendation of the board regarding the Courses of Study, Curricula and Scheme of Examinations of the following Examinations as given in **Annexure-VII** (of BOS minutes).

10.8 The faculty board endorsed the view of the board regarding the reports of examiners in various examinations of 2010-2011. Most of the examiners found the content of answers satisfactory or good and overall were quite satisfied with the performance of the students.

10.9 The faculty approved the recommendations of Board concerning the analysis of the question papers for the year 2010-2011 and noted that all the papers were well balanced.

11. The faculty considered the recommendations of the **Board of Studies in Geography** made at its meeting held on 11 March, 2012 and resolved that the recommendations of the Board be accepted. The salient features are as noted below:

11.1 The faculty approved the syllabus of the Ph.D. entrance examination as recommended by the Board (**Enclosure 2**, pages 8-9 of BOS minutes)

11.2 The faculty approved the recommendations of the board regarding the names of degrees given to Geography specified by the University Grants Commission that

M.A. / M.Sc. degrees shall be given to those candidates who have B.A./ B.Sc. degrees respectively in graduation.

11.3 The faculty approved the recommendation of the board BOS regarding correction of the course structure and their sequence in B.A. and M.A./M.Sc as two papers of IV Semester Remote Sensing & GIS (Theory & Practical) are missing but it was shown in M.Tech. in Remote Sensing (**Enclosure 3**, pages 12-105 of BOS minutes).

11.4 The recommendation of the faculty for Handouts as given in the section 7.4 above was approved.

11.5 The faculty approved the recommendation of the board regarding making Certificate/Diploma courses more effective by:

1. Practical based evaluation
2. Overall performance in the classroom - regularity, attentiveness and punctuality
3. Assignment

11.6 The faculty approved the recommendations of the BOS that the Continuous Assessment should be conducted in the form of class test before and after the periodical test by giving presentation or assignment and the concerned teacher should also take into account the student's class performance, regularity and punctuality.

11.7 The faculty approved the recommendations of the board regarding courses of study, curricula and scheme of examinations of Post Graduate Examinations. Details of the Scheme of Examinations (Existing and Modified Schemes of PG Examination) and the syllabi (Existing and Modified Syllabai of PG Examination) of PG course are given in (**Enclosure 4**, pages 12-15 of BOS minutes) and (**Enclosure 5**, pages.16-103 of BOS minutes).

11.8 The faculty board endorsed the view of the board regarding the reports of examiners in various examinations of 2010-2011. Most of the examiners found the content of answers satisfactory or good and overall were quite satisfied with the performance of the students.

11.9 The faculty approved the recommendations of Board concerning the analysis of the question papers for the year 2010-2011 and noted that all the papers were well balanced.

11.10 The faculty approved the recommendation of the board regarding categorizing the journals in Geography as follows:

S. No.	Category of Journals	Impact Factor
1.	Category A (i) A1 (ii) A2	 >1.5 0.1 to 1.5
2.	Category B	All refereed National Journals and mostly subscribed in different reputed Universities
3.	Category C	All regional journals

12. The faculty considered the recommendations of the **Board of Studies in Aviation Science** made at its meeting held on 15 March, 2012 and resolved that the recommendations of the Board be accepted. The salient features are as noted below:

12.1 The faculty approved the verified list of degrees offered by Dept of Aviation Science as recommended by the board.

12.2 The faculty approved the recommendation of the board that in place of B.Tech. (Aeronatical Engineering), the course name should be B.Tech [Avionics].

The faculty also approved recommendation of the board to start B.Tech program in Avionics from session 2013 -14. The scheme of B.Tech [Avionics] is enclosed as **Annexure II** (pages 6-13 of BOS minutes).

The faculty approved the course structure of Aircraft Maintenance Engineering [ES/IS/RN] as recommended by the board.

12.3 The faculty approved the changes in course codes as recommended by the board. The Board has verified the course codes of various programmes relevant to the Department except the common papers of Electronics of B.Sc [Av Sc] with B.Sc [Electronics] i.e. the same course code of electronics should be there for B.Sc [Av Sc] as well i.e. EL 1020 & EL 1040.

12.4 The recommendation of the faculty for Handouts as given in the section 7.4 above was approved.

12.5 The faculty approved the draft policy for SPL Licensing as recommended by the board. **(Annexure IV,** page 15 of BOS minutes).

12.6 The faculty approved the recommendation of the board regarding ways and means to strengthen the continuous assessment policy whereby that more number of continuous

tests are to be taken for undergraduate students of objective type and at post graduate level the assessment is to be based on self study and reviewing and implementing the Journal Papers. Dates mentioned in the handout must not be altered. Although the type of the assessment (Multiple type questions, Quiz, Seminar) for the particular course is different but whatever is the policy, it should be mentioned in the handout.

12.7 The faculty approved a draft policy for SPL students as recommended by the board (**Annexure V,** page 16 of BOS minutes)

12.8 The faculty approved the list of practical/tasks in Hangar workshop as recommended by the board (**Annexure VI,** page 17 of BOS minutes).

12.9 The faculty approved the changes in syllabi in B.Sc. (Aviation Science) as recommended by the board. The modified syllabi is enclosed as **Annexure VII** (page 18-25 of BOS minutes)

12.10 The faculty board endorsed the view of the board regarding the reports of examiners in various examinations of 2010-2011 that the content of the answers were satisfactory or good.

12.11 The faculty endorsed the views of Board regarding the analysis of the question papers for the year 2010-2011 and noted that all the papers were well balanced.

13. The faculty considered the recommendations of the **Board of Studies in Remote Sensing** made at its meeting held on 12 March, 2012 and resolved that the recommendations of the Board be accepted. The salient features are as noted below:

13.1 The faculty approved the syllabi for Ph.D. Entrance Examination for Banasthali Research Entrance Test (BRET) in Remote Sensing recommened by the board (**Annexure – I,** page 3 of BOS minutes).

13.2 The faculty approved the recommendation of the board regarding naming the degree awarded in Remote Sensing as Master of Technology (Remote Sensing) in short M.Tech (RS)

13.3 The faculty approved the recommendations of the board regartding the syllabus of B.Sc. in Geology for six semesters with list of practicals and list of text books and reference books. (**Annexure –II**, pages 4-20 of BOS minutes).

13.4 The faculty approved the recommendation of the board that the course code of B.Sc. in Geology be given as B.Sc (GOL) (**Annexure –III,** pages 21-22 of BOS minutes).

13.5 The recommendation of the faculty for Handouts as given in the section 7.4 above was approved.

13.6 The board approved the following recommendations of the board to strengthen the continuous assessment policy:

a. Maximum 25% of internal assessment should be based on tutorials depending on the nature of practical component.
b. Independent studies on review of popular research papers and presentations in summarized form (not more than 8 slides) on a scientific or research topic based on remote sensing understanding and maintaining the technical writing standards.

13.7 The faculty approved the recommended revised list of books for different courses (**Annexure II, pages** 4-20 of BOS minutes).

13.8 The faculty approved the modified syllabi of all papers of M.Tech (RS) as recommended by the board. (**Annexure – V** pages 49-115 of BOS minutes)

13.9 The faculty approved the recommendations of Board concerning the analysis of the question papers and noted that all the papers were up to the desired level for M.Tech (RS) course.

13.10 The faculty approved the maters recommended in the supplementary agenda of the board regarding the following:

a. Two more reading elective on technology front as under
   i. Atmospheric correction modeling, Pattern recognisation and spectral matching
   ii. Spatial modeling.
b. Selection of reading electives should have pre requisite of knowledge on the subject through academic background or assignments
c. Reading material for the reading elective to be suggested by the faculty.
d. For the course B.Sc. in Geology a geological field trip is suggested for one week.
e. For M.Tech (RS) one week Ground truthing programme is suggested.

14. Supplementary Agenda I: In regard to the agenda item t**o** strengthen the research activities of the faculty, the members noted with satisfaction that during the past few years, there has been a steady improvement both in the quantity and quality of research as reflected by increased number of research publications with higher impact factor. The Vidyapith has also received several major research projects including Basic Science project under the DST CURIE program which has contributed immensely to the development of Infrastructure in Sciences. Individual faculty

members have also been able to generate substantial amount of external funding towards research projectrs from various funding agencies like UGC, DST, DBT, DRDO etc. In order to sustain the momentum of these research activities, and bring about further steady improvements, the faculty extensively discussed various issues to strenghthen research and recommended that following steps need to be undertaken:

- Faculty members to be encouraged to write research project and will be expected to submit at least one major research project in 3 years
- Collaborations and interdisciplinary research to be encouraged
- Colloquia involving external experts can be organized at suitable intervals. Further Internal faculty members may also periodically deliver seminars in the area of their research interest.
- To nurture the innovative capabilities of research students, it is proposed to provide a platform where:
  - Students would be encouraged to organize academic activities like science fairs, discussion forum etc.
  - They would be encouraged to interact with peer academicians.
  - Interaction of students with select industrialists relevant to their field so as to promote their placement opportunities.
- Teaching load for the faculty may be reviewed case by case and a reduction in the load may be considered on the basis of set criteria, viz. no. of registered PhD scholars, research projects etc.
- International and national conferences/ workshops are organized more frequently with increased intensity.
- Whereever applicable, the faculty members should try to get their work pateneted over the next 5 years
- Teachers within 1 year of their recruitement may be provided some seed money for research (upto Rs 2.0 lacs). This will facilitate the incumbent to intitiate research until the submission of a major research project and its approval by the funding agency.

15. Supplementary Agenda II: The faculty prepared and approved a development roadmap for the faculty as under:

- Launching of New Teaching Programmes like M.Tech. (Biotyechnology), M.Tech. (Bioinformatics), M.Pharm (Pharmaceutics), B.Tech. (Avionics), Master in Environmental Engineering, Master in Water Resources, Mater in Urban and Regional Planning etc.
- The individual departments may try to attract funding through various central funding agencies, viz. DST-FIST etc. to further upgratde teaching and research infrastructure.
- The individual departments should develop a Institution-Industry Interaction cell for long term productive interaction with industries.
- Workshops for teachers focused on teaching-learning methods be organized.
- Faculty should compulsuroly attened atleast one seminar/ symposium/ conference/ worshop in one academic session,
- Special leave should be considered to enable the faculty to avail specialized short term research programs/ fellowships (up to 6 months) in India and abroad.

16. The faculty endorsed the views of Hon. Vice Chancellor regarding the draft proposal of the revised Assessment Indicators of NAAC and strongly recommended that these should be considered and adopted by NAAC. The faculty further extensively discussed various assessment indicators as per the NAAC's proposal and noted that several of these indicators are already in practice and rest could be adopted within the broad framework of Vidyapith's educational ideology.

17. The faculty considered the policy to implement the recommendation of the Academic Council made at its meeting held on 19th February, 2012 regarding scholarship to the full-time research scholars and approved a scholarship of Rs 8000/- per month (with no teaching load) for the first year; Rs 11,000/- per month (with 6 hr teaching load) for second year; Rs 13,000/- per month (with 8 hr teaching load) for the subsequent years. The Departments would prepare the list of eligible full time research scholars under the new fee structure.

Annexure - II

BANASTHALI VIDYAPITH

SCHEME OF EXAMINATION
AND
COURSES OF STUDY

Bachelor of Science (B. Sc.)

First Year

First semester examination, December-2012

Second semester examination, April/May-2013

BANASTHALI VIDYAPITH

P. O. BANASTHALI VIDYAPITH

(Rajasthan)-304022

July, 2012

No. F. 9-6/81-U.3

Government of India

Ministry of Education and Culture

(Department of Education)

BANASTHALI VIDYAPITH

SCHEME OF EXAMINATION
AND
COURSES OF STUDY

Bachelor of Science (B. Sc.)

Second Year

Third semester examination, December-2013

Fourth semester examination, April/May-2014

BANASTHALI VIDYAPITH

P. O. BANASTHALI VIDYAPITH

(Rajasthan)-304022

July, 2013

No. F. 9-6/81-U.3

Government of India

Ministry of Education and Culture

(Department of Education)

BANASTHALI VIDYAPITH

SCHEME OF EXAMINATION
AND
COURSES OF STUDY

Bachelor of Science (B. Sc.)

Third Year

Fifth semester examination, December-2014

Six semester examination, April/May-2015

BANASTHALI VIDYAPITH

P. O. BANASTHALI VIDYAPITH

(Rajasthan)-304022

July, 2014

No. F. 9-6/81-U.3

Government of India

Ministry of Education and Culture

(Department of Education)

New Delhi, the 25th October, 1983

N O T I F I C A T I O N

In exercise of the powers conferred by Section 3 of the University Grants Commission Act, 1956 (3 of 1956) the Central Government, on the advice of the Commission, hereby declare that Banasthali Vidyapith, P. O. Banasthali Vidyapith, (Rajasthan) shall be deemed to be a University for the purpose of the aforesaid Act.

Sd/-

(M. R. Kolhatkar)

Joint Secretary to the Government of India

N O T I C E

Changes in Bye-laws/Syllabi and Books may from time to time be made by amendment or remaking, and a Candidate shall, except in so far as the Vidyapith determines otherwise, comply with any change that applies to years she has not completed at the time of change.

Disciplinary Courses: [July-December]

Course No	Name of Paper	Contact hrs/week	Duration of Exam. (Hrs)	Max Marks	Cont. Ass. Marks	Ann. Ass. Marks	Min. Pass marks
1.1	Elementary Physical and Structural Geology	6	3	90	30	60	32
1.2	Practical	4	3*	30	10	20	11
2.1	Elements of mineralogy, economic geology and geochemistry	6	3	90	30	60	32
2.2	Practical	4	3*	30	10	20	11
3.1	Petrology and Crystallography	6	3	90	30	60	32
3.2	Practical	4	3*	30	10	20	11
4.1	Paleontology and Stratigraphy	6	3	90	30	60	32
4.2	Practical	4	3*	30	10	20	11
5.1	Hydrogeology, Environmental and Engineering Geology	6	3	90	30	60	32
5.2	Practical	4	3*	30	10	20	11
6.1	Photo-geology, Remote Sensing and Geology of India	6	3	90	30	60	32
6.2	Practical	4	3*	30	10	20	11

*Subject to change according to Viva-Voce **TOTAL: 720**

Students have to choose any one from the following four options

SEMESTER-V

Options	Course	Con.hrs/ week		Cont. Assess. Marks		Sem. Exam Marks		Total	
		Th	Pr	Th.	Pr	Th.	Pr		
(i)	Entrepreneurship & Motivation		2	-	10	-	20	-	30
(ii)	Library Science I	1	2	5	5	10	10	30	
(iii)	Basic Dress Making Skills	-	4	-	10	-	20	30	
(iv)	Computer Fundamentals	1	2	5	5	10	10	30	

SEMESTER-VI

Options	Course	Con.hrs/ week		Cont. Assess. Marks		Sem. Exam Marks		Total
		Th	Pr	Th.	Pr	Th.	Pr	
(i)	Dynamics of Entrepreneurship	2	-	10	-	20	-	30
(ii)	Library Science II	1	2	5	5	10	10	30
(iii)	Dress Designing	-	4	-	10	-	20	30
(iv)	Computer Programming	1	2	5	5	10	10	30

Activities under five fold education :

(Intellectual, Physical, Aesthetic, Moral & Practical)

A student must take part in at least one of the activity in each semester from the activities listed under five fold education choosing at least one activity from each group during the course of entire UG Programmes.

Group - 1 - Fine Arts

Classical Dance (Kathak/Manipuri), Folk Dance, Orchestra, Music (Instrumental/Vocal), Theatre, Creative Arts

Group - 2 - Physical Education & Sports

Athletics (Track & Field), Sports & Games (Hockey, Volley Ball, Tennis, Cricket, Kho-Kho, Kabbaddi, Handball, Throw Ball, Basket Ball, Net Ball, Soft Ball, Weight Training, Martial Art, Judo Karate, Badminton, Table Tennis, Rifle Shooting, Archery Range) Horse Riding,- Equestrian, Swimming, Flying, Yog, Aerobics, Gymnastics

Group - 3 - Social Service & Extension Activities

National Service Scheme (NSS), Banasthali Sewa Dal (BSD), FM Radio (Editing, Anchoring, Program Design), Informal Education, Extension Programs for Women Empowerment

BANASTHALI VIDYAPITH

DEPARTMENT OF GEOLOGY

B.Sc. GEOLOGY SYLLABUS, SEMESTER SYSTEM proposed w.e.f. 2012-13

B.Sc. Geology shall be imparted to students for three academic sessions consisting of six semesters as given below. Candidates will be examined and evaluated on marks basis at the end of each semester in the different courses of theory and practical as per marks given against each course. The B.Sc. Geology will consist of (a) Core Courses and (b) Geological Field Training.

a) The Core courses will be compulsory for all the admitted students. There will be fourteen core courses grouped into six papers, each of 90 marks (60 marks for theory and 30 marks for practical) covering major branches of Geology.

b) The compulsory geological field training includes a few days field work at the end of Semesters – II, IV and V. The field training will be conducted by faculty members. The semester breaks can also be utilized for the geological field training.

SEMESTER – I

Paper - 1.1: Elementary Physical and Structural Geology

Physical geology

Unit-1

Introduction to geology, scope, sub disciplines and relationship with other branches of science; Earth in the solar system, origin, size, shape, mass, density, rotational and evolutional parameters.

Internal constitution of the earth, core, mantle and crust; Convections in the earth's core and production of magnetic field; Composition of earth in comparison to other bodies in the solar system; Origin of hydrosphere and atmosphere, biosphere; Origin of oceans, continents and mountains; Age of the earth; Radioactivity and its application in determining the age of the earth; Rocks, minerals and fossils.

Unit-2

Earthquakes - causes, geological effects and their measurement, distribution of earthquake belts; Volcanoes - types, causes and geological effects, distribution of volcanic belts; Relationship of earthquakes with volcanic belts.

Unit-3

Weathering and erosion; erosion agents- wind, rivers, glaciers, oceanic current and evolution of related land forms; Soil, soil formation, soil profile and soil type; Geological time scale; Major events in the earth's history.

Structural Geology

Unit-4

Topography and its representation; Dip and strike; Outcrop, effects of topography on outcrop; Forms of igneous rocks; Folds; parts of fold, nomenclature and description of folds and causes of folding; mechanics of folding; superpose folding; simple fold interference pattern.

Unit-5

Faults and fractures - parts of faults, types of faults and causes of faulting; Joints- their geometric classification; Unconformity, its kinds and significance; Overlap; Outlier and inlier; ductile shear zone.

Paper 1.2: Practical - I

1. Reading topographical maps of the Survey of India
2. Determination of Map Scale
3. Study of clinometer compass
4. Study of important geomorphological models
5. Exercises on structural problems;
6. Completion of outcrops
7. Drawing and interpretation of sections across elementary representative geological structures.

Books Recommended:

1. Billings, M.P. (1972): Structural Geology, Prentice Hall.
2. Dennis, J.G. (1972): Structural Geology, Ronald Press Company, NewYork.
3. Hills, E.S. (1963): Elements of Structural Geology, Farrold and Sons, London.
4. Holmes, Arthur (1992): Principles of Physical Geology, Vol. 1, Chapman and Hall, London.
5. Leet, L.D. and Judson, S. (1969): Physical Geology, Prentice Hall.
6. Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology, Vol. III, Academic Press.

7. Ruhe, R.V. (1975): Geomorphology, Houghton Miffin Co., Boston.
8. Singh, R. P. (1995): Structural Geology, A Practical Approach, Ganga Kaveri Publ., Varanasi.
9. Sparks (1960): Geomorphology, Longmans, London.
10. Singh, Savinder () Physical Geomorphology.

SEMESTER – II

Paper - 2.1: Elements of mineralogy, economic geology and geochemistry

Mineralogy

Unit-1

Minerals, definition and classification; relation of magma to mineral deposits, ore genesis; Processes of mineral formation- magmatic concentration, sublimation, post-magmatic, pegmatite, weathering, sedimentary and metamorphic; Common physical properties of minerals - form and shape, colour, streak, luster, cleavage, fracture, hardness, tenacity, transparency, specific gravity, magnetic nature.

Unit-2

Polarizing microscope, its parts and functioning; Nicol Prism and its construction; Optically isotropic and anisotropic substances; Ordinary and polarized lights; Common optical properties observed under ordinary and polarized lights and crossed nicols; Optical properties of some common rock forming minerals -quartz, orthoclase, microcline, plagioclase, garnet, biotite, muscovite, augite, hypersthene, hornblende, olivine and calcite.

Unit-3

Chemical composition and diagnostic physical properties of rock forming minerals- quartz, orthoclase, microcline, albite, labradorite, nepheline, muscovite, biotite, augite, hypersthene, tremolite, hornblende, olivine, serpentine, talc, chlorite, apatite, calcite, dolomite, garnet, kyanite, sillimanite, andalusite, staurolite, topaz, tourmaline, corundum, gypsum, graphite and kaolinite.

Economic geology

Unit-4

Definition of ore, Classification of ore deposits, mode of occurrence, association, uses and Indian occurrences of metallic (iron, manganese, Chromium nickel, copper, zinc, lead, aluminum, tin, tungsten, titanium, gold, silver) and nonmetallic (Mica, Asbestos, barites, graphite, Gypsum) minerals. Minerals used in ceramics, abrasives, glass, fertilizers, cements, paints and pigments industries. Elementary idea regarding origin, uses and distribution of coal and petroleum in India.

Geochemistry

Unit-5

Geochemical classification of elements, radioactive decay scheme of U-Pb, Rb-Sr, K-Ar, Sm- Nb; laws of thermodynamics, concept of geochemical cycles, principles of ionic substitutions in minerals s, composition of earth.

Paper 2.2: Practical - II

1. Study of physical properties of minerals mentioned in theory course
2. Use of polarizing microscope
3. Study of optical properties of important rock forming minerals.
4. Study of ore and economic minerals in hand specimens as detailed in the theory syllabus
5. Preparation of maps showing distribution of important metallic and non-metallic deposits
6. Identification of different types of coal

Books Recommended:

1. Berry, L.G., Mason, B. and Dietrich, R.V. (1982): Mineralogy, CBS Publ..
2. Dana, E.S. and Ford, W.E.(2002): A textbook of Mineralogy (Reprints).
3. Nesse, D.W. (1986): Optical Mineralogy, McGraw Hill.
4. Read, H.H. (1968): Rutley's Element of Mineralogy (Rev. Ed.), Thomas Murby and Co.
5. Krauskopf E.B. Introduction to geochemistry Mc. Graw Hill, 1967.
6. Bat eman A.M. Economic Minerals Deposit, Willy, 1962

SEMESTER – III

Paper – 3.1: Petrology and crystallography

Petrology

Unit-1: Igneous Petrology

Magma and its composition; Phase rule application to H_2O system; Common textures; Magmatic differentiation and assimilation; Introduction to mineralogical classification; Brief petrographic description of common igneous rocks (granite, diorite, syenite, gabbro, dolerite, basalt, rhyolite, trachyte, pyroxenite and peridotite)

Unit-2: Sedimentary Petrology

Weathering and denudation of supra-crustal rocks; Origin of clastic and nonclastic sediments and genesis of sedimentary rocks; Primary sedimentary structures; Elementary idea about texture and mineral composition of clastic and nonclastic sedimentary rocks; General classification of sedimentary rocks; Descriptive petrography of fundamental rock types such as - conglomerate, breccia, sandstone, limestone and shale.

Unit-3: Metamorphic Petrology

Definition, types and agents of metamorphism; Classification of metamorphic rocks; Metamorphic textures and structures; Metamorphic zones and isograds; Progressive, regional and thermal metamorphism of pelitic, calcareous and basic igneous rocks; Common metamorphic rocks and their protoliths as given below:

slate, phyllite, schist, gneiss, hornfels, marble, quartzite.

Crystallography

Unit-4

Properties of light-plane and polarized light, Crystallography-Crystalline state, repetition theory; translation periodicity of crystal, Basic rotational symmetry in different direction of crystals; symmetrical plane and symmetrical space lattices; Crystal projection – stereographic.

Unit-5

Elementary idea of crystal structure; Parts of crystal - face, edge, apex, solid angle and interfacial angle; Crystallographic axes and angles; Parameters and indices; Common crystal forms - dome, prism, pyramid and pinacoid; Elements of crystal symmetry; Introduction to different crystals systems.

Paper 3.2: Practical - III

1. Megascopic and microscopic study of the following rock types: (granite, gabbro, , rhyolite, basalt, sandstone, limestone, conglomerate, , gneiss, schist, quartzite)

2. Study of elements of symmetry of representative crystals

3. Study of physical properties of minerals in hand specimen.

Books Recommended:

1. Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman and Co., NewYork.
2. Brown, C. and Dey, A.K. (1955): Indian Mineral Wealth, Oxford Univ.
3. Ehlers, E.G. & Blatt, H (1982): Igneous, Sedimentary and Metamorphic Petrology, CBS Publ.
4. Huang: (1962): Petrology, McGraw Hill Book Co.
5. Jense, M.L., Bateman, and A.M. (1981): Economic Mineral Deposits, John Wiley and Sons.
6. Krishnaswamy, S. (1979): India's Minerals Resources, Oxford and IBH Publ.
7. Sharma, N.L. and Ram, K.V.S. (1972): Introduction to India's Economic Minerals, Dhanbad Publ.
8. Phillips, F.C (1971): Introduction to Crystallography, Longman Group Publ.

Reference Book

1. Nockold, Knox and Chinner (1978): Petrology for students, Cambridge Univ. Press.
2. Winkler, H. G.F. (1967): Petrogenesis of Metamorphic Rocks, Springer-Verlag.
3. Best, Myron G.(2002): Igneous and Metamorphic Petrology, Blackwell Science.

SEMESTER – IV

Paper – 4.1: Paleontology and stratigraphy

Paleontology

Unit-1

Paleontology, definition, subdivisions and scope, its relationship with other sub-disciplines of geology; History of development in paleontology; Fossils, definition, characters, kinds (body and trace fossils); Conditions of fossilization; Incompleteness of fossils record; Elementary ideas about origin of life; their adaptation to various kinds of environments; Bathymetric distribution of organisms.

Unit-2

Systematic classification of organisms; Elementary knowledge about the chief characteristics of the following phyla - Arthropoda, Hemichordata, Brachiopoda, Mollusca, Echinodermata, Cnidaria and Bryozoa; A detailed study of the morphology and geological distribution of the following classes/orders - Trilobita, Graptoloidea, Anthozoa and Echinoidea.

Unit-3

Application of paleontological data in palaeo ecology, evolution, stratigraphy, palaeo oceanography and palaeo geographic reconstructions; invertebrate paleontology, vertebrate paleontology, palaeo botany, micropaleontology.

Stratigraphy

Unit-4

Stratigraphy: Definition, its scope and relationships with other subdisciplines of geology; History of advancement in stratigraphy; Principles of stratigraphy; Geological time scale; Elements of stratigraphic classification; Rock units, time units and time rock units; Physical and structural subdivisions of India and their characteristics; Brief elementary account of important Indian Paleozoic, Mesozoic and Tertiary stratigraphic horizons.

Unit-5

Study of the following supergroups of Indian Precambrian rocks with special reference to classification, lithology and economic significance - Dharwar of Karnataka, Mahakoshal (Bijawars) of Central India, Cuddapah of Andhra Pradesh and Vindhyan of Son valley.

Paper - 4.2: Practical - IV

1. Study of morphological characters of different genera pertaining to Trilobita, Graptoloidea, Echinoidea and Anthozoa.
2. Preparation of lithostratigraphic maps of India showing distribution of the following:

   Dharwar Supergroup, Aravali super group, DelhiSupergroup, Cuddapah Supergroup and Vindhyan Supergroup.
3. Study of important rock types of the above mentioned stratigraphic units
4. Preparation of physiographic map of India showing important features.

Books Recommended:

1. Krishnan, M.S. (1968): Geology of India and Burma, Higgibothon, Madras.
2. Wadia, D.N. (1966): Geology of India, English language Publ.
3. Kumar, R. (1985): Historical Geology and Stratigraphy of India, Wiley Eastern Ltd.
4. Woods, H. (1985): Palaeontology Invertebrate, CBS Publ.
5. Moore, R.C., Lalicker, C.G. and Fischer, A.G.(1997): Invertebrate Fossils, CBS Publ.
6. Jain, P.C. and Anantharaman, M.S. (1983): Palaeontology: Evolution and Animal Distribution, Vishal Publ.

7. Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill.
8. Weller, J.M. (1960): Stratigraphic Principles and Practices, Universal Book.

Reference Book

1. Black, R.M. (1988): The Elements of Palaeontology, Cambridge Univ.
2. Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.
3. Shrock, R.R. and Twenhoffel,W.H. (1952): Principles of Invertebrate Paleontology, CBS Publ.
4. Nield, E.W. and Tucker, V.C.T. (1985): Palaeontology: An Introduction, Pergmon Press.

SEMESTER – V

Paper – 5.1: Hydrogeology, environmental and engineering geology

Hydrogeology

Unit-1

Definition of hydrogeology, geohydrology and hydrology; Hydrological cycle and groundwater in the hydrological cycle; Hydrological parameters - Precipitation, evaporation, transpiration and infiltration;

Unit-2

Theory of ground water flow, Darcy's law and its validity, surface and sub-surface explorations of ground water, Ground water level fluctuation, Physical & chemical properties of Ground water. Water quality - dissolved constituent of groundwater, salinization of groundwater.

Unit-3

Origin and age of groundwater; Vertical distribution of groundwater; Types of aquifers; Water bearing properties of rocks - Porosity and Permeability; Retention of water in rocks and yield of water from rocks; Different types of springs and their formations; elementary well hydraulic Groundwater provinces of India.

Environmental geology

Unit-4

Definition and dimensions of environment; General idea about components and composition of different environmental domains such as atmosphere, hydrosphere and biosphere; Types of environmental pollution; Introduction to weather and climate; Introduction to paleoclimate; Concept and origin of monsoon; Elements of natural hazards.

Engineering geology

Unit -5

Elementary concept of rock mechanics and rock engineering, soil mechanics, site investigation, characterization and problem related to civil engineering project: Foundation treatment, geological and geotechnical investigation for Dams, reservoirs and spillways, tunnels, bridges, Construction materials. Geological hazard- their causes and preventive measures (landslides and earthquakes).

Paper 5.2: Practical - V

1. Groundwater provinces of India
2. Major hydro-geochemical provinces of India
3. Preparation of water table contour map and their interpretation
4. Determination of permeability by falling and constant head method
5. Graphical presentation of water quality data
6. Preparation of seismic and flood zonation maps of India.
7. Exercises on ore reserve calculation; Delineation of ore body on the basis of geological data
8. Preparation of graphs using spread-sheet and electronic presentation.

Books Recommended:

1. Raghunath, H. M. (1990): Groundwater, Wiley Eastern Ltd.
2. Todd, D. K. (1995): Groundwater hydrology, John Wiley and Sons.
3. Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press.
4. Chaussier, Jean-Bernard and Morer, J. (1987): Mineral Prospecting Manual. North Oxford Academic.
5. Davies, S. N. and De Wiest, R. J. N. (1966): Hydrogeology, John Wiley and Sons.
6. Karanth, K. R. (1989): Hydrogeology, Tata McGraw Hill Publ.
7. Keller, E.A. (1978): Environmental Geology, Bell and Howell, USA.
8. Lal, D. S. (2007): Climatology, Sharda Pustak Bhawan, Allahabad.
9. Nagabhushaniah, H. S. (2001): Groundwater in Hydrosphere, CBS Publ.
10. Rajendran S. et al (2007) : Mineral Exploration : Recent Strategies.
11. Tolman, C. F. (1937): Groundwater, McGraw Hill Book Co.
12. Valdiya, K.S. (1987): Environmental Geology – Indian Context, Tata McGraw Hill.

13. Johnson, R.B. and DeGraft, J.V., 1988. Principle of engineering geology, John Wiley.

Reference Book

1. Arogyaswamy, R.N.P. (1973): Courses in Mining Geology, Oxford and IBH Publ.
2. Telford, W.M., Geldart, L.P, Sheriff, R.E. and Keys, D.A. (1990): Applied Geophysics, Cambridge Univ. Press.
3. Dobrin, M. B., and Savit, C. H., (1988): Introduction to Geophysical Prospecting, McGraw-Hill Book Co.

SEMESTER – VI

Paper – 6.1: Photo-geology, Remote Sensing and Geology of India

Photo-geology and Remote Sensing

Unit-1

Introduction to aerial photography, types of aerial photos, types of camera, films and filters, multispectral photography, flight plan - location/area, purpose time and season of photography. Introduction to overlap, side lap, drift, crab, fiducial marks.

Unit-2

Geometric principles of photographs-relief and tilt displacement, vertical exaggeration and distortion, taking measurement from aerial photographs: scale, distance, area and height. Elements of interpretation of aerial photograph. Back-ground knowledge, Preparation of photo geological map, mosaic controlling factor of aerial photograph, scale, application of photo geology and remote sensing in the study of geomorphology, lithology and structural features and hydrogeology studies.

Unit-3

Types of electromagnetic radiation (EMR) energy used in remote sensing, energy interaction with earth surface and atmosphere, sensor platform, (active and passive sensors imaging. Multi-specral scanners, NIR, thermal infra-red line scanners, radar imagery, microwave, SLAR, SAR,),spectral response pattern of minerals , rocks and water, introduction to image processing continuous image processing, discrete image processing system.

Geology of India

Unit-4

Physical and tectonic subdivisions of India sub-continent, distribution of stratigraphy unit, lithological characteristic of India, Precambrian basement rock in Dharwar, Aravali , baster and Singh Bhoom province. Protozoic basin:Vindyan ,Kuddapa,Kurnool,Bhima.

Unit-5

Stratigraphic boundary of Indian geology and its problem: Precambrian- Cambrian boundary; Permiam-Triasic boundry; Cretacoius-Tertiary boundary. Basic idea of Paleo geographic reconstruction, position of Indian subcontinent in different geological period and the paleoclaimatic event. Glacial event in the earth history, sea level changes in quatenary period and its significance s in Indian sub-continent.

Paper 6.2: Practical - VI

1. Elementary study of aerial photographs.
2. Visual interpretation of aerial photograph
3. Stereo-pair interpretation and depth perception
4. Visual interpretation of standard FCC data
5. Identification of drainage pattern, rock types, geology and geomorphology.
6. Study of geological map of India and major stratigraphic units
7. Identification and delineation of lithotechtonic unit in India

Books Recommended:

1. Sabins Principles of Remote Sensing.
2. Pandey SN 2001: principle and applications of photogeology
3. Patel AN surrender Singh: principle of remote sensing. Scientific publishers.
4. Ravindra Kumar, 1985,fundamental of historical geology and stratigraphy of India, Wiley Eastern ltd, Delhi

5. Valdiya, K. S. Tectonics of IndiaWadia,
6. D.N. 1957. Geology of India 3rd Mc. Millan London.

Verified

Offg. Secretary
Banasthali Vidyapith
P.O. Banasthali Vidyapith
Distt. Tonk (Raj.)-304022

MINUTES OF THE MEETING OF BOARD OF STUDIES IN SCHOOL OF EARTH SCIENCES HELD ON 29th DECEMBER, 2018 AT 3.00 P.M. IN THE CONFERENCE ROOM, BHU MANDIR, BANASTHALI VIDYAPITH, RAJASTHAN.

PRESENT

1. Mr. Amit Kumar Mishra	-	Internal Member
2. Dr. Anju Patel	-	Internal Member
3. Mrs. ArpanaChaudhary	-	Internal Member
4. Ms. ArushiRana	-	Internal Member
5. Dr. Ashima Sharma	-	Internal Member
6. Dr. Ashutosh	-	Internal Member
7. Dr. Ashutosh Kumar Pandey	-	Internal Member
8. Ms. ChetnaSoni	-	Internal Member
9. Dr. Chilka Sharma	-	Internal Member
10. Dr. Kartar Singh	-	Internal Member
11. Dr. Kh. Moirangleima	-	Internal Member
12. Dr. MamtaChauhan	-	Internal Member
13. Dr. Ng. Mamata Devi	-	Internal Member
14. Mrs. PradeepikaKaushik	-	Internal Member
15. Dr. Rashmi Sharma	-	Convener
16. Dr. Resmi M.R.	-	Internal Member
17. Dr. SalahuddinMohd.	-	Internal Member
18. Dr. Sarika Singh	-	Internal Member
19. Dr. Subhashree Mishra	-	Internal Member
20. Dr. Vipin Kumar	-	Internal Member
21. Mr. Vivek Deep	-	Internal Member
22. Ms. NishaChoudhary	-	Special Invitee
23. Ms. Rinku Singh	-	Special Invitee
24. Prof. H.S.Sharma	-	External Member
25. Prof. M.G. Thakkar	-	External Member
26. Prof.P.K. Joshi	-	External Member

Note: Prof. H.S.Sharma, Prof. P.K. Joshi, Prof. M.G. Thakkar, Dr. Ng. Mamata Devi and Mrs. PradeepikaKaushik could not attend the meeting.

The meeting started with a welcome of the members by the convener of Board of Studies for School of Earth Sciences, Dr. Rashmi Sharma, Dean, School of Earth Sciences, Banasthali Vidyapith, Rajasthan.

1. The board took up the minutes of its last meeting held on April, 24, 2016.

The Board resolved that the minutes to be confirmed.

2. The board reviewed the existing panel of examiners and suggested to update the address and phone numbers of the existing examiners for each examination of Geography, Geology, Remote Sensing, Environmental Science and Environment Studies of UG, PG,

and M.Phil. examination keeping in view the by-law 15.03.02 of the Vidyapith. Updated panel is sent to the examination and secrecy section.

3. The board reviewed the Study/Curricula, scheme of examination and proposed revisions in various courses of study as follows:

B.A./B.Sc.

i.	First Semester	Minor change[a]
ii.	Second Semester	Minor change[b]
iii.	Third Semester	Minor change[c]
iv.	Fourth Semester	Minor change[d]
v.	Fifth Semester	Major change[e]
vi.	Sixth Semester	Majorchange[f]

The Board reviewed the objectives, syllabi, learning outcomes of the B.A./B.Sc. (Geography).

(a) In B.A./B.Sc. (Geography) I Semester, revision in the syllabus of *Fundamentals of Cartography Lab* (Course Code: GEOG 101L) was proposed. Board discussed the revision proposed and agreed upon the suggested syllabus. Board also recommended implementing the proposed revision in syllabus of *Fundamentals of Cartography lab*Semester Examination, December, 2019.

(b) In B.A./B.Sc. (Geography) II Semester, revision in the syllabus of *Statistical Techniques and Data Representation lab* (Course Code: GEOG 104L) &*Human Geography* (Course Code: GEOG 102) were proposed. Board discussed the revision proposed and agreed upon the suggested syllabus. Board also recommended implementing the proposed revision in syllabi of *Statistical Techniques and Data Representation lab*, *Human Geography*Semester Examination,April/May, 2020.

(c) In B.A./B.Sc. (Geography) III Semester, revision in the syllabus of *Introduction to Geography of India*(Course Code: GEOG 202) was proposed. Board discussed the revision proposed and agreed upon the suggested syllabus. Board also recommended implementing the proposed revision in syllabus of *Introduction to Geography of India*Semester Examination, December, 2020.

(d) In B.A./B.Sc. (Geography) IV Semester, revision in the syllabus of *Relief Representation and Topographical Maps lab* (Course Code: GEOG 204L) &*Economic Geography* (Course Code: GEOG 201) were proposed. Board discussed the revision proposed and agreed upon the suggested syllabus. Board also recommended implementing the proposed revision in syllabi of *Relief Representation and Topographical Maps lab*, *EconomicGeography* Semester Examination,April/May, 2021.

(e) In B.A./B.Sc. (Geography) V Semester, revision in the syllabus of *Map Projection lab* (Course Code: 5.2) was proposed. Board discussed the revision proposed and agreed upon the suggested syllabus. Board also recommended implementing the proposed revision in syllabus of *Map Projection lab* Semester Examination, December, 2021.The Board proposed introduction of pool of Discipline Elective courses and agreed upon it. The courses *Geographical Thought* (Course Code: GEOG 302) and *World Regional Geography* (Course Code: GEOG 304) has been shifted in the pool as courses *Geographical Thought* (Course Code: GEOG_to be generated) and *World Regional Geography* (Course Code: GEOG_to be generated) of Discipline electives and another two new courses has also been added.

(f) In B.A./B.Sc. (Geography) VI Semester, revision in the syllabus of *Geographical Thought* (Course Code: GEOG 6.1) was proposed. Board discussed the revision proposed and agreed upon the suggested syllabus.

The Board proposed introduction of pool of Discipline Electives in Semester V and VI also and agreed upon it.

List of Discipline Electives:
Environment and Disaster Management (Course Code: GEOG_*to be generated*)
Geographical Thought (Course Code: GEOG_*to be generated*)
Settlement Geography (Course Code: GEOG_*to be generated*)
World Regional Geography (Course Code: GEOG_*to be generated*)

Board proposed to introduce Open (Generic) audit/credit Elective and agreed to implement as per Vidyapith policy.

Board also recommended implementing the proposed changes in syllabus from Semester Examination,April/May, 2022.

Board recommended implementation of reviewed Recommended Books and e-learning materials from session 2019-20 in all semesters respectively.

Programme educational objectives, outcomes and the list of courses of the B.A./B.Sc. (Geography) programme is attached and marked as **Annexure –1 (PP. 1-4).**

The revised syllabus, learning outcomes, list of recommended books and e-learning materials of the B.A./B.Sc. (Geography) programme is attached and marked as **Annexure –2 (PP. 1-37).**

I. **B.Sc. (Geology)**:

i.	First Semester	Major change[a]
ii.	Second Semester	Major change[b]
iii.	Third Semester	Major change[c]

iv.	Fourth Semester	Major change[d]
v.	Fifth Semester	Major change[e]
vi.	Sixth Semester	Major change[f]

The Board reviewed the objectives, syllabi, learning outcomes of the **B.Sc. (Geology).**

a) In B.Sc. Geology I Semester, the courses *Physical Geology and Plate Tectonics* (Course Code: GEOL 102) *& Physical Geology and Plate Tectonics Lab* (Course Code: GEOL 102 L) have been proposed to be replaced by new course *Physical Geology* (Course Code: *to be generated*) *containing* both theory and practical. Board discussed the changes proposed and agreed upon suggested changes. Board also recommended implementing the proposed replacement in the syllabus of new course in Semester Examination, December, 2019.

b) In B.Sc. Geology II Semester, the courses *Mineralogy, Crystallography and Economic Geology* (Course Code: GEOL 101) & *Mineralogy, Crystallography and Economic Geology Lab* (Course Code: GEOL 101L) have been proposed to be replaced by new course *Structural Geology and Plate Tectonics* (Course Code: *to be generated*)containing both theory and practical. Board discussed the changes proposed and agreed upon suggested changes. Board also recommended implementing the proposed replacement in the syllabus of new courses inSemester Examination, April/May, 2020.

c) In B.Sc. Geology III Semester, the courses *Petrology and Structural Geology* (Course Code: GEOL 202) &*Petrology and Structural Geology Lab* (Course Code: GEOL 202L) have been proposed to be replaced by new course *Mineralogy, Crystallography and Geochemistry*(Course Code: *to be generated)* containing both theory and practical. Board discussed the changes proposed and agreed upon suggested changes. Board also recommended implementing the proposed replacement in the syllabus of new courses in Semester Examination, December, 2020.

d) In B.Sc. Geology IV Semester, the courses *Palaeontology and Stratigraphy* (Course Code: GEOL 201)&*Palaeontology and Stratigraphy Lab* (Course Code: GEOL 201L)have been proposed to be replaced by new course *Petrology and Economic Geology* (Course Code: *to be generated*)containing both theory and practical. Board discussed the proposed changes and shifting of the courses and agreed upon suggested changes. Board also recommended implementing the proposed changes in the syllabus of new courses inSemester Examination, April/May, 2021.

e) In B.Sc. Geology V Semester, the courses *Geochemistry, Geomorphology, Photogeology and Remote Sensing* (Course Code: 5.1) & *Geochemistry, Geomorphology, Photogeology and Remote Sensing Lab* (Course Code: 5.2) have been proposed to be replaced by newly introduced pool of Discipline Electives containing both theory and practical. Board discussed the changes proposed and agreed upon the suggested changes. Board also

recommended implementing the proposed replacement in the syllabus of new courses in Semester Examination, December, 2021.

f) In B.Sc. Geology VI Semester, the courses *Hydrogeology, Environmental and Engineering Geology* (Course Code: 6.1) &*Hydrogeology, Environmental and Engineering Geology Lab* (Course Code: 6.2) have been replaced by newly introduced pool of Discipline Electives containing both theory and practical. Board discussed the changes proposed and agreed upon suggested changes. Board also recommended implementing the proposed replacement in the syllabus of new courses in Semester Examination, April/May, 2022.

The Board proposed introduction of pool of Discipline Electives containing both theory and respective practicals and agreed upon it.

List of Discipline Electives:

Applied Geology (Course Code: GEOL_*to be generated*)
Field Geology: Tools and Techniques (Course Code: GEOL_*to be generated*)
Geology of Rajasthan (Course Code: GEOL_*to be generated*)
Palaeontology and Stratigraphy (Course Code: GEOL_*to be generated*)

Board proposed to introduce Open (Generic) audit/credit Elective and agreed to implement as per Vidyapith policy.

Board recommended implementation of reviewed Recommended Books and e-learning materials from session 2019-20 in all semesters respectively.

Programme educational objectives, outcomes and the list of courses of the B.Sc. (Geology) programme is attached and marked as **Annexure –3 (PP. 1-5).**

The revised syllabus, learning outcomes, list of recommended books and e-learning materials of the B.Sc. (Geology) programme is attached and marked as **Annexure -4 (PP. 1-55).**

III. M.A./M.Sc. (Geography):

i.	First Semester	Minor Change[a]
ii.	Second Semester	Minor Change[b]
iii.	Third Semester	Major Change[c]
iv.	Fourth Semester	Major Change[d]

The Board reviewed the objectives, syllabi, learning outcomes of the M.A./M.Sc. (Geography).

The Board discussed the recent trends in Geography at postgraduate level and found that the knowledge of computational software is the necessity of today's research environment. In addition to this, board suggested to give more weightage to self-learning and independent research activities.

(a) In M.A./M.Sc. (Geography) I Semester, the board reviewed the syllabi of *Cartographic Techniques Lab* (Course Code: GEOG 402L). It was found that students had already studied the diagrammatic representation of data manually in their graduation. It was suggested to introduce advanced techniques of this diagrammatic representation using Microsoft Excel at post graduate level. Board also recommended implementing the proposed revision in syllabus of *Cartographic Techniques Lab* Semester Examination, December, 2019.

(b) In M.A./M.Sc. (Geography) II Semester, the board reviewed the syllabi of *Geography of India* (Course Code: GEOG 406) & *Oceanography* (Course Code: GEOG 409) and recommended to add some topics for enrichment and specification. Board also recommended implementing the proposed revision in syllabi of *Geography of India* and *Oceanography* Semester Examination, April/May, 2020.

(c) In M.A./M.Sc. (Geography) III Semester, the board reviewed the syllabi of *Political Geography* (Course Code: GEOG 504), *Research Methodology and Quantitative Techniques* (Course Code: GEOG 507), *Systematic Agricultural Geography* (Course Code: GEOG 510) and *Surveying Lab* (Course Code: GEOG 509L) and recommended to add some topics for enrichment and specification. Board also recommended implementing the proposed revision in syllabi of *Political Geography*, *Research Methodology and Quantitative Techniques*, *Systematic Agricultural Geography* and *Surveying Lab* Semester Examination, December, 2020.

The Board proposed introduction of pool of Discipline Electives and courses of Elective I *Population Geography* (Course Code: GEOG 505) and *Social Geography* (Course Code: GEOG 508) to be shifted in pool of Discipline Electives and agreed upon it.

Board recommended the introduction of Reading Elective I which has to be opted from common pool of Reading Electives in PG courses of School of Earth Sciences (Environmental Science, Geology & Geography).

The Board also recommended implementing the Reading Elective by III Semester Examination, December, 2020.

(d) In M.A./M.Sc. (Geography) IV Semester, the board reviewed the syllabi of *Environmental Geography* (Course Code: GEOG 501), *Remote Sensing and GIS* (Course Code: GEOG 506), *Remote Sensing and GIS Lab* (Course Code: GEOG 506 L), *Geography of Rural Settlements* (Course Code: GEOG 502) and *Urban Geography* (Course Code: GEOG 512) and recommended to add some topics for enrichment and specification. Board also recommended implementing the proposed revision in syllabi of *Environmental Geography*, Remote *Sensing and GIS*, *Remote Sensing and GIS Lab*, *Geography of Rural Settlements* and *Urban Geography* Semester Examination, April/May, 2021.

The Board proposed introduction of pool of Discipline Electives and courses of Elective II *Geography of Rural Settlements*(Course Code: GEOG 502)and *Tourism Geography*(Course Code: GEOG 511) and courses of Elective III *Medical Geography*(Course Code: GEOG 503) and *Urban Geography*(Course Code: GEOG 512) to be shifted in pool of Discipline Electives and agreed upon it.

List of Discipline Electives:

- *Geography of Rural Settlements* (Course Code: GEOG 502)
- *Medical Geography* (Course Code: GEOG 503)
- *Population Geography* (Course Code: GEOG 505)
- *Social Geography* (Course Code: GEOG 508)
- *Tourism Geography* (Course Code: GEOG 511)
- *Urban Geography* (Course Code: GEOG 512)

Board recommended the introduction of Reading Elective II which has to be opted from common pool of Reading Electives in PG courses of School of Earth Sciences (Environmental Science, Geology & Geography).

The Board has proposed the following List of Reading Electives in the curricula:

- *Agroforestry* (Course Code :ENVS_R *to be generated*)
- *Energy Resources and Conservation* (Course Code: ENVS_R *to be generated*)
- *Man and Environment* (Course Code :ENVS_R *to be generated*)
- *Water and Sustainable Development* (Course Code : ENVS_R *to be generated*)
- *Environmental Challenges and Disaster Management* (Course Code :GEOG_R *to be generated*)
- *India: Socio-Political and Environmental Scenario* (Course Code: GEOG_R *to be generated*)
- *Rajasthan: Challenges and Prospects*(Course Code :GEOG_R *to be generated*)
- *Transforming India* (Course Code: GEOG_R *to be generated*)
- *Geo Tourism* (Course Code: GEOL_R *to be generated*)
- *Indian Mineral Deposits, Economics and Mining Ethics* (Course Code: GEOL_R *to be generated*)
- *Innovation and Entrepreneurship in Earth Sciences* (Course Code: GEOL_R *to be generated*)
- *Natural Hazards and Disasters* (Course Code: GEOL_R *to be generated*)

Board proposed to introduce open elective course in Semester IV.

Board recommended implementation of reviewed recommended books and e-learning materials from session 2019-20 in all semesters respectively.

Programme educational objectives, outcomes and the list of courses of the M.A./M.Sc. (Geography) programme is attached and marked as **Annexure –5 (PP. 1-6).**

The revised syllabus, learning outcomes, list of recommended books and suggested e-learning materials of the M.A./M.Sc. (Geography) programme is attached and marked as **Annexure -6 (PP. 1-80).**

IV. M.Sc. (Geology):

i.	First Semester	Major change[a]
ii.	Second Semester	Major change[b]
iii.	Third Semester	Major change[c]
iv.	Fourth Semester	Major change[d]

The Board reviewed the objectives, syllabi, learning outcomes of the **M.Sc. (Geology)**.

The course scheme has been changed as earlier there were five credits for lectures and in proposed the credits are four. The credits for Lab are remaining same.

a) In M.Sc. Geology I Semester, the course *Fuel Geology* (Course Code: GEOL 401) has been proposed to shift to semester III as a pool of discipline elective course and is replaced by modified course *Geochemistry and Isotope Geology* (Course Code: GEOL__ *to be generated*) from semester III.
Geomorphology (Course Code: GEOL__ *to be generated*) is suggested to introduce in place of *Ore Genesis and Economic Geology* (Course Code: GEOL 409). Earlier it was present in semester IV.
The courses *Geotectonics and Structural Geology* (Course Code: GEOL 405) & *Mineralogy and Analytical Techniques* (Course Code: GEOL 408) were proposed to be retained with modifications in the same semester as *Geotectonics and Structural Geology* (Course Code: GEOL__ *to be generated*) & *Mineralogy and Analytical Techniques* (Course Code:GEOL__ *to be generated*) respectively under revised scheme.
The course *Sedimentary Petrology* (Course Code: GEOL__ *to be generated*) is proposed to introduce as a modified course under revised scheme. Earlier it was in Semester II as *Sedimentary Petrology* (Course Code: GEOL 410).
The course *Geology Lab-I* (Course Code: GEOL 402L) has been suggested to be replaced with the updated course *Geology Lab-I with Field work* (Course Code: GEOL__L *to be generated*). Board discussed all the changes proposed in the new syllabus and agreed with the suggested changes. Board also recommended implementing the proposed changes in the syllabus of new courses in Semester Examination, December, 2019.

b) In M.Sc. Geology II Semester**,** the courses *Geophysics and Exploration Method* (Course Code: GEOL 404), *Igneous Petrology* (Course Code: GEOL 406) & *Metamorphic Petrology* (Course Code: GEOL 407) are proposed to retain in the same semester with minor modifications under revised scheme as *Geophysics and Exploration Method* (Course Code: GEOL__ *to be generated*), *Igneous Petrology* (Course Code:GEOL__ *to be generated*) &*Metamorphic Petrology*(Course Code:GEOL__ *to be generated*).
Sedimentary Petrology (Course Code: GEOL 410) has been proposed to replace by *Ore Genesis and Economic Geology* (Course Code:GEOL__ *to be generated*), earlier was in semester I.
The course *Stratigraphy*(Course Code:GEOL 510) was earlier in semester III, suggested to shift to semester II with minor modifications under revised course scheme as *Stratigraphy*(Course Code:GEOL__ *to be generated*).
The course *Geology Lab-II with Field work* (Course Code: GEOL 403L) has been proposed to replace by new course *Geology Lab-II* (Course Code: GEOL__L *to be generated*).
Board discussed the changes proposed and agreed upon suggested changes. Board also recommended implementing the proposed replacement in the syllabus of new courses in Semester Examination, April/May, 2020.

c) In M.Sc. Geology III Semester,the course *Geochemistry and Isotope Geology* (Course Code: GEOL 504) have been shifted to semester I and replaced by new course *Hydrogeology*(Course Code: GEOL__*to be generated*).
Mining and Engineering Geology(Course Code: GEOL 508) has been shifted to pool of discipline electives under new course scheme with minor modifications as *Mining and Engineering Geology*(Course Code: GEOL__*to be generated*).
Palaeontology (Course Code: GEOL 509) is retained in the same semester under new course scheme with minor modifications *Palaeontology*(Course Code: GEOL__*to be generated*).
Stratigraphy(Course Code: GEOL 510) is replaced by new course *Remote Sensing and GIS in Geology* (Course Code: GEOL__ *to be generated*).
Geology Lab-III with Field work(Course Code: GEOL 505L) is retained as *Geology Lab-III with Field work*(Course Code: GEOL__L *to be generated*) in the same semester with significant modifications.
Board discussed the changes proposed and agreed upon suggested changes. Board also recommended implementing the proposed replacement in the syllabus of new courses in Semester Examination, December, 2020.

Board discussed and recommended to introduce pool of discipline electives in III semester
The complete list of pool of discipline electives is as follows:

- *Environmental Geology* (Course Code: GEOL_ *to be generated)*
- *Fuel Geology* (Course Code: GEOL_ *to be generated)*
- *Marine Geology* (Course Code: GEOL_ *to be generated)*
- *Mining and Engineering Geology* (Course Code: GEOL_ *to be generated)*

Board recommended the introduction of Reading Elective I which has to be opted from common pool of Reading Electives in PG courses of School of Earth Sciences (Environmental Science, Geology & Geography).

The Board also recommended implementing the Reading Elective by III Semester Examination, December, 2020.

Board proposed to introduce open elective course in Semester III.

d) In M.Sc. Geology IV Semester, the courses *Concepts of Remote sensing and GIS* (Course Code: GEOL 501) & *Environmental Geology and Hydrogeology* (Course Code: GEOL 503) have been removed and *Geomorphology* (Course Code: GEOL 507) has been shifted to Semester I under revised course scheme.
   Geology Lab-IV (Course Code: GEOL 506L) has been removed from the semester. *Dissertation* (Course Code: GEOL 502 D) has been retained as Dissertation (Course Code: GEOL_D *to be generated*) and now being introduced for the **entire semester** under revised scheme.
   Board discussed the changes proposed and agreed upon suggested changes. Board also recommended implementing the proposed replacement in the syllabus of new courses in Semester Examination, April/May, 2021.

Board recommended the introduction of Reading Elective II which has to be opted from common pool of Reading Electives in PG courses of School of Earth Sciences (Environmental Science, Geology & Geography).
The Board has proposed the following Reading Electives in the curricula:

- *Agroforestry* (Course Code :ENVS_R *to be generated*)
- *Energy Resources and Conservation* (Course Code: ENVS_R *to be generated*)
- *Man and Environment* (Course Code :ENVS_R *to be generated*)
- *Water and Sustainable Development* (Course Code : ENVS_R *to be generated*)
- *Environmental Challenges and Disaster Management* (Course Code :GEOG_R *to be generated*)
- *India: Socio-Political and Environmental Scenario* (Course Code: GEOG_R *to be generated*)
- *Rajasthan: Challenges and Prospects*(Course Code :GEOG_R *to be generated*)
- *Transforming India* (Course Code: GEOG_R *to be generated*)
- *Geo Tourism* (Course Code: GEOL_R *to be generated*)
- *Indian Mineral Deposits, Economics and Mining Ethics* (Course Code: GEOL_R *to be generated*)
- *Innovation and Entrepreneurship in Earth Sciences* (Course Code: GEOL_R *to be generated*)
- *Natural Hazards and Disasters* (Course Code: GEOL_R *to be generated*)

Board recommended implementation of reviewed recommended books and e-learning materials from session 2019-20 in all semesters respectively.

Programme educational objectives, outcomes and the list of courses of the M.Sc. (Geology) programme is attached and marked as **Annexure –7 (PP. 1-8).**

The revised syllabus, learning outcomes, list of recommended books and suggested e-learning materials of the M.Sc. (Geology) programme is attached and marked as **Annexure - 8 (PP. 1-67).**
Board reviewed the process of Dissertation and recommended formal guidelines for it. The proposed guidelines with evaluation scheme are attached and marked as **Annexure-9 (PP.1).** Board also recommended implementing the proposed guidelines by IV Semester Examination, April/May, 2021.

IV. M.Sc. (Environmental Science)

i.	First Semester	Major Change[a]
ii.	Second Semester	Major Change[b]
iii.	Third Semester	Major Change[c]
iv.	Fourth Semester	Major Change[d]

The Board reviewed the objectives, syllabi, learning outcomes of the M.Sc. (Environmental Science).

The Board discussed the recent trends in Environmental Science at postgraduate level and found that the knowledge of computational software is the necessity of today's research environment. In addition to this, board suggested to give more weightage to self-learning and independent research activities.

(a)In M.Sc. (Environmental Science I Semester), revision in the syllabi of *Ecology and Environment* (Course Code: ENVS 402), *Environmental Chemistry* (Course Code: ENVS 405) and *Environment Lab - I* (Course Code: ENVS 403 L) were proposed. Board discussed the revision proposed and agreed upon the suggested syllabi. Board recommended implementing the proposed revision in the syllabi of *Ecology and Environment*, *Environmental Chemistry* and *Environment Lab - I* by I Semester Examination, December, 2019.

Board agreed to replace the course *Geography of Environment* (Course Code: ENVS 410) by *Climate Change and Environment* (Course Code: ENVS_*to be generated*). Board found that proposed syllabus is more elaborated and well arranged. Board recommended implementing the proposed revision in the syllabus of *Climate change and Environment* by I Semester Examination, December, 2019.

(b) In M.Sc. (Environmental Science II Semester), Board reviewed the syllabi of *Biostatistics and Research Methodology* (Course Code: BIO 406) and *Environmental Biology and Toxicology* (Course Code: BIO 408), discussed and agreed that these course should be

replaced by new courses *Environmental Statistics and Research Methodology* (Course Code:ENVS_*to be generated*) & *Environmental Toxicology* (Course Code:ENVS_*to be generated*) respectively. Board recommended implementing the proposed changes by II Semester Examination, April, 2020.

Board reviewed the revision in the syllabi of *Environmental Legislation* (Course Code: ENVS 406) & *Environment Lab - II* (Course Code: ENVS 404 L) and agreed upon the suggested syllabi. Board recommended implementing the proposed revision in the syllabi of *Environmental Legislation* along with *Environment Lab - II* respectively by II Semester Examination, April, 2020.

Board suggested replacement of *Environmental Physics* (Course Code: ENVS 407) by *Biodiversity & conservation* (Course Code: ENVS 502), which was an elective course of III semester as *Biodiversity & conservation* (Course Code: ENVS_*to be generated*) and Board recommended *Environmental Physics* (Course Code: ENVS_*to be generated*) to be placed in discipline elective pool of III semester. Board discussed the change and agreed upon the suggested syllabus. Board recommended implementing the proposed changes by II Semester Examination, April, 2020.

(c) In M.Sc. (Environmental Science III Semester), Board reviewed the course of *Disaster Management and Mitigation Strategies*(Course Code: ENVS 504) and *Energy Auditing and Conservation*(Course Code: ENVS 505) and suggested that these courses have been replaced by *Air Pollution Monitoring, Control Technology and Management* (Course Code: ENVS 501) & *Water Pollution Monitoring, Control Technology and Management* (Course Code: ENVS 511) as *Air Pollution Monitoring, Control Technology and Management* (Course Code: ENVS_*to be generated*) & *Water Pollution Monitoring, Control Technology and Management* (Course Code: ENVS_*to be generated*), which was part of an elective in III semester. Board suggested inclusion of air and water courses should be part of core subjects of Environmental Science. Board recommended *Disaster Management and Mitigation Strategies* (Course Code: ENVS_*to be generated*) and *Energy Auditing and Conservation* (Course Code: ENVS_*to be generated*) to be placed in discipline elective pool of III semester.

Board reviewed the revision in the syllabi of *Environment Lab -III* (Course Code: ENVS 506L) agreed upon the suggested syllabi.

Board suggested to shift *Biodiversity and Conservation* (Course Code: ENVS 502) from the pool of Elective to core course in Semester II. *Environmental Impact Assessment and Management* (Course Code: ENVS 508) to be shifted as *Environmental Impact Assessment and Management* (Course Code: ENVS_*to be generated*) in the Pool of Discipline Elective Semester III from core course of same semester.

Board recommended implementing the proposed changes by III Semester Examination, December, 2020.

Board discussed and recommended to introduce pool of discipline electives in III semester

The complete list of Discipline Electives is as follows:

- *Biotechnology Application to Environmental Science* (Course Code: ENVS *to be generated*)
- *Disaster Management and Mitigation Strategies* (Course Code: ENVS *to be generated*)
- *Energy Auditing and Conservation* (Course Code: ENVS *to be generated*)
- *Environmental Health Management* (Course Code: ENVS *to be generated*)
- *Environmental Impact Assessment and Management* (Course Code: ENVS *to be generated*)
- *Environmental Physics* (Course Code: ENVS *to be generated*)

Board recommended the introduction of Reading Elective I which has to be opted from common pool of Reading Electives in PG courses of School of Earth Sciences (Environmental Science, Geology & Geography).

Board proposed to introduce open elective course in Semester III.

(d) In M.Sc. (Environmental Science IV Semester), Board discussed and agreed modification in credits of *Project* (Course Code: ENVS 509P) and proposed implementation as *Project* (Course Code: ENVS_P *to be generated*), also proposed the Reading Elective-II in IV semester.

Board recommended the introduction of Reading Elective II which has to be opted from common pool of Reading Electives in PG courses of School of Earth Sciences (Environmental Science, Geology & Geography).

The Board has proposed the following Reading Electives in the curricula:

- *Agroforestry* (Course Code :ENVS_R *to be generated*)
- *Energy Resources and Conservation* (Course Code: ENVS_R *to be generated*)
- *Man and Environment* (Course Code : ENVS_R *to be generated*)
- *Water and Sustainable Development* (Course Code : ENVS_R *to be generated*)
- *Environmental Challenges and Disaster Management* (Course Code :GEOG_R *to be generated*)
- *India: Socio-Political and Environmental Scenario* (Course Code: GEOG_R *to be generated*)
- *Rajasthan: Challenges and Prospects*(Course Code : GEOG_R *to be generated*)
- *Transforming India* (Course Code: GEOG_R *to be generated*)
- *Geo Tourism* (Course Code: GEOL_R *to be generated*)
- *Indian Mineral Deposits, Economics and Mining Ethics* (Course Code: GEOL_R *to be generated*)
- *Innovation and Entrepreneurship in Earth Sciences* (Course Code: GEOL_R *to be generated*)

- *Natural Hazards and Disasters* (Course Code: GEOL_R *to be generated*)

Board recommended implementing the proposed revision in the scheme of *Project* by IV Semester Examination, April, 2021.

Programme educational objectives, outcomes and the list of courses of the M.Sc. (Environmental Science) programme is attached and marked as **Annexure –10 (PP. 1-6).**
Board recommended implementation of reviewed recommended books and e-learning materials from session 2019-20 in all semesters respectively.

The revised syllabus, learning outcomes, list of recommended books and suggested e-learning materials of the M.Sc. (Environmental Science) programme is attached and marked as **Annexure -11 (PP. 1-88).**

Board reviewed the process of *Project* and recommended formal guidelines for it. The proposed guidelines with evaluation scheme is attached and marked as **Annexure-12 (PP. 1).**
Board also recommended implementing the proposed guidelines by IV Semester Examination, April/May, 2021.

V. M. Phil. (Geography):

Board discussed the curriculum structure of M.Phil. (Geography) and proposed further discussion in Faculty meeting. (Annexure I)

Board recommended implementation of reviewed Recommended Books and e-learning materials from session 2019-20 in all semesters respectively.

VI. M.Tech. (Remote Sensing):

i.	First Semester	Major Change[a]
ii.	Second Semester	Major Change[b]
iii.	Third Semester	Major Change[c]
iv.	Fourth Semester	Major Change[d]

Board reviewed the scheme of M.Tech. and recommended to introduce discipline electives and Term paper/Minor project/Seminar in semester I & II with modified credit. Board also recommended introduction of open elective in semester II. Board suggested to replace existing lab with restructured labs.

(a) In M.Tech. (Remote Sensing) I Semester, Board reviewed the syllabi of *Fundamentals of Geographic Information Sciences and Digital Cartography*(Course Code: RS 504), *GIS Programming and Scripting* (Course Code: RS 505), *Microwave, Thermal and Hyperspectral Remote Sensing* (Course Code: RS 506), *Principles of Remote Sensing* (Course Code: RS 508), *Fundamentals of Geographic Information Sciences and Digital Cartography Lab* (Course Code: RS 504L), *GIS Programming and Scripting Lab* (Course Code: RS 505L), and *Microwave, Thermal and Hyperspectral Remote Sensing Lab* (Course Code: RS 506L) and found that few topics need to be reordered, modified and detailed for adequate and systematic approach. It was suggested to introduce recent technologies and essential application following the modified national security policies and advanced data, tools and techniques for underpinning the essential component for further research. It was suggested to introduce discipline elective I and discipline elective II and shift courses *GIS Programming and Scripting* (Course Code: RS__*to be generated*), *Microwave, Thermal and Hyperspectral Remote Sensing*(Course Code: RS__*to be generated*), *Applied Statistics and Research Methodology* (Course Code: RS__*to be generated*) to pool of discipline electives. Introduction of Term paper-I /Minor project-I/Seminar-I was suggested. *Fundamentals of Geographic Information Sciences and Digital Cartography Lab* (Course Code: RS 504L) and *GIS Programming and Scripting Lab* (Course Code: RS 505L) was combined as new Remote Sensing Lab-II (Course Code: RS_L *to be generated*) and *Microwave, Thermal and Hyperspectral Remote Sensing Lab* (Course Code: RS506L) and *Principles of Remote Sensing Lab* (Course Code: RS 508L) was combined as new Remote Sensing Lab-I (Course Code: RS_L *to be generated*). *Applied Statistics and Research Methodology Lab* (Course Code: RS 502L) was proposed to remove. Board proposed and agreed to implement the revision in syllabi and introduction of new components of above mentioned courses by I Semester Examination, December, 2019.

(b) In M.Tech. (Remote Sensing)II Semester,Board reviewed the syllabi of *Applications of Remote Sensing*(Course Code: RS 501), *Digital Image Processing* (Course Code: RS 503), *Photogrammetry, Global Positioning Systems and Mobile Mapping* (Course Code: RS 507), *Spatial Database Systems, Analysis and Modeling* (Course Code: RS 509), *Spatial Decision Supports Systems* (Course Code: RS 510), *Applications of Remote Sensing Lab* (Course Code: RS 501L), *Digital Image Processing Lab* (Course Code: RS 503L) and *Photogrammetry, Global Positioning Systems and Mobile Mapping Lab* (Course Code: RS 507L) and found that few topics need to be reordered, modified and detailed for adequate and systematic approach. It was suggested to introduce recent technologies and essential application following the modified national security policies and advanced data, tools and techniques for underpinning the essential component for further research. It was suggested to introduce discipline elective III and open elective and shift courses *Applications of Remote Sensing* (Course Code: RS__*to be generated*), *Spatial Database Systems, Analysis and Modeling* (Course Code: RS__*to be generated*), *Spatial Decision Supports Systems* (Course Code: RS__*to be generated*) to pool of discipline electives. Introduction of Term paper-II /Minor project-II/Seminar-II was suggested. *Digital Image Processing Lab* (Course Code: RS 503L) and *Applications of Remote Sensing Lab* (Course Code: RS 501L) was combined as new Remote Sensing Lab-III (Course Code: RS_L *to be generated*) and *Photogrammetry, Global Positioning Systems and Mobile Mapping* (Course Code: RS 507) and *Spatial Database Systems, Analysis and Modeling Lab* (Course Code: RS 509L), was combined as new Remote Sensing Lab-IV (Course Code: RS_L *to be generated*). Board proposed and agreed to implement the revision in syllabi and introduction of new components of above mentioned courses by II Semester Examination, April/May, 2020.

List of Discipline Electives:
Applications of Remote Sensing(Course Code: RS_*to be generated*)
Applied Statistics and Research Methodology(Course Code: RS_*to be generated*)
Geospatial Entrepreneurship (Course Code: RS_*to be generated*)
Geospatial Intelligence(Course Code: RS_*to be generated*)
GIS Programming and Scripting(Course Code: RS_*to be generated*)
Microwave, Thermal and Hyperspectral Remote Sensing(Course Code: RS_*to be generated)*
Spatial Database Systems, Analysis and Modeling(Course Code: RS_*to be generated*)
Spatial Decision Supports Systems(Course Code: RS_*to be generated*)

(c) In M.Tech. (Remote Sensing) III Semester, Board reviewed the list of reading electives and found that the course *Geoinformatics in Human Settlement Analysis*(Course Code: RS 601R) should be replaced by *Spatial Planning and Urban Development* (Course Code: RS _ R *to be generated*), the course *Pattern Recognition and Processing* (Course Code: RS 602R) should be replaced by *Geospatial BigData: Challenges and Opportunities* (Course Code: RS _ R *to be generated*) and the course *Remote Sensing in Environment Studies* (Course Code: RS 605R) should be replaced by *Environmental Remote Sensing and Modeling* (Course Code: RS _ R *to be generated*) and shifted to the pool of reading electives. Board also suggested that some more emerging technologies and national programmes should be added. Board proposed and agreed to implement the syllabus by III Semester Examination, December, 2020.

(d) In M.Tech. (Remote Sensing) IV Semester, Board reviewed the list of reading electives and found that the course *Remote Sensing in hydrology and water resources*(Course Code: RS _R*to be generated*), should be modified, as there are significant changes in syllabi and few topics need to be reordered and detailed for adequate and systematic approach. The board also found that the course *Remote Sensing in Resource Management* (Course Code: RS 607R) should be replaced by *Geo-informatics for Resource Management* (Course Code: RS _ R *to be generated*) and the course *Spatial Modeling and Resource Model* (Course Code: RS 608R) should be replaced by *Open Source Software, Services and Utility Application* (Course Code: RS _ R *to be generated*) and shifted to the pool of reading electives. Board also suggested that some more emerging technologies and national programmes should be added. Board proposed and agreed to implement the syllabus byIV Semester Examination, April/May, 2021.

The Board also recommended implementing the reading electives by Session 2020-2021.

Board recommended implementation of reviewed Recommended Books and e-learning materials from session 2019-20 in all semesters respectively.

Programme educational objectives, Programme specific outcomes and the list of courses of the M.Tech. (Remote Sensing) programme is attached and marked as **Annexure –13 (PP. 1-5).**

The revised syllabus, learning outcomes, list of recommended books and e-learning materials of the M.Tech. (Remote Sensing) programme is attached and marked as **Annexure -14 (PP. 1-74).**

In M.Tech. (Remote Sensing) III Semester, Board reviewed the process of *Project* (*Part I)* (Course Code: RS 603P) and recommended formal guidelines for it. The proposed guidelines with evaluation scheme is attached and marked as **Annexure-15 (PP. 1).** Board also recommended implementing the proposed guidelines by III Semester Examination, December, 2020.

In M.Tech. (Remote Sensing) IV Semester, Board suggested that similar guidelines **Annexure-15(PP. 1).**as suggested for *Project* (*Part I)* (Course Code: RS 603P), should be followed for *Project* (*Part II)* (Course Code: RS 604P). Board also recommended implementing the proposed guidelines by IV Semester Examination, April/May, 2021.

4. Board reviewed the curriculum for the courses running in the other programs of the Vidyapith. Following suggestions were given

Bachelor of Arts and Bachelor of Education		
GEOG 101L	Fundamentals of Cartography lab	Minor Change
GEOG 102	Human Geography	Minor Change
GEOG 103	Physical Geography	No change
GEOG 104L	Statistical Techniques and Data Representation lab	Minor Change
GEOG 201	Economic Geography	Minor Change
GEOG 202	Introduction to Geography of India	Minor Change
GEOG 203L	Mapping and Prismatic Compass Survey lab	No change
GEOG 204L	Relief Representation and Topographical Maps lab	Minor Change
GEOG 301L	Fundamentals of Geoinformatics lab	No change
GEOG 302	Geographical Thought	Major Change
GEOG 303L	Map Projection lab	Minor Change
GEOG 304	World Regional Geography	Major change

The Board proposed introduction of pool of Discipline Elective courses and agreed upon it.The courses *Geographical Thought* (Course Code: GEOG 302) and *World Regional Geography* (Course Code: GEOG 304)has been shifted in the pool as courses*Geographical Thought* (Course Code: GEOG_ to be generated) and *World Regional Geography* (Course Code: GEOG_to be generated) of Discipline electives and another two new courses has also been added.

The board reviewed the courses of Bachelor of Arts and Bachelor of Education and recommended to implement as per **Annexure 1 (PP. 1-4) &Annexure 2(PP. 1-38) .**

Bachelor of Science and Bachelor of Education		
GEOG 101L	Fundamentals of Cartography lab	Minor Change
GEOG 102	Human Geography	Minor Change
GEOG 103	Physical Geography	No change
GEOG 104L	Statistical Techniques and Data Representation lab	Minor Change
GEOG 201	Economic Geography	Minor Change
GEOG 202	Introduction to Geography of India	Minor Change
GEOG 203L	Mapping and Prismatic Compass Survey lab	No change
GEOG 204L	Relief Representation and Topographical Maps lab	Minor Change
GEOG 301L	Fundamentals of Geoinformatics lab	No change
GEOG302	Geographical Thought	Major Change
GEOG 303L	Map Projection lab	Minor Change
GEOG 304	World Regional Geography	Major change
GEOL 101	Mineralogy, Crystallography and Economic Geology	Major Change
GEOL 101L	Mineralogy, Crystallography and Economic Geology Lab	Major Change
GEOL 102	Physical Geology and Plate Tectonics	Major Change
GEOL 102L	Physical Geology and Plate Tectonics Lab	Major Change
GEOL 201	Palaeontology and Stratigraphy	Major Change
GEOL 201L	Palaeontology and Stratigraphy Lab	Major Change
GEOL 202	Petrology and Structural Geology	Major Change
GEOL 202L	Petrology and Structural Geology Lab	Major Change
GEOL 301	Hydrology, Environmental and Engineering Geology	Major Change
GEOL 301L	Hydrology, Environmental and Engineering Geology Lab	Major Change
GEOL 303	Geochemistry, Geomorphology, Photogeology and Remote Sensing	Major Change
GEOL 303L	Geochemistry, Geomorphology, Photogeology and Remote Sensing Lab	Major Change

In B.Sc. Geology I Semester, the courses *Physical Geology and Plate Tectonics* (Course Code: GEOL 102) *&Physical Geology and Plate Tectonics Lab*(Course Code: GEOL 102

L) have been proposed to be replaced by new course *Physical Geology* (Course Code: *to be generated*) *containing* both theory and practical. In B.Sc. Geology II Semester, the courses *Mineralogy, Crystallography and Economic Geology* (Course Code: GEOL 101) &*Mineralogy, Crystallography and Economic Geology Lab* (Course Code: GEOL 101L) have been proposed to be replaced by new course *Structural Geology and Plate Tectonics* (Course Code: *to be generated*) containing both theory and practical. In B.Sc. Geology III Semester, the courses *Petrology and Structural Geology* (Course Code: GEOL 202) &*Petrology and Structural Geology Lab* (Course Code: GEOL 202L) have been proposed to be replaced by new course*Mineralogy, Crystallography and Geochemistry*(Course Code: *to be generated)* containing both theory and practical. In B.Sc. Geology IV Semester, the courses *Palaeontology and Stratigraphy* (Course Code: GEOL 201) & *Palaeontology and Stratigraphy Lab* (Course Code: GEOL 201L)have been proposed to be replaced by new course *Petrology and Economic Geology* (Course Code: *to be generated*)containing both theory and practical. In B.Sc. Geology V Semester, the courses *Geochemistry, Geomorphology, Photogeology and Remote Sensing* (Course Code: 5.1) & *Geochemistry, Geomorphology, Photogeology and Remote Sensing Lab* (Course Code: 5.2) have been proposed to be replaced by newly introduced pool of Discipline Electives containing both theory and practical. In B.Sc. Geology VI Semester, the courses *Hydrogeology, Environmental and Engineering Geology* (Course Code: 6.1) &*Hydrogeology, Environmental and Engineering Geology Lab* (Course Code: 6.2) have been replaced by newly introduced pool of Discipline Electives containing both theory and practical.

The board reviewed the courses of Bachelor of Science and Bachelor of Education and recommended to implement as per **Annexure 1 (PP. 1-4) & Annexure 2(PP. 1-37) and Annexure 3 (PP. 1-5) &Annexure 4 (PP. 1-55).**

Master of Arts (Textile Designing - Printing)		
ENVS 408	Environmental Studies	Deal by Design Department
Master of Arts (Textile Designing - Weaving)		
ENVS 408	Environmental Studies	Deal by Design Department

It will be submitted by Design Department.

Bachelor of Technology (Computer Science and Engineering)		
RS 401	Geoinformatics	No change
Bachelor of Technology (Electronics and Communication Engineering)		
RS 401	Geoinformatics	No change
Bachelor of Technology (Information Technology		
RS 401	Geoinformatics	No change

Bachelor of Technology (Electronics and Electricals		
RS 401	Geoinformatics	No change
Bachelor of Technology (Electronics and Instrumentation		
RS 401	Geoinformatics	No change
Bachelor of Technology (Biotechnology)		
RS 401	Geoinformatics	No change

The Board also recommended to introduce RS 401 Geoinformatics in Chemical Engineering Fourth Year.

The course scheme, learning outcomes, list of recommended books and e-learning materials of the (RS 401 Geoinformatics) programme is attached and marked as **Annexure- 16 (PP.1) and 17 (PP. 1-2).**

5. Board reviewed the reports received from the examiners of different examinations of 2017 and 2018. All the reports were found to be satisfactory. It was noted that the examiners have generally reported 'to the point' answers and have found expression/method of representation satisfactory/good. Few examiners suggested to give more emphasis on maps & charts, graphical representation and labeled diagrams to support their answers.

6. The board evaluated the semester examination papers and found that most of them were descriptive and few analytic &application based depending on the nature of course. The Board concluded that the quality of question papers is good but sometimes some questions are out of syllabus, format is not clear, so, the board recommended for consideration of the syllabi while setting question papers.
The analysis of question papers is enclosed in **Annexure–18 (PP. 1-9).**

7. a).

Foundation Course (Environment Studies)		
BVF 002	Environment Studies	No change

Board reviewed the learning outcomes and syllabus and agreed to continue with the existing syllabus of *Environment Studies*(Course Code:BVF 002).

The course scheme, learning outcomes, list of suggested books and e-resources of the Foundation Course (Environment Studies)programme is attached and marked as **Annexure-19(PP. 1) and Annexure - 20 (PP. 1).**

b). Online courses
The Board suggested to introduce online courses as a substitute of Reading Electives in PG Programmesin III & IV Semester, respectively of School of Earth Sciences.

List of Alternate online courses (to be given in BOS minutes)

S No	Agency/ Portal	Name of course	Duration	(Core/ Elective/ Reading Elective)	Credit point(s)	URL
In M.Sc.(Environmental Science/Geology/ Geography) and M.A. (Geography) III & IV Semester Reading Electives						
1	**Indian Institute of Technology** Roorkee, NPTEL	Mineral Resources: Geology, Exploration, Economics and Environment	Self paced 48h (Registration at any time)	Reading Elective I	2	https://onlinecourses.nptel.ac.in/noc18_ce13/preview
2	**Indian Institute of Technology** Kanpur, NPTEL	Natural Hazards Part 1	Self paced 48h (Registration at any time)	Reading Elective I	2	https://onlinecourses.nptel.ac.in/noc19_
3	**Indian Institute of Technology Madras,** NPTEL	Non-Conventional Energy Resources	Self paced 48h (Registration at any time)	Reading Elective II	2	https://onlinecourses.nptel.ac.in/noc18_ge 09/preview

The alternate online course name, duration, credits and URL is attached and marked as **Annexure -21(PP. 1).**

Annexure - 1

BANASTHALI VIDYAPITH
SCHOOL OF EARTH SCIENCES

Name of the Programme : B.A. /B.Sc./B.A. B. Ed./ B. Sc. B. Ed.

Programme Educational Objectives :

Banasthali Vidyapith is an epitome of tradition and modernity. Vidyapith aims to preserve and inculcate the essential values and ideals of Indian culture. It believes in simple living and high thinking. Our educational ideology is based on the concept of fivefold education focusing on physical, practical, aesthetic, moral and intellectual aspects in order to develop a balanced personality.

As a member of earth science team, Geographers are unique in their detailed and comprehensive study of physical& human aspects and their interrelationships. Geographic study begins with the location of places on the earth which have absolute locations that pinpoint them on the earth and relative locations that place each location in respect to other locations. Place have physical and human characteristics and Geography emphasizes the understanding of both of these factors and their integration together. The landscape of the earth is no longer a purely physical feature due to human activities which have both positive and negative impact on the local environment. The essential geographic feature is the region. A region is any unit of space that is unified by the presence of some characteristic.

The curriculum has identified essential competencies in the respective areas for which practical training will be provided to the students specializing in surveying, mapping, data analysis and photogrammetry.

The main objectives of the Under Graduate Geography programme are:

- **To study physical and human dimensions of environment in order to elucidate the man and environment relationship.**
- **To elucidate physical, socio-cultural, economic aspects of India as well as world for better perception of geographical environment.**
- **To develop skills in cartography, data analysis and interpretation of physical and cultural features on topographical maps as well as on aerial photographs of an area.**
- **To study resource utilization, production and distribution at regional and global level.**
- **To explain contribution of various scholars in the evolution and origin of the discipline.**
- **To minimize negative impacts of agriculture, industries, urbanization etc. by imparting concept of environmental protection and conservation.**
- **To create awareness in society about the conservation and management of Resources.**
- **To develop gender-neutral attitudes and practices; respect for all races, nations, religions, cultures, languages and traditions.**
- **To raise sensitivity for ethical codes of conduct, social values and respect to all.**

Programme Outcomes :

PO1: Geography Knowledge: Elucidate the physical and human dimensions of geography and also skilled in scale representation; reduction, enlargement and combination of maps; illustrate physical, socio-cultural, economic aspects of India as well as world for better understanding of geographical environment.

PO2: Planning abilities: Develop planning abilities and skills in cartography by using plane table & prismatic compass survey; analysis & representation of data, interpretation of physical and cultural features using topographical maps as well as aerial photographs for understanding spatial aspects.

PO3: Design/development of solution for problems: the students develops attitude which focuses on societal and environmental problems. Geographic location may influence the acceptability of a particular design of solution to a problem. The exposure to several principles makes them aware to focus largely on daily activities and occurring problems.

PO4: Problem analysis: Utilize the principles of scientific enquiry, thinking analytically, rationally and critically, while solving problems and making decision during daily activities. Find, analyze, evaluate and apply information systematically and shall make defensible decisions.

PO5: Modern tool usage: Learn, select, and apply appropriate techniques, methods, models and procedures, resources, and modern geography-related tools with an understanding of the limitations.

PO6: Leadership skills: Understand and consider the human reaction to change, motivation issues, leadership and team building when planning changes required for fulfillment of practice, professional and societal responsibilities. Assume participatory roles as responsible citizen or leadership roles when appropriate to facilitate improvement in environment, society, health and well-being.

PO7: Professional Identity: Understand resource production, distribution and trade at regional and global level and join hands towards sustainable development of the society. Spread awareness to minimize negative impacts of agriculture, industries, urbanization etc. by imparting concept of environmental protection, conservation and sustainable development.

PO8: Geographical Ethics: geographers have given attention to the conceptual and practical relationships between ethics and their discipline. Conceptual work has also included examination of the moral relations between human and natural worlds, for instance at environmental caretaking for future generations. Among the more applied ethical issues that geographers have embraced are ethical relationships with subjects, ethics in geographical education, and the moral significance of new spatial technologies.

PO9: Communication: Communicate effectively with the Earth Science community and with society at large, such as, being able to comprehend and write effective presentations and documentation. The students can communicate their ideas while incorporating in it and knowledge. Geographical facts enhance their content and make them an effective communicator.

PO10: The Geographer and society: Apply reasoning informed by the contextual knowledge to assess environmental, natural, societal, health, safety and sustainability issues and the consequent responsibilities relevant to the Geographical practice.

PO11: Environment and sustainability: Understand the impact of anthropogenic activities in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12: Life- long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. Self-access and use feedback effectively from others to identify learning needs and to satisfy theses needs on an ongoing basis.

Programme Scheme :

EXISTING

Semester I

Course Code	Course Name	L	T	P	C
GEOG 103	Physical Geography	6	0	0	6
GEOG 101L	Fundamentals of Cartography lab	0	0	4	2

Semester II

Course Code	Course Name	L	T	P	C
GEOG 102	Human Geography	6	0	0	6
GEOG 104L	Statistical Techniques and Data Representation lab	0	0	4	2

Semester III

Course Code	Course Name	L	T	P	C
GEOG 202	Introduction to Geography of India	6	0	0	6
GEOG 203L	Mapping and Prismatic Compass Survey lab	0	0	4	2

Semester IV

Course Code	Course Name	L	T	P	C
GEOG 201	Economic Geography	6	0	0	6
GEOG 204L	Relief Representation and Topographical Maps lab	0	0	4	2

PROPOSED

Semester I

Course Code	Course Name	L	T	P	C
GEOG 103	Physical Geography	6	0	0	6
GEOG 101L	**Fundamentals of Cartography Lab**	0	0	4	2

Semester II

Course Code	Course Name	L	T	P	C
GEOG 102	**Human Geography**	6	0	0	6
GEOG 104L	**Statistical Techniques and Data Representation Lab**	0	0	4	2

Semester III

Course Code	Course Name	L	T	P	C
GEOG 202	**Introduction to Geography of India**	6	0	0	6
GEOG 203L	Mapping and Prismatic Compass Survey Lab	0	0	4	2

Semester IV

Course Code	Course Name	L	T	P	C
GEOG 201	**Economic Geography**	6	0	0	6
GEOG 204L	**Relief Representation and Topographical Maps Lab**	0	0	4	2

Semester V

Course Code	Course Name	L	T	P	C
~~5.1~~	~~World Regional Geography~~	6	0	0	6
~~5.2~~	Map Projection lab	0	0	4	2

Course Code	Course Name	L	T	P	C
GEOG___	**Discipline Elective I**	**6**	**0**	**0**	**6**
GEOG 303L	**Map Projection Lab**	**0**	**0**	**4**	**2**

Semester VI

Course Code	Course Name	L	T	P	C
~~6.1~~	~~Geographical Thought~~	6	0	0	6
~~6.2~~	Fundamentals of Geoinformatics lab	0	0	4	2

Course Code	Course Name	L	T	P	C
GEOG___	**Discipline Elective II**	**6**	**0**	**0**	**6**
GEOG 301L	Fundamentals of Geoinformatics Lab	0	0	4	2

List of Discipline Electives

Course Code	Course Name	L	T	P	C
GEOG___	**Environment and Disaster Management**	**6**	**0**	**0**	**6**
GEOG___	**Geographical Thought**	**6**	**0**	**0**	**6**
GEOG___	**Settlement Geography**	**6**	**0**	**0**	**6**
GEOG___	**World Regional Geography**	**6**	**0**	**0**	**6**

Note: Yellow highlighted and bold content illustrate the modification in the syllabus.

Annexure - 2

Name of the Programme: B.A. /B.Sc./B.A. B. Ed./ B. Sc. B. Ed.

COURSE DETAILS:

FIRST SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1	GEOG 103 Physical Geography	**After the completion of this course, students should be able to:** • **Describe origin of earth, continents and ocean basin, Isostasy, diastrophism, drainage pattern and several landforms** • **Describe the wind movements, pressure, composition and structure of the earth, jet streams** • **Classify world in terms of climate, air masses and fronts and describe cyclones and their types** • **Describe ocean bottom reliefs of Indian ocean, distribution of temperature and salinity, tides, currents and coral reefs**	—	— Recommended Books: **1. Barry, R. G., & Chorley, R. J. (1998). *Atmosphere: Weather and Climate* (7th ed.). London, UK: Routledge.** **2. Das, P. K. (1968). *The Monsoons*. New Delhi, India: National Book Trust.** **3. Dayal, P. (1996). *A Text book of Geomorpholog.* (2nd ed.). Patna, India: Shukla Book Depot.**	**Reviewed learning outcomes, recommended books & e-learning materials and rearranged the content.**

				4. Garrison, T. (1998). *Oceanography*. (3rd ed.). California, CA:Wadsworth. 5. Gohchengleong (2011). *Certificate Physical and Human Geography*. New Delhi, India:Oxford University Press. 6. Khullar, D. R. (2016).*Physical Geography*. Ludhiana, India:Kalyani. 7. Siddartha, K. (2014). *The Earth's Dynamic surface:A textbook on Geomorphology*. New Delhi, India: Kisalya. 8. Singh, S. (2015). *Geomorphology*. Allahabad, India: Pravalika. 9. Smails, R. J. (1985). *The Study of Landforms*. New York, NY: McGraw Hill. 10. Strahler, A. N., & A. H. Strahler (2008). *Modern Physical Geography*.(4th ed.).New Jersey,NJ: John Wiley & Sons. 11. चौहान, वी. एस. (1996). *भौतिक भूगोल.* मेरठ, भारतः स्तोगी. 12. शर्मा, एच. एस. (2014). *भौतिक भूगोल.* जयपुर,भारतः पंचशील. 13. सिंह, एस. (2005*). भौतिक भूगोल.* गोरखपुर,भारतः वसुन्धरा. **Suggested e-learning materials** 1. **Interior of earth** https://www.nationalgeographic.com/science/earth/surface-of-the-earth/earths-interior/ 2. **Plate Tectonics, Weathering, Mass Wasting and Erosion** http://hkss.cedd.gov.hk/hkss/eng/education/GS/eng/hkg/chapter4.htm 3. **Geomorphic Processes** http://ncert.nic.in/ncerts/l/kegy206.pdf	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	GEOG 101L Fundamentals of Cartography Lab	**After the completion of this course, students should be able to:** • **Describe cartography and theoretical background of scales and their types** • **Draw plain, diagonal, comparative, time and Vernier scale** • **Enlarge, reduce and combine maps** • **Describe the uses of thermometer, barometer, hair hygrometer, rain gauze and wind vane** • **Conduct a plane table survey through radiation, intersection and traversing.**	a. ~~Introduction~~ of cartography. b. Scale; - Plain, Diagonal, Comparative, Time & Vernier (2 exercises of each scale). c. Enlargement, Reduction & Combination of maps. d. Weather Instruments: - Thermometer, Barometer, Hair hygrometer, Rain Gauge & Wind vane. e. Plain Table Survey: - Methods of Planetabling; Radiation Intersection and traverse. Non Scientific calculators are allowed during the examination Notes: 1. Candidates will be examined by an External Examiner in consultation with the Internal Examiner. 2. Each exercise should be drawn on ¼th of a full drawing sheet. 3. The test paper of practical will be of three hours duration and candidates will be required to answer three questions out of five. 4. The distribution of marks will be as follows: a. Paper 35 Marks b. Record Work* 15 Marks c. Viva-voce** 10 Marks * Record work will be assessed by the teacher in-charge of the practical group and the external examiner. ** Viva-voce will be based on the record work and weather instruments. Recommended Books: ~~1. Robinson, A. R. (2004) : Elements of Cartography, Chapman & Hall.~~ ~~2. Singh, R. L. (2011) : Elements of Practical Geography, Kalyani Publishers.~~ ~~3. Raize, E. (1948) : General Cartography, McGraw Hill Book Co., London.~~ ~~4. Singh, R. N. and Kanaujia L. R. S. (1998) : Map Work & Practical Geography, Central Book Depot,~~	**1. Meaning and Definition** of Cartography. 2. Scale: - Plain, Diagonal, Comparative **(Distances and Time),** & Vernier (2 exercises of each scale). 3. Enlargement, Reduction & Combination of maps. 4. Weather Instruments: - Thermometer, Barometer, Hair hygrometer, Rain Gauge & Wind vane. 5. **Plane** Table Survey: - Methods of Plane Tabling; Radiation Intersection and Traverse. Non Scientific calculators are allowed during the examination Recommended Books: **1. Mishra, R. P. (2014*). Fundamentals of Cartography* (2nd ed.). New Delhi, India: Concept.** **2. Robinson, A. R. (2011). *Elements of Cartography* (6th ed.). London, UK: Chapman & Hall.** **3. Saha, P., & Basu, P. (2011). *Advanced Practical Geography* (7th ed.). Kolkatta, India: Books & Allied.** **4. Singh, R. L. (2011). *Elements of Practical Geography* (8th ed.). New Delhi, India: Kalyani.** **5. खुल्लर, डी. आर. (2015). *प्रयोगात्मक भूगोल.* लुधियाना, भारतः कल्याणी.** **6. दयाल, पी. (2006). *प्रयोगात्मक भूगोल की रूपरेखा.* नई दिल्ली, भारतः राजेश.** **7. शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल* (पंचम् सं.). मेरठ, भारतः रस्तोगी.** **8. सिंह, आर. एल. (2013). *प्रायोगिक भूगोल के सिद्धान्त* (तृतीय सं.). इलाहाबाद, भारतः शारदा पुस्तक भवन.** **Suggested e-learning materials** **1. Introduction to Cartography http://www.sfu.ca/~hickin/Maps/Chapter%201.pdf** **2. Scale http://earthsci.org/education/fieldsk/Map_Scales/geo_scales.html** **3. Plane table surveying https://nptel.ac.in/courses/105107122/33** **4. Methods of Plane table Surveying**	**Reviewed learning outcomes, e-learning materials, recommended books and re-arranged the content. Added new topics to clarify the content.**

			~~Allahabad.~~ 5. ~~Mishra, R. P. and A. Ramesh (2014): Fundamentals of Cartography, Concept Publishers, New Delhi.~~ 6. ~~Kanetkar, T. P. (1985) : Surveying and Levelling, Vol. I, A. V. Griha Prakashan, Bombay.~~ 7. ~~Sarkar, Ashish (2010) : Practical Geography : A Systematic Approch, Orient BlackSwan, Kolkatta.~~ 8. ~~Singh, Gopal (2009) : Map work and Practical Geography, Vikas Publishing House Pvt. Ltd., Delhi.~~ 9. ~~Saha, Piyushkant and Basu Partha (2011) : Advanced Practical Geography, Books & Allied Pvt. Ltd., Kolkatta.~~ 10. ~~शर्मा, जे.पी. (2011) : प्रायोगिक भूगोल, रस्तोगी प्रकाशन, मेरठ~~ 11. ~~दयाल, प. (2006) : प्रयोगात्मक भूगोल की रूपरेखा, राजेश पब्लिकेशन्स, नई दिल्ली।~~ 12. ~~शर्मा, राजकुमार (2011) : अभिनव प्रयोगात्मक भूगोल, हिमांशु पब्लिकेशन्स, नई दिल्ली।~~ 13. ~~वर्मा, ल. व लोढ़ा राजमल (1999) : प्रयोगात्मक भूगोल, राजस्थान हिन्दी ग्रन्थ अकादमी, जयपुर।~~ 14. ~~सिंह, आर.एल. (2011) : प्रायोगिक भूगोल के सिद्धान्त, शारदा पुस्तक भवन, इलाहाबाद।~~ 15. ~~इश्तियाक, एम. (1999) : प्रायोगिक भूगोल, मानक पब्लिकेशन्स, दिल्ली।~~ 16. ~~सिंह एवं सिंह (2013) : प्रयोगात्मक भूगोल के मूल तत्व, कल्याणी प्रकाशन, लुधियाना।~~ 17. ~~खुल्लर, डी. आर. (2015) : प्रयोगात्मक भूगोल, कल्याणी प्रकाशन, लुधियाना।~~ 18. ~~चौहान, पी.आर. (2010) : प्रयोगात्मक भूगोल, वसुन्धरा प्रकाशन, गोरखपुर।~~	**https://nptel.ac.in/courses/105107122/34** 5. **Weather Instruments** **http://sites.tufts.edu/stompactivitydatabase/files/formidable/Weather-Instruments.pdf**	

SECOND SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	GEOG102 Human Geography	**After the completion of this course, students should be able to:** • **Define human geography and relate it to the other social sciences; describe man environment relationships and schools of human geography.** • **Describe evolution of man, classify human races and describe migration theories.** • **Map and describe the distribution of several tribes- pigmies, badawins, eskimos, khirgiz, gujjars, bakarwals, toda, bhilsanthal and their economic activities.** • **Describe population distribution of the world with maps, concepts of population growth, population theories and human development.** • **Classify cities functionally; describe urbanization, settlements and their**	Unit – I a) Definition and scope of Human geography. b) Its relation with other social sciences. c) Man – environment relationship d) Schools of Human Geography: Determinism, Possibilism and Neo – determinism. e) Fundamental principles of Human geography: Principle of Activity, Principle of Areal Differentiation, Principle of Terrestrial Unity. Unit – II a) Evolution of Man: Monogenetic theory, Multi Origin Theory and Modern Theory b) Criteria of classification of Human Races c) Classification and distribution of Human Races according to G. Taylor d) Factors of evolution of Human Races e) Migration Zone theory by ~~Griffith~~ Taylor Unit – III a) Distribution of Tribes in the Equatorial and Desert Region: habitat, economic activities and social organization of Pigmies and Badawins b) Distribution of Tribes in the Grasslands and Tundra Region: Habitat, economic activities and social organization of Eskimos and Khirgiz c) Distribution of Tribes in North and South India: Habitat, economic activities and social organization of Gujjars & Bakarwals and Toda. d) Distribution of Tribes in East and West India: Habitat, economic activities and social organization of Santhal and Bhil e) Early economic activities of mankind: - Food gathering, Hunting & Shifting cultivation. Unit – IV a) Distribution of population: world distribution pattern physical, economic and social factors influencing	Unit I Definition and Scope of Human Geography, its relation with other Social Sciences; Man – Environment relationship; Schools of Human Geography: Determinism, Possibilism and Neo – determinism; Fundamental principles of Human geography: Principle of Activity, Principle of Areal Differentiation, and Principle of Terrestrial Unity. Unit II Evolution of Man: Monogenetic Theory, Multi Origin Theory and Modern Theory; Criteria of classification of Human Races; Classification and Distribution of Human Races according to G. Taylor; Factors of evolution of Human Races; Migration Zone Theory by **G. Taylor** Unit III Distribution of Tribes in the Equatorial and Desert Region: Habitat, Economic activities and Social organization of Pigmies and Badawins; Distribution of Tribes in the Grasslands and Tundra Region: Habitat, Economic activities and Social organization of Eskimos and Khirgiz; Distribution of Tribes in North and South India: Habitat, Economic activities and Social organization of Gujjars & Bakarwals and Toda; Distribution of Tribes in East and West India: Habitat, Economic activities and Social organization of Santhal and Bhil; Early Economic activities of mankind: - Food gathering, Hunting & Shifting cultivation. Unit IV Distribution of population: World distribution pattern Physical, Economic and Social factors influencing spatial distribution; Concept of Over population, Under population, Optimum population and Zero population growth; Demographic Transition Theory; Migration-Internal and International, General laws of Migration-E.G. Revenstetin, Lee's model, Zelinskey's mobility transition model;Concept of Human Development and Population	**Reviewed Learning outcomes, e-learning materials, recommended books re-arranged the content.** **Rename the content to Maintain uniformity**

		types.	spatial distribution. a) Concept of over population, under population, optimum population and zero population growth. b) Demographic transition theory. c) Migration-internal and international, general laws of Migration-E.G. Revenstetin, Lee's model, Zelinskey's mobility transition model d) Concept of human development and population problems and policy of India. Unit – V a) Settlement: origin and types of settlement. b) Rural settlement-Pattern of rural settlements, house types and building materials, rural settlement in India c) Urban settlement- origin of towns, patterns of cities. d) Functional classification of cities, zoning of cities e) Urbanization and problems: with special reference to slums *Note - Stencils are to be permitted during the examination Recommended Books: ~~1. Huntington, E. (1959): The Principles of Human Geography, John Wiley & Sons, New York.~~ ~~2. Husain, Majid (2011) : Human Geography, Rawat Publication, Jaipur~~ ~~3. Jain, J.K. & Bohra, D.M. (1986): Vishwa ka Sanskritik Bhugol. Academic Publishers, Jaipur.~~ ~~4. Leong, G.C. & Morgan, G.C. (1986): Human and Economic Geography, O.U.P., Oxford.~~ ~~5. Maurya, S.D. (2015): Human Geography, Pravalika Publication, Allahabad.~~ ~~6. Negi, B.S. (1982): Human Geography- An Ecological Aproach, Kedarnath Ramnath, Meerut.~~ ~~7. Perpillou, A.V. (1965): Human Geography, Longmans.~~ ~~8. Singh, L. R. (2005): Fundamentals of Human~~	problems and Policy of India. UnitV Settlement: Origin and Types of settlement; Rural settlement- Pattern of rural settlements, House types and Building materials, Rural settlement in India; Urban settlement- Origin of towns, Patterns of cities; Functional classification of cities, zoning of cities; Urbanization and Problems: with special reference to slums Note - Stencils are to be permitted during the examination Recommended Books: **1. Huntington, E. (1959). *The Principles of Human Geography* (2nd ed.). New York, NY: John Wiley & Sons.** **2. Husain, M. (2014). *Human Geography* (4th ed.). Jaipur, India: Rawat.** **3. Leong, G. C., & Morgan, G. C. (2010). *Human and Economic Geography* (2nd ed.). Oxford, UK: O.U.P.** **4. Maurya, S. D. (2015). *Human Geography*. Allahabad, India: Pravalika.** **5. Negi, B. S. (1982). *Human Geography- An Ecological Aproach*. Meerut, India: Kedarnath Ramnath.** **6. Rubenstein, J. M. (2003). *An Introduction to Human Geography* (7thed.). New Jersey, NJ: Prentice Hall.** **7. Singh, L. R. (2005). *Fundamentals of Human Geography* (2nded.). Allahabad, India: Sharda Pustak Bhawan.** **8. Verma, J.K. (2008). *Human Geography*. New Dehli, India: GNOSIS.** **9. कौशिक, एस. डी. (2011).*मानव भूगोल के सरल सिद्धांत* (12 वाँ सं.). मेरठ, भारत: रस्तोगी.** **10. गर्जुर, आर., एवं जाट, बी. सी. (2006). *मानव भूगोल.* जयपुर, भारत: पंचशील.** **11. मौर्या, एस. डी. (2009). *मानव भूगोल* (तृतीय सं.). इलाहाबाद, भारत: शारदा पुस्तक भवन.** **12. सिंह, के., एवं सिंह, जे. (2009). *मानव भूगोल.* नई दिल्ली, भारत:**	

			~~Geography, Sharda Pustak Bhawan, Allahabad.~~ ~~9. Verma, J.P. (2008): Human Geography, GNOSIS, Jawahar Park, New Dehli.~~ ~~10. कौशिक, एस. डी. (2011) : मानव भूगोल के सस्त सिद्धांत, रस्तोगी पब्लिकेशन्स, मेरठ~~ ~~11. हूसैन, माजिद (2012) : मानव भूगोल, रावत पब्लिकेशन्स, जयपुर।~~ ~~12. मौर्या, एस.डी. (2012) : मानव भूगोल, शारदा पुस्तक भवन, इलाहाबाद।~~ ~~13. सिंह, काशिनाथ व सिंह जगदीश (2009) : मानव भूगोल, सधा पब्लिकेशन्स, नई दिल्ली।~~ ~~14. गर्जुर, समकुमार व जाट बी.सी. (2006) : मानव भूगोल, पंचशील प्रकाशन, जयपुर।~~ ~~15. सिंह, कविता (2010): मानव भूगोल, इशिका पब्लिशिंग हाउस, जयपुर।~~	राधा. 13. सिंह, के. (2010). *मानव भूगोल.* जयपुर, भारत:इशिका. 14. हुसैन, एम. (2012). *मानव भूगोल* (चतुर्थ सं.). जयपुर, भारत: रावत. **Suggested e-learning materials** **1. Schools of Human Geography: Determinism, Possibilism and Neo – determinism** **http://ncert.nic.in/ncerts/l/legy101.pdf** **2. factor of Evolution human race and criteria** **http://egyankosh.ac.in/bitstream/123456789/41420/1/Unit-4.pdf** **3. Migration Zone theory by Griffith Taylor** **https://booksite.elsevier.com/brochures/hugy/SampleContent/Mapping-Race-and-Ethnicity.pdf** **4. Bushmen Tribe** **http://www.newworldencyclopedia.org/entry/Bushmen**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	GEOG 104L Statistical Techniques and Data Representation Lab	**After the completion of this course, students should be able to:** • **Describe statistical sampling and represent frequency distribution in several forms.** • **Represent statistical data through diagrams- multiple bar diagram, simple pyramid diagram, rectangular diagram, wheel or pie diagram, and spherical diagram** • **Measure mean, median mode & standard deviation** • **Represent Statistical data through graphs- poly linear graph, climograph and triangular graph.**	a) Frequency distribution and its presentation b) Measures of Central tendency : Arithmetic mean mode & median (Direct Method) c) Standard deviation method d) Representation of statistical data though diagrams :- Multiple Bar diagram, Simple Pyramid diagram, Rectangular diagram (Simple and Divided), Wheel or pie diagram, Spherical diagram e) Representation of statistical data through graphs: - Poly Linear graph, Climograph, Triangular graph. **Notes:** 1. Candidates will be examined by an External Examiner in consultation with the Internal Examiner. 2. Each exercise should be drawn on 1/4th of a full drawing sheet. 3. The test paper of practical will be of three hours duration and candidates will be required to answer three questions out of five. 4. The distribution of marks will be as follows: Paper 35 Marks Record Work* 15 Marks Viva-voce** 10 Marks * Record work will be assessed by the teacher in-charge of the practical group and the external examiner. ** Viva-voce will be based on the record work. Non Scientific calculators are allowed during the examination. Recommended Books: ~~1. Kanetkar, T. P. (1985) : Surveying and Levelling, Vol. I, A. V. Griha Prakashan, Bombay.~~ ~~2. Mishra, R. P. and A. Ramesh (2014): Fundamentals of Cartography, Concept Publishers, New Delhi.~~	**1. Meaning and definition of statistics, data and sampling.** **2. Statistical series and their types** 3. Frequency distribution and its presentation 4. Measures of Central tendency : Arithmetic Mean, Mode & Median (Direct Method) 5. **Measure of Dispersion: Standard deviation** 6. Representation of statistical data though diagrams :- Multiple Bar diagram, Simple Pyramid diagram, Rectangular diagram (Simple and Divided), Wheel or pie diagram, Spherical diagram 7. Representation of statistical data through graphs: - Poly Linear graph, Climograph, Triangular graph. Scientific calculators are allowed during the examination. Recommended Books: **1. Alvi, Z. (2005). *Statistical Geography Methods and Applications* (2nd ed.). New Delhi, India: Rawat.** **2. Dadson, S. J. (2017). *Statistical Analysis of Geographical Data an Introduction*. Oxford, UK: John Wiley & Sons.** **3. Gupta, S. P. (2012). *Statistical methods* (4th ed.). New Delhi, India: Sultan Chand and Sons.** **4. Mahmood, A. (2017). *Statistical Methods in Geographical Studies* (6th ed.). New Delhi, India: Rajesh.** **5. Saha, P., & Basu, P. (2011). *Advanced Practical Geography* (7th ed.). Kolkatta, India: Books & Allied.** **6. Singh, R. L. (2011). *Elements of Practical Geography* (8th ed.). New Delhi, India: Kalyani.** **7. खुल्लर, डी. आर. (2015). *प्रयोगात्मक भूगोल.* लुधियाना, भारतः कल्याणी.** **8. नागर, के. एन. (2013). *सांख्यिकीय के मूलतत्व* (चतुर्थ सं.). मेरठ, भारतः मीनाक्षी.** **9. शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल* (पंचम् सं.). मेरठ, भारतः रस्तोगी.**	**Reviewed Learning outcomes, e-learning materials, recommended books re-arranged the content** **Added topics to clarify**

			3. Raize, E. (1948) : General Cartography, McGraw Hill Book Co., London. 4. Robinson, A. R. (2004) : Elements of Cartography, Chapman & Hall. 5. Saha, Piyushkant and Basu Partha (2011) : Advanced Practical Geography, Books & Allied Pvt. Ltd., Kolkatta. 6. Sarkar, Ashish (2010) : Practical Geography : A Systematic Approch, Orient BlackSwan, Kolkatta. 7. Singh, Gopal (2009) : Map work and Practical Geography, Vikas Publishing House Pvt. Ltd., Delhi. 8. Singh, R. L. (2011) : Elements of Practical Geography, Kalyani Publishers. 9. Singh, R. N. and Kanaujia L. R. S. (1998) : Map Work & Practical Geography, Central Book Depot, Allahabad. 10. शर्मा, जे.पी. (2011) : प्रायोगिक भूगोल, रस्तोगी प्रकाशन, मेरठ 11. दयाल, प. (2006) : प्रयोगात्मक भूगोल की रूपरेखा, रजेश पब्लिकेशन्स, नई दिल्ली। 12. शर्मा, राजकुमार (2011) : अभिनव प्रयोगात्मक भूगोल, हिमांशु पब्लिकेशन्स, नई दिल्ली। 13. वर्मा, ल. व लोढ़ा राजमल (1999) : प्रयोगात्मक भूगोल, राजस्थान हिन्दी ग्रन्थ अकादमी, जयपुर। 14. सिंह, आर.एल. (2011) : प्रायोगिक भूगोल के सिद्धान्त, शारदा पुस्तक भवन, इलाहाबाद। 15. इश्तियाक, एम. (1999) : प्रायोगिक भूगोल, मानक पब्लिकेशन्स, दिल्ली। 16. सिंह एवं सिंह (2013) : प्रयोगात्मक भूगोल के मूल तत्व, कल्याणी प्रकाशन, लुधियाना। 17. खुल्लर, डी. आर. (2015) : प्रयोगात्मक भूगोल, कल्याणी प्रकाशन, लुधियाना। 18. चौहान, पी.आर. (2010) : प्रयोगात्मक भूगोल, वसुन्धरा प्रकाशन, गोरखपुर।	**Suggested e-learning materials** 1. **Sampling** https://epgp.inflibnet.ac.in/ahl.php?csrno=17 **P01,M-12** 2. **Frequency distribution** https://epgp.inflibnet.ac.in/ahl.php?csrno=17 **P01,M-12** 3. **Histogram** https://www.liverpool.ac.uk/~cll/lskills/WN/NumeracyDiagrms.html#histo 4. **Measures of central tendency** https://www.mathsisfun.com/data/central-measures.html 5. **Standard deviation method** https://www.learner.org/courses/againstallodds/pdfs/AgainstAllOdds_StudentGuide_Unit06.pdf 6. **Diagrams** http://egyankosh.ac.in/bitstream/123456789/20422/1/Unit-14.pdf	

THIRD SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
5.	GEOG202 Introduction to Geography of India	**After the completion of this course, students should be able to:** • **Describe and map the location of India, its physiographic divisions** • **Describe the drainage, climate, soil and vegetation their types and distribution** • **Describe major crops, minerals, industrial regions, population of India and their distribution** • **Demarcate Rajasthan in terms of physiography, describe climate, drainage, vegetation, soils and their distribution.** • **Describe agriculture, livestock, irrigation, human resources and tourism.**	Unit – I a) Introduction :- Location ; Neighbouring countries; frontiers. b) India :- A land of diversities ; Unity within diversities. c) Physiographic division ; Himalayan region. d) The Great plains of India; Peninsular plateau. e) Coastal plains and Islands. Unit – II a) Drainage systems of India. b) Climate: - Summer and winter Season. c) Monsoon: - Mechanism of monsoon. d) Soil: - Type, distribution & characteristics. e) Vegetation: - Type and their distribution. Unit – III a) Agriculture: - Major crops and their distribution (Wheat, Rice & Tea). b) Minerals: - Distribution and Production of Iron ore & coal. c) Industrial regions of India and their problems d) Transport & Trade: - Ports and foreign Trade. e) Population: - Distribution & Density of population, Sex composition & Literacy rate. Unit – IV a) Physiographic division of Rajasthan. b) Climate:- Major seasons . c) Drainage systems. d) Natural Vegetation:- Type, distribution & their importance. e) Soils of Rajasthan. Unit – V a) Agriculture :- Type and distribution of major crops	Unit I Introduction :- Location; Neighbouring countries; Frontiers; India :- A land of Diversities ; Unity within Diversities; Physiographic Division- Himalayan Region, The Great Plains of India, Peninsular Plateau, Coastal Plains and Islands. Unit II Drainage systems of India; Climate: - Summer and Winter Season; Monsoon: - Mechanism of Monsoon; Soil - Type, Distribution & Characteristics; Vegetation: - Type and their Distribution. Unit III Agriculture: - Major Crops and their Distribution (Wheat, Rice & Tea); Minerals: - Distribution and Production of Iron ore & coal; Industrial Regions of India and their Problems; Transport & Trade: - Ports and Foreign Trade; Population: - Distribution & Density of population, Sex Composition & Literacy Rate. Unit IV Physiographic Division of Rajasthan; Climate:- Major Seasons; Drainage Systems; Natural Vegetation:- Type, Distribution & their importance; Soils of Rajasthan. Unit V Agriculture :- Type and Distribution of Major Crops **in Rajasthan** (Bajra & Mustard) ; Livestock :- Sheep & Camel; Irrigation :- Indira Gandhi Canal Project; Human Resources of Rajasthan: - Distribution & Density, Sex ratio, SC/ ST; Tourism in Rajasthan : Major Tourist Spots & its importance in the Economy of Rajasthan Stencils are to be permitted during the examination	**Reviewed Learning outcomes, e-learning materials, recommended books re-arranged the content** **To make more specific.**

			(Bajra & Mustard). b) Livestock :- Sheep & Camel. c) Irrigation :- Indira Gandhi canal project. d) Human Resources of Rajasthan: - Distribution & density, Sex ratio, SC/ ST. e) Tourism in Rajasthan : Major Tourist spot s & its importance in the Economy of Rajasthan. *Note - Stencils are to be permitted during the examination Recommended Books: 1. ~~Bhalla, L. R. (2015) : Geography of Rajasthan, Kuldeep Publications~~ 2. ~~Deshpande, C. D., India (1992) : A Regional Interpretation, Northern Book Centre, New Delhi.~~ 3. ~~Farmer, B. H. (1983) : An Introduction to South Asia, Methuen, London.~~ 4. ~~Govt. of India (1965) : The Gazetteer of India, Vol. I & III Publication Division, New Delhi.~~ 5. ~~Govt. of India (2011) : National Atlas of India, NATMO Publication, Calcutta.~~ 6. ~~Govt. of India, India – Reference Annual, Pub. Div, New Delhi, (latest edition)~~ 7. ~~Khullar D.R. (2014) India : a Comprehensive Geography, Kalyani Publication, Ludhiyana~~ 8. ~~Krishnan, M.S., (2012) Geology of India and Burma, CBS Publication, New Delhi.~~ 9. ~~Learmonth, A. T. A. et al (ed) (1982) : Man and Land of South Asia, Concept, New Delhi.~~ 10. ~~Manorama Press, Manorma Year Book, Kottayam (Kerala), (Latest Edition).~~ 11. ~~Mishra, V.C. (1967) Geography of Rajasthan.National Book Trust, New Delhi.~~ 12. ~~Mitra, A. (1967) : Levels of Regional Development of India, Census of India, Vol. 1, Part I A (i) and (ii), New Delhi.~~ 13. ~~Puri, G. S. (1960) Indian forest Ecology, Oxford Book and Stationary, New Delhi.~~ 14. ~~Raychaudhary. S.P. (1966) Land and Soil, National Book Trust, New Delhi.~~	Recommended Books: **1. Bhalla, L. R. (2016). *Geography of Rajasthan* (12th ed.). Jaipur, India: Kuldeep.** **2. Khullar, D. R. (2014). *India, A Comprehensive Geography* (3rd ed.). Ludhiyana, India: Kalyani.** **3. Mishra, V. C. (1967). *Geography of Rajasthan*. New Delhi, India: National Book Trust.** **4. Singh, G. (2010). *Geography of India* (9th ed.). Delhi, India: Atma Ram.** **5. बंसल, एस. सी. (2015). *भारत का भूगोल* (तृतीय सं.). मेरठ, भारत: मीनाक्षी.** **6. मामोरिया, सी. (2018). *भारत का वृहत भूगोल.* आगरा, भारत: साहित्य भवन.** **7. शर्मा, एच. एस., एवं शर्मा, एम. एल. (2017). *राजस्थान का भूगोल* (13वाँ सं.). जयपुर, भारत: पचंशील.** **8. शर्मा, एच. एस., एवं शर्मा, एम. एल. (2017). *भारत का नूतन भूगोल.* जयपुर, भारत: आर. बी. डी. पब्लिशिंग हाउस.** **9. शर्मा, आर. (2014). *राजस्थान का वृहत भूगोल* (द्वितीय सं.). उदयपुर, भारत: हिमाशुं.** **10. सक्सैना, एच. (2014). *राजस्थान का भूगोल* (12वाँ सं.). जयपुर, भारत: राजस्थान हिन्दी ग्रंथ अकादमी.** **11. सक्सैना, एच. एम., सक्सैना, आर., एवं सक्सैना, पी. (2017). *भारत का भूगोल.* जयपुर, भारत: रावत.** **12. सिंह, जी. (2006). *भारत का भूगोल.* दिल्ली, भारत: आत्माराम.** **13. हुसैन, एम. (2018). *भारत का भूगोल* (सप्तम् सं.). नई दिल्ली, भारत: टाटा मैक्ग्राहिल.** **Suggested e-learning materials** 1. **Monsoon** https://www.britannica.com/science/Indian-monsoon 2. **Drainage system of India** https://iasscore.in/pdf/samplenotes/4.%20Drainage.pdf 3. **Indira Gandhi canal https://nroer.gov.in/55ab34ff81fccb4f1d806025/file/57cff6e816b51c038dedd394** 4. **Human Resources of Rajasthan** http://worldpopulationreview.com/countries/india-population/	

			15. Routray, J. K. (1993) : Geography of Regional Disparity, Asian Institute of Technology, Bangkok. 16. Shafi, M. (2000) : Geography of South Asia, McMillan & Co., Calcutta. 17. Singh Gopal, (2010) Geography of India, Atma Ram Publication, Delhi 18. Spate, O. H. K. and Learmonth, A. T. A. (1967) : India and Pakistan - Land, People and Economy Methuen & Co., London. 19. Spate, O. H. K., & Learrmonth, A.T.A., India & Pakistan, London. 20. Vaidiya, K. S. (1988) : Dynamic Himalaya, University Press, Hyderabad. 21. Wadia, D. N., (1957) Geology of India, Macmillan, London. 22. चौहान, तेजसिंह (1994) : भारत का भूगोल, विज्ञान प्रकाशन, जयपुर 23. हुसैन माजिद, सिंह रमेश (2015) : भारत का भूगोल, टाटा मैक्ग्राहिल प्रकाशन, नई दिल्ली। 24. मामोरिया चतुर्भुज (2009) : भारत का वृहत भूगोल, साहित्य भवन आगस। 25. बंसल सुरेश चन्द्र (2011) : भारत का भूगोल, मीनाक्षी प्रकाशन, मेरठ। 26. सिंह गोपाल (2006) : भारत का भूगोल, आत्मारास, दिल्ली। 27. सक्सैना हरिमोहन (2014) : राजस्थान का भूगोल, राजस्थान हिन्दी ग्रंथ अकादमी प्रकाशन। 28. शर्मा राजकुमार (2010) : राजस्थान का भूगोल, हिमाशुं पब्लिकेशंन, उदयपुर। 29.शर्मा एच. एस.एवं शर्मा एम.एल. (2015) : राजस्थान का भूगोल, पचंशील प्रकाशन, जयपुर		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
6.	GEOG 203L Mapping and Prismatic Compass Survey Lab	**After the completion of this course, students should be able to:** • **Create distribution maps through chorochromatic, simple shading, choro-schematic methods.** • **Create maps of isobars, isotherms and dot method.** • **Conduct prismatic compass survey through radiation and intersection method.** • **Correct closing error through Bowditch rule.**	___	___	**Reviewed Learning outcomes, e-learning materials, recommended books and re-arranged the content**

				Recommended Books: 1. **Mishra, R. P., & Ramesh, A. (2014). *Fundamentals of Cartography* (2nd ed.). New Delhi, India: Concept.** 2. **Raize, E. (1948). *General Cartography*. London, UK: McGraw Hill.** 3. **Sarkar, A. (2015). *Practical Geography*: *A Systematic Approch* (3rd ed.). Kolkatta, India: Orient Black Swan.** 4. **Singh, R. N., & Kanaujia, L. R. S. (1998). *Map Work & Practical Geography*. Allahabad, India: Central Book Depot.** 5. खुल्लर, डी. आर. (2015). *प्रयोगात्मक भूगोल.* लुधियाना, भारत: कल्याणी. 6. दयाल, पी. (2006). *प्रयोगात्मक भूगोल की रुपरेखा.* नई दिल्ली, भारत: राजेश. 7. शर्मा, जे.पी. (2011). *प्रायोगिक भूगोल* (पंचम् सं.). मेरठ, भारत: रस्तोगी. **Suggested e-Learning Materials** 1. **Distribution Maps** http://ncert.nic.in/ncerts/l/legy303.pdf 2. **Prismatic Compass Survey** https://www.svce.ac.in/departments/cve/downloads/Surveying%20I/Unit%202.pdf	

FOURTH SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
7.	GEOG 201 Economic Geography	**After the completion of this course, students should be able to:** • **Define economic geography, describe its scope and relate it with other social sciences** • **Classify resources and describe soil mineral and energy resources** • **Describe spatial distribution, production and trade of rice, wheat, cotton, tea and Classify world into agricultural regions** • **Describe several industries, their location determinants, and distribution of iron-steel and cotton-textile industry.** • **Describe trade, transport, their controlling factors, major law making bodies of the world and major transport routes.**	Unit – I a) Definition and scope of Economic geography. b) Development of Economic geography. Its relation with other subjects. c) Concept of the economy. d) Economic activities: Primary, Secondary and Tertiary. e) Impact of economic activities on the environment. Unit – II a) Natural Resources: Meaning and classification of resources. b) Conservation of Resources: Water & Forest. c) Soil Resources: Composition of soil, factors affecting soil formation; soil profile. d) Mineral Resource: Type, Distribution & production of iron ore. e) Energy Resources: Types, Distribution and Production of coal and Petroleum. Unit – III a) Agriculture: Physical and socio– cultural environment influencing crop production. b) Spatial distribution, production and international trade of rice & wheat. c) Spatial distribution, production and international trade of cotton. d) Spatial distribution, production and international trade of tea. e) Agricultural classification: Whittlessey's classification. Unit – IV a) Manufacturing Industry: Meaning & Types. b) Determinants of location of industry. c) Industrial location Theory: A. Weber. d) Distribution & production of Iron & Steel industry. e) Distribution & production of cotton textile industry.	Unit I Definition and Scope of Economic geography; Development of Economic geography. Its relation with other Subjects; Concept of the Economy; Economic Activities: Primary, Secondary and Tertiary; Impact of Economic Activities on the Environment. Unit II Natural Resources: Meaning and Classification of Resources; Conservation of Resources: Water & Forest; Soil Resources: Composition of Soil, Factors affecting soil formation; Soil profile, **Soil classification (NRCS)**; Mineral Resource: Type, Distribution & Production of Iron Ore; Energy Resources: Types, Distribution and Production of Coal and Petroleum. Unit III Agriculture: Physical and Socio– Cultural environment influencing crop production; Spatial Distribution, Production and International trade of Rice & Wheat; Spatial Distribution, Production and Iinternational trade of Cotton; Spatial Distribution, Production and International trade of Tea; Agricultural Classification: Whittlesey's Classification. Unit IV Manufacturing Industry: Meaning & Types; Determinants of Location of industry; Industrial location Theory: A. Weber; Distribution & Production of Iron & Steel industry; Distribution & Production of Cotton Textile Industry. Unit V Trade: Type of trade, Factors affecting International trade; Evolution of International trade, Barriers of International trade, Agencies: GATT, WTO, EUROPEAN UNION; Transport: Importance & Development of transport; Means of transport; Water Transport: Suez Canal, Panama Canal,	**Reviewed Learning outcomes, e-learning materials, recommended books and re-arranged the content.** **Added topic for specification.**

Unit – V

a) Trade: Type of trade, Factors affecting International trade

b) Evolution of international trade; barriers of international trade.

c) Agencies: GATT, WTO, EUROPEAN UNION.

d) Transport: Importance & development of transport; Means of transport.

e) Water Transport: Suez Canal, Panama Canal, North Atlantic route.

*Note - Stencils are to be permitted during the examination

Recommended Books:

1. ~~Boesch, H. (1964) : A Geography of World Economy, D. Van Nostrand Co., New York.~~
2. ~~Chapman, J. D. (1989) : Geography and Energy, Longman, London.~~
3. ~~Gregor, H. F. (1970) : Geography of Agriculture, Prentice Hall, New Jersey, USA.~~
4. ~~Griggs, D. B. (1974) : The Agricultural Systems of the World, Cambridge University Press, New York.~~
5. ~~Hartshorne, T. N. and J. W. Alexander (1988) : Economic Geography, Prentice Hall, New Delhi.~~
6. ~~Jones, C. F. and G. G. Darkenwald (1975) : Economic Geography, McMillan Co., New York.~~
7. ~~Millar E. (1962) : Geography of Manufacturing, Prentice Hall, New York.~~
8. ~~Pickes, L. D., The Wealth of The World, Dan & Co., London.~~
9. ~~Raza. M. and Y. Agrawal (1986) : Transport Geography of India, Concept, New Delhi.~~
10. ~~Smith, D. M. (1971) : Industrial Location - An Economic Geographical Analysis, John Wiley, New York.~~
11. ~~Stamp, L. D., A Commercial Geography, Longmans.~~
12. ~~Thomas, R. S. (1962) : The Geography of Economic Activities, McGraw Hill, New York. UNO, Statistical~~

North Atlantic Route.

Note - Stencils are to be permitted during the examination

Recommended Books:

1. **Guha, J. L., & Chattoraj, P. R. (2009). *Economic geography – A Study of Resources* (9th ed.). Kolkata, India: The World Press.**
2. **Gurjar, R., & Jat, B. C. (2010). *Resources and Environment* (7th ed.). Jaipur, India: Panchsheel.**
3. **Hodder, B. W., & Lee, R. (2008). *Economic Geography* (Indian Reprint). Jaipur, India: Rawat.**
4. **Leong, G.C., & Morgan, G. C. (1982). *Human and Economic Geography* (2nd ed.). New York. NY: Oxford Press.**
5. **Maurya, S. D. (2018). *Economic Geography*. Allahabad, India: Pravalika.**
6. **Shelar, S. K. (2013). *Priciples of Economic Geography*. Kanpur, India: Chandralok.**
7. **Siddhartha, K. (2006). *Economic Geography Theories, Processes and Patterns* (2nd ed.). Delhi, India: Kisalaya.**
8. **Siddhartha, K. (2016). *Economic Geography* (3rd ed.). Delhi, India: Kitab Mahal.**
9. **गौतम, ए. (2015). *आर्थिक भूगोल के मूल तत्व.* इलाहाबाद, भारतः शारदा पुस्तक भवन.**
10. **जाट, बी. सी. (2016). *आर्थिक भूगोल* (चतुर्थ सं.). जयपुर, भारतः पंचशील.**
11. **मामोरिया, सी. (2012). *आर्थिक भूगोल* (द्वितीय सं.) .आगरा, भारतः साहित्य भवन.**
12. **राव. एस. (2013). *आर्थिक भूगोल.* गोरखपुर, भारतः वसुन्धरा.**
13. **सिंह, के. एन., एवं सिंह, जे. (2010). *आर्थिक भूगोल के मूल तत्व* (11वीँ सं.). गोरखपुर, भारतः ज्ञानोदय.**
14. **सिंह, जे. (2009). *संसाधन भूगोल.* नई दिल्ली, भारतः राधा.**

Suggested e-learning materials

1. **Suez Canal trade route**
   https://www.britannica.com/topic/Suez-Canal
2. **Panama Canal**
   https://www.pancanal.com/eng/op/routes.html

			Year Book (Latest Edition). 13. Guha, J.L. & Chattoraj, P.R. (2009) : 'A new Approach to Economic Geography' The World Press Private Ltd. Kolkata 14. Gautam, A. & Restogi, S. (2003): Economic Geography, International publishing House, Meerut. 15. Saxena, H.M. (2003): Economic Geography, Rawat Publications, New Delhi. 16. Sharma, T.C. (2003) : Economic Geography of India, Rawat Publications, Jaipur 17. गौतम अ. (2015): आर्थिक भूगोल के मूल तत्व,शारदा पुस्तक भवन, इलाहाबाद। 18. राव एवं श्रीवास्तव (2013) : आर्थिक भूगोल, वसुन्धरा प्रकाशन, गोरखपुर। 19. जाट, बी. सी. (2006) आर्थिक भूगोल, पंचशील प्रकाशन, जयपुर। 20. हुसैन, माजिद (2000) कृषि भूगोल, रावत पब्लिकेशन, जयपुर। 21. मामोरिया, चतुर्भुज (2008) आर्थिक भूगोल, साहित्य भवन पब्लिकेशन, आगरा। 22. एस. डी. कौशिक एवंम डॉ. अल्का गोतम (2011) संसाधन भूगोल, रस्तोगी एण्ड रस्तोगी पब्लिकेशन। 23. शर्मा, हरिशचंद्र, (1983) भारत का आर्थिक भूगोल तथा भारतीय अर्थशास्त्र, रमेश बुक डिपो, जयपुर। 24. सिंह जे. (2009) संसाधन भूगोल, राधा पब्लिकेशन, नई दिल्ली। 25. सिंह के. एन., और सिंह जे. (2003) आर्थिक भूगोल के मूल तत्व, ज्ञानोदय प्रकाशन, गोरखपुर। 26. सिंह, काशीनाथ (2009) आर्थिक भूगोल के मूल तत्व : संसाधन उपयोग, संरक्षण एवं आर्थिक विकास का अध्ययन, ज्ञानोदय प्रकाशन। 27. सिंह, काशीनाथ (2009) आर्थिक भूगोल के मूल तत्व : संसाधन उपयोग, संरक्षण एवं आर्थिक विकास का अध्ययन, ज्ञानोदय प्रकाशन, गोरखपुर।		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
8.	GEOG204L Relief Representation and Topographical Maps Lab	**After the completion of this course, students should be able to:** • **Interpret topographical maps.** • **Represent topographical features with the help of contours.** • **Identify Human and natural phenomenon.** • **Create Profiles using Contours in the topographical sheets.**	a) Method s of Relief Representation : Hachures, Contours, Layer tint, BM, Spot height b) Representation of Relief Features : Water fall, Ridge, Gorge, Pass, Hanging valley along with U-shaped valley, sand dunes, cirque, dolines c) Profiles: Serial, Superimposed, Projected & Composite. d) Conventional Signs & Symbols on Toposheets. e) Interpretation of Toposheets. Notes: Candidates will be examined by an External Examiner in consultation with the Internal Examiner. Each exercise should be drawn on 1/4th of a full drawing sheet. The test paper of practical will be of three hours duration and candidates will be required to answer three questions out of five. The distribution of marks will be as follows: a. Paper 35 Marks b. Record Work* 15 Marks c. Viva-voce** 10 Marks *Record work will be assessed by the teacher in-charge of the practical group and the external examiner. ** Viva-voce will be based on the record work. Recommended Books: ~~1. Kanetkar, T. P. (1985) : Surveying and Levelling, Vol. I, A. V. Griha Prakashan, Bombay.~~ ~~2. Mishra, R. P. and A. Ramesh (2014): Fundamentals of Cartography, Concept Publishers, New Delhi.~~ ~~3. Raize, E. (1948) : General Cartography, McGraw Hill Book Co., London.~~ ~~4. Robinson, A. R. (2004) : Elements of Cartography, Chapman & Hall.~~	1. Method s of Relief Representation : Hachures, Contours, Layer tint, BM, Spot Heights. 2. Representation of Relief Features : Water fall, Ridge, Gorge, Pass, Hanging valley along with U-shaped valley, Sand Dunes, Cirque, Dolines. 3. Profiles: Serial, Superimposed, Projected & Composite. 4. Conventional Signs & Symbols on Toposheets/ **Open Series Map (OSM)**. 5. Interpretation of Toposheets/**Open Series Map (OSM)**. Recommended Books: 1. **Mishra, R. P., & Ramesh, A. (2014). *Fundamentals of Cartography* (2nd ed.). New Delhi, India: Concept.** 2. **Raize, E. (1948). *General Cartography*. London, UK: McGraw Hill.** 3. **Singh, G. (2009). *Map work and Practical Geography* (4th ed.). Delhi, India: Vikas.** 4. **खुल्लर, डी. आर. (2015). *प्रयोगात्मक भूगोल*. लुधियाना, भारत: कल्याणी.** 5. **शर्मा, जे.पी. (2011). *प्रायोगिक भूगोल* (पंचम् सं.). मेरठ, भारत: रस्तोगी.** **Suggested e-learning materials** **1. Method of relief representation** **http://www.sfu.ca/~hickin/Maps/Chapter%204.pdf** **2. Representation of relief features** **http://ncert.nic.in/ncerts/l/kegy305.pdf**	**Reviewed Learning outcomes, e-learning materials, recommended books and re-arranged the content for specification.**

			5. Saha, Piyushkant and Basu Partha (2011) : Advanced Practical Geography, Books & Allied Pvt. Ltd., Kolkatta. 6. Sarkar, Ashish (2010) : Practical Geography : A Systematic Approch, Orient BlackSwan, Kolkatta. 7. Singh, Gopal (2009) : Map work and Practical Geography, Vikas Publishing House Pvt. Ltd., Delhi. 8. Singh, R. L. (2011) : Elements of Practical Geography, Kalyani Publishers. 9. Singh, R. N. and Kanaujia L. R. S. (1998) : Map Work & Practical Geography, Central Book Depot, Allahabad. 10. शर्मा, जे.पी. (2011) : प्रायोगिक भूगोल, रस्तोगी प्रकाशन, मेरठ 11. दयाल, प. (2006) : प्रयोगात्मक भूगोल की रूपरेखा, रजेश पब्लिकेशन्स, नई दिल्ली। 12. शर्मा, राजकुमार (2011) : अभिनव प्रयोगात्मक भूगोल, हिमांशु पब्लिकेशन्स, नई दिल्ली। 13. वर्मा, ल. व लोढ़ा राजमल (1999) : प्रयोगात्मक भूगोल, राजस्थान हिन्दी ग्रन्थ अकादमी, जयपुर। 14. सिंह, आर.एल. (2011) : प्रायोगिक भूगोल के सिद्धान्त, शारदा पुस्तक भवन, इलाहाबाद। 15. इश्तियाक, एम. (1999) : प्रायोगिक भूगोल, मानक पब्लिकेशन्स, दिल्ली। 16. सिंह एवं सिंह (2013) : प्रयोगात्मक भूगोल के मूल तत्व, कल्याणी प्रकाशन, लुधियाना। 17. खुल्लर, डी. आर. (2015) : प्रयोगात्मक भूगोल, कल्याणी प्रकाशन, लुधियाना। 18. चौहान, पी.आर. (2010) : प्रयोगात्मक भूगोल, वसुन्धरा प्रकाशन, गोरखपुर।		

FIFTH SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
9.	~~5.1~~ World Regional Geography	**Learning Outcomes:** • **After the completion of this course, students should be able to:** • **Elucidate physical aspects of Asia, Europe, Africa, North & South America and Oceania.** • **Describe cultural aspects of Asia, Europe, Africa, North & South America and Oceania.** • **Compare different continents of world.** • **llustrate terrain, drainage, climate, natural vegetation and Industrial regions of studied continents.**	Unit – I :- Asia a) Geographical location and extension, unity in diversity in Asia. b) Terrain and drainage. c) Spatial distribution of population. d) Climate, Natural vegetation & soil. e) Industrial regions of Japan and China. Unit – II :– Europe a) Location, Extension and Geographical characteristics. b) Terrain & drainage. c) Climate, natural vegetation & soil. d) Spatial distribution of population. e) Industrial regions of Britain. Unit – III : - Africa a) Location and extension. b) Terrain & drainage. c) Climate, natural vegetation & soil. d) Spatial distribution of population. e) Industrial regions of Africa. Unit – IV :- North & South America a) Location, extension and geographical characteristics. b) Terrain & drainage. c) Climate, natural vegetation & soil. d) Spatial distribution of population. e) Industrial regions of U.S.A. Unit – V :- Oceania (Australia and New Zealand) a) Location, extension and geographical characteristics. b) Terrain & drainage.	**Discipline Elective**	**Shifted to pool of discipline electives.**

			c) Climate, natural vegetation & soil. d) Spatial distribution of population. e) Industrial regions of Australia. *Note - Stencils are to be permitted during the examination Recommended Books: 1. ~~Cole, J. (1996) : A Geography of the World's Major Regions, Routledge, London.~~ 2. ~~Cole, J. P. (1975) : Latin America - Economic and Social Geography, Butterworth, USA.~~ 3. ~~Cole, M. M. (1961) : South Africa, Dutton, New York.~~ 4. ~~de Blij, H. J. (1994) : Geography: Regions and Concepts, John Wiley & Sons Inc., New York.~~ 5. ~~Dickenson, J. P. et al. (1996) : The Geography of the Third World, Routledge, London.~~ 6. ~~Gourou, R. (1980) : The Tropical World, Longman, London.~~ 7. ~~Kolb, A., East Asia (1977) : Geography of a Cultural Region, Methuen, London.~~ 8. ~~Minshull, G. N. (1984) : Western Europe, Hoddard & Stoughton, New York.~~ 9. ~~Patterson, J. H. (1985) : Geography of Canada and the United States, Oxford University Press.~~ 10. ~~Songquiao, Z. (1994) : Geography of China, John Wiley & Sons Inc., New York.~~ 11. ~~Ward, R. W. and A. Miller (1989) : World Regional Geography: A Question of Place, John Wiley & Sons Inc., New York.~~ 12. ~~Hussain, M. (2012) : World Geography 4th Edition, Rawat Publications, Jaipur~~ 13. ~~सिंह, जगदीश, राव बी. पी. (2007) : तीन दक्षिणी महाद्वीप, प्रो. राम बली सिंह गोरखपुर, ।~~ 14. ~~राव बी. पी., सत्यपति, डी.पी. (2010) : एशिया की~~		

			~~भौगोलिक समीक्षा, वसुन्धरा पब्लिकेशन, गोरखपुर।~~ ~~15. लोढा, राजमल (2010) : औद्योगिक भूगोल, राजस्थान हिन्दी ग्रंथ अकादमी, जयपुर ।~~ ~~16. अग्रवाल रा. (2011) : विश्व का भूगोल, इशिका पब्लिशिंग हाउस, जयपुर।~~ ~~17. सक्सेना, एच.एम (2011) : विश्व का प्रादेशिक भूगोल, रस्तोगी, पब्लिकेशन्स, मेरठ।~~		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
10.	~~5.2~~ Map Projection Lab	**Learning Outcomes:** **After the completion of this course, students should be able to:** • **Elucidate necessity & classification of map projections.** • **Compare different kind of map projections.** • **Construct map projections graphically.** • **Suggest projection for any area of earth surface.**	a. Map Projection Definition and history of map projection. b. Necessity & classification of map projection. c. Graphical construction of map projection. d. Zenithal Projection: Polar zenithal equidistant projection, polar zenithal equal area, Gnomonic polar zenithal projection, orthographic polar zenithal projection. e. Conical Projection : Simple conical projection with one standard parallel. Bonne's projection & polyconic projection. f. Cylindrical Projection : Perspective cylindrical projection, cylindrical equal area projection, Mercator's projection. g. Conventional Projection : Molleweide's projection & globular projection. Non Scientific calculators are allowed during the examination Notes: 1. Candidates will be examined by an External Examiner in consultation with the Internal Examiner. 2. Each exercise should be drawn on a full drawing sheet. 3. The test paper of practical will be of three hours duration and candidates will be required to answer three questions out of five. 4. The distribution of marks will be as follows: a. Paper 12 Marks b. Record Work* 05 Marks c. Viva-voce** 03 Marks *Record work will be assessed by the teacher in-charge of the practical group and the external examiner. ** Viva-voce will be based on the record work. Recommended Books: 1. ~~Robinson, A. R. (2004) : Elements of Cartography,~~	1. Map Projection Definition and History of Map Projection. 2. Necessity & Classification of Map Projection. 3. Graphical Construction of Map Projection. 4. Zenithal Projection: Polar zenithal equidistant projection, Polar zenithal equal area, Gnomonic polar zenithal projection, Orthographic polar zenithal projection. 5. Conical Projection: Simple conical projection with one **and two** standard parallel. Bonne's projection & Polyconic projection. 6. Cylindrical Projection: Perspective cylindrical projection, Cylindrical equal area projection, Mercator's projection. 7. Conventional Projection: Molleweide's projection & globular projection. Non Scientific calculators are allowed during the examination Recommended Books: 1. **Saha, P., & Basu, P. (2011). *Advanced Practical Geography* (7th ed.). Kolkatta, India: Books & Allied.** 2. **Singh, G. (2009). *Map work and Practical Geography* (4th ed.). Delhi, India: Vikas.** 3. **खुल्लर, डी. आर. (2015). *प्रयोगात्मक भूगोल.* लुधियाना, भारत: कल्याणी.** 4. **शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल* (पंचम् सं.). मेरठ, भारत: रस्तोगी.** 5. **सिंह, आर. एल. (2013). *प्रायोगिक भूगोल के सिद्धान्त* (तृतीय सं.). इलाहाबाद, भारतः शारदा पुस्तक भवन.** **Suggested e-learning materials** **1. Types of map projection** **https://www.gistda.or.th/main/en/node/950** 2. **Meaning and elements of map projection,**	**Reviewed Learning outcomes, e-learning materials, recommended books and re-arranged the content** **Added Topic for enrichment**

			Chapman & Hall. 2. Singh, R. L. (2011) : Elements of Practical Geography, Kalyani Publishers. 3. Raize, E. (1948) : General Cartography, McGraw Hill Book Co., London. 4. Singh, R. N. and Kanaujia L. R. S. (1998) : Map Work & Practical Geography, Central Book Depot, Allahabad. 5. Mishra, R. P. and A. Ramesh (2014): Fundamentals of Cartography, Concept Publishers, New Delhi. 6. Kanetkar, T. P. (1985) : Surveying and Levelling, Vol. I, A. V. Griha Prakashan, Bombay. 7. Sarkar, Ashish (2010) : Practical Geography : A Systematic Approch, Orient BlackSwan, Kolkatta. 8. Singh, Gopal (2009) : Map work and Practical Geography, Vikas Publishing House Pvt. Ltd., Delhi. 9. Saha, Piyushkant and Basu Partha (2011) : Advanced Practical Geography, Books & Allied Pvt. Ltd., Kolkatta. 10. शर्मा, जे.पी. (2011) : प्रायोगिक भूगोल, रस्तोगी प्रकाशन, मेरठ 11. दयाल, प. (2006) : प्रयोगात्मक भूगोल की रूपरेखा, रजेश पब्लिकेशन्स, नई दिल्ली। 12. शर्मा, राजकुमार (2011) : अभिनव प्रयोगात्मक भूगोल, हिमांशु पब्लिकेशन्स, नई दिल्ली। 13. वर्मा, ल. व लोढ़ा राजमल (1999) : प्रयोगात्मक भूगोल, राजस्थान हिन्दी ग्रन्थ अकादमी, जयपुर। 14. सिंह, आर.एल. (2011) : प्रायोगिक भूगोल के सिद्धान्त, शारदा पुस्तक भवन, इलाहाबाद। 15. इश्तियाक, एम. (1999) : प्रायोगिक भूगोल, मानक पब्लिकेशन्स, दिल्ली। 16. सिंह एवं सिंह (2013) : प्रयोगात्मक भूगोल के मूल तत्व, कल्याणी प्रकाशन, लुधियाना। 17. खुल्लर, डी. आर. (2015) : प्रयोगात्मक भूगोल, कल्याणी प्रकाशन, लुधियाना। 18. चौहान, पी.आर. (2010) : प्रयोगात्मक भूगोल, वसुन्धरा प्रकाशन, गोरखपुर।	**construction of conical and cylindrical projection** **http://ncert.nic.in/textbook/pdf/kegy304.pdf**	

SIXTH SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
11.	~~6.1~~ Geographical Thought	**After the completion of this course, students should be able to:** • **Explain evolution of geographical thought and relationship of Geography with other branches of knowledge.** • **Describe different tools and techniques of geographical study.** • **Compare ancient, medieval and modern scholar's contributions in geography.** • **Elucidate important concepts of geography as well as recent trends and current issues of subject.**	Unit – I a) Definition and aims of geography. b) Branches of Geography. c) Relationship of geography with other science. d) Tools and techniques in Geography. e) Evolution of Geographical thought. Unit – II a) Beginning of Classical Geography: Contribution of Greeks (Herodotus & Eratosthenes). b) Contribution of Romans – Strabo & Ptolemy. c) Early medieval geography : contribution of Arab Geographers (Al – Burini & Ibn-Battuta). d) Renaissance : Marco polo & Varenius. e) Main aspects of geography in Ancient India. Unit – III a) Contribution of German Schools of Geography: Humboldt & Carl Ritter. b) Contribution of French School of Geography: Vidal –de- la blache & Jean Brunhes. c) Contribution of British School of Geography: Halford J. Mackinder. d) Contribution of American School of Geography: E. Huntington & Carl O. Sauer. e) Contribution of Soviet School of Geography : Peter Kropotkin Unit – IV a) Man – environment relations: Determinism, Possibilism and Neo-Determinism. b) Dichotomies in Geography : Physical Vs Human Geography , Systematic Vs Regional Geography. c) Positivism and Quantitative revolution. d) Behaviouralism in Geography e) Radicalism: Origin, Salient features & Objectives of	**Discipline Elective**	**Shifted to pool of Discipline electives.**

			Radical Geography. Unit – V a) Concept of Areal differentiation. b) Concept of region and types of region. c) Concept of cultural landscape: Meaning & elements of cultural landscape. d) Recent trends of Modern Geography: Six Trends by Freeman. e) Applied Geography: Meaning and methods of Applied geography; Need of Applied geography in India. *Note - Stencils are to be permitted during the examination Recommended Books: 1. ~~Abler, Ronald F. et al, Geography's Inner Worlds: Pervasive themes in contemporary American Geography, Routledge, New Jersey, 1992.~~ 2. ~~Dikshit R. D.: Geographical Thought - A Contextual History of Ideas, Prentice Hall of India Pvt. Ltd. 2000.~~ 3. ~~Dikshit R. D.: The Art and Science of Geography: Integrated Readings, Prentice Hall of India, New Delhi, 1994.~~ 4. ~~Dohrs, F. E. and Sommers, L. W. (eds.) Introduction to Geography, Thomas Y. Crowell Co., New York, 1967~~ 5. ~~Hartshorne, Richard, Perspective on the Nature of Geography, Rand McNally and Co., Chicago, 1959.~~ 6. ~~Harvey, David, Explanation in Geography, Edward Arnold, London, 1972.~~ 7. ~~Holt-Jensen, A., Geography: Its History and Concepts, Longmans, 1980.~~ 8. ~~Husain, Majid, Evolution of Geographical Thought, Rawat Publications, Jaipur, 1984.~~ 9. ~~James, P. E., All Possible Worlds: A History of Geographical Ideas, Sachin Publication, Jaipur, 1980 .~~ 10. ~~Johnston, R. J. and Claval, R (eds.), Geography Since the Second World War, Croom Heim, London/Bernes and Noble, N. J., 1984.~~ 11. ~~Jones, P.A.: Field Work in Geography, Longmans,~~		

			1968. 12. Lownsburg, J. F. and Aldrich, F. T., Introduction to Geographical Methods and Techniques, Charles Marrill, Columbus, 1979. 13. Minshull, R., The Changing Nature of Geography, Hutchinson University Library, London, 1970. 14. Wooldridge, S. W., The Geographer As Scientist, Thomas Nelson and Sons. Ltd., London, 1956. 15. कौशिक, एस. डी. (2014) : भौगोलिक विचारधारा एवं विधि तंत्र, रस्तोगी प्रकाशन, मेरठ। 16. माथुर एवं जोशी (2010) : भौगोलिक विचारधाराओं का इतिहास, आर. बी. एस. पब्लिशर्स, जयपुर। 17. सिंह, जे. (2012) : भौगोलिक चिन्तन के मूलाधार, वसुन्धरा प्रकाशन, नई दिल्ली 18. सिंह यू. (2008) : भौगोलिक चिन्तन का विकास, कल्याणी पब्लिशर्स, नई दिल्ली।		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
12	~~6.2~~ Fundamentals of Geoinfomatics Lab	**After the completion of this course, students should be able to:** • **Explain development and types of aerial photographs.** • **Identify and interpret aerial photographs.** • **Elucidate different elements and development of remote sensing.** • **Describe different kinds of remote sensing platforms and discuss important elements of GIS.**	____	____ Recommended Books: 1. **American Society of Photogrammetry. (1993). *Manual of Remote Sensing (2nd ed.)*. Virginia, VA: ASP, Falls Church.** 2. **Fazal, S. (2008). *Remote Sensing Basics*. New Delhi, India: Kalyani.** 3. **Hammond, R., & McCullagh, P. (1978). *Quantitative Techniques in Geography: An Introduction (2nd ed.)*. Oxford, UK : Clarendon Press.** 4. **Nag, P., & Kudrat, M. (1998). *Digital Remote Sensing*. New Delhi, India: Concept.** 5. **Singh, R. L. (2011). *Elements of Practical Geography* (8th ed.). New Delhi, India: Kalyani.** 6. चौनियाल, डी. (2010). *सुदूर संवेदन एवं भौगोलिक सूचना प्रणाली.* इलाहाबाद, भारत: शारदा पुस्तक भवन. 7. शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल (पंचम् सं.).* मेरठ, भारत: रस्तोगी. **Suggested e-learning materials** 1. **History, type and application of aerial photography https://www.environmentalscience.org/principles-applications-aerial-photography** 2. **Remote sensing platform and GIS http://ags.geography.du.ac.in/Study%20Materials_files/Punyatoya%20Patra_AM.pdf** 3. **Principles of Aerial Photography http://www.sfu.ca/~hickin/Maps/Chapter%208.pdf** 4. **Interpretation of Aerial Photographs https://www.nrem.iastate.edu/class/assets/nrem345/Week6_ALL.pdf**	**Reviewed Learning outcomes, e-learning materials, recommended books and re-arranged the content**

List of Discipline Electives

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	GEOG___ **Environment and Disaster Management**	**After the completion of this course, students should be able to:** • **Understand about the ecosystem and their functions** • **Describe disaster, its types and issues generated during different cycles of disasters** • **Describe the policies of disaster management in India** • **Assimilate role of different bodies established for the cause of disaster relief.**		**Unit I** **Ecosystem: Types, Structure and Functions, Energy Flow; Food Chains, Food Web, Ecological Succession.** **Unit II** **Introduction, Characteristic Features, Structure and Functions of Forest Ecosystem, Grassland Ecosystem, Desert Ecosystem, Aquatic Ecosystem (Ponds, Lakes, Streams)** **Unit III** **Disaster and Types: Earthquake, Cyclone, Floods, Volcanoes, Tsunami, Famine, Draught, Epidemics.** **Unit IV** **Scenario of Disaster Management in India; India's Vulnerability Profile; Disaster Management Act 2009 and Policy Guidelines, Case studies: Bhuj Earthquake 2001, The Indian Ocean Tsunami 2004, Kashmir Floods 2014.** **Unit V** **National Institute of Disaster Management; National Disaster Response Force (NDRF); National Disaster Management Authority; State Disaster Management Authority; District Disaster Management Authority.** **Recommended Books:** 1. **Bolt, B. A. (1988). *Earthquakes.* New York, NY: WH Freeman & Company.** 2. **Decker, R. W., & Decker, B. B. (2005). *Volcanoes* (4th ed.). New York, NY: WH Freeman & Company.** 3. **Dowrick, D. (2003). *Earthquake Risk Reduction Zone.* England, UK:John Wiley & Sons.** 4. **Gere, J. M., & Shah, H. C. (1984). *Terra Non Firme***	**New course has been introduced in pool of discipline electives.**

				Understanding and Preparing for Earthquakes. **New York, NY: WH Freeman & Company.** 5. **IGNOU (2005).** ***Understanding Natural Disasters*****. eGyanKosh, Noida, India: Shagun Offset Press.** 6. **Keller, E. A., &Devecchio, E. D. (2015). Natural Hazards (4th ed.). New York, NY: Pearson.** 7. **Keller, E.A. (1978).** ***Environmental Geology*** **(9th ed.). North Carolina, NC: Bell & Howell.** 8. **Montgomery, C.W. (2013).** ***Environmental Geology*** **(10th ed.). Texas, TX: McGrawHill.** 9. **Prakash, I. (1994).** ***Disaster Management*****. Ghaziabad, India: Rastriya Prahari.** 10. **Sharma, V. K. (1995).** ***Disaster Management*****. New Delhi, India: Indian Institute of Public Administration (*IIPA*).** 11. **Singh, S. (2015).** ***Environmental Geography*****. Allahabad, India: Pravalika** **Suggested e-learning materials:** **1.Disaster management policy 2009** **https://ndma.gov.in/images/guidelines/national-dm-policy2009.pdf** **2.Policies of Disaster Preparedness** **https://www.ifrc.org/Global/Governance/Policies/disaster-policy-en.pdf**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	**GEOG___** Geographical Thought	**After the completion of this course, students should be able to:** • **Explain evolution of geographical thought and relationship of Geography with other branches of knowledge.** • **Describe different tools and techniques of geographical study.** • **Compare ancient, medieval and modern scholar's contributions in geography.** • **Elucidate important concepts of geography as well as recent trends and current issues of subject.**		Unit I Definition and Aims of Geography, Branches of Geography. Relationship of geography with other Science, Tools and Techniques in Geography; Evolution of Geographical Thought. Unit II Beginning of classical geography: Contribution of Greeks (Herodotus & Eratosthenes); Contribution of Romans (Strabo & Ptolemy); Early medieval Geography: contribution of Arab Geographers (Al – Burini & Ibn-Battuta); Renaissance : Marco polo, Varenius and **E. Kant**; Main Aspects of geography in Ancient India. Unit III Contribution of German Schools of Geography: Humboldt & Carl Ritter; Contribution of French School of Geography: Vidal –de- la blache & Jean Brunhes; Contribution of British School of Geography: Halford J. Mackinder; Contribution of American School of Geography: E. Huntington & Carl O. Sauer; Contribution of Soviet School of Geography : Peter Kropotkin Unit IV Man – Environment Rrelations: Determinism, Possibilism and Neo-Determinism; Dichotomies in Geography: Physical Vs Human Geography, Systematic Vs Regional Geography; Positivism and Quantitative revolution; Behaviouralism in Geography; Radicalism: Origin, Salient features & Objectives of Radical Geography. Unit V Concept of Areal differentiation, Concept of Region and Types of Region; Concept of Cultural Landscape: Meaning & Elements of Cultural Landscape; Recent trends of Modern Geography: Six Trends by Freeman;	**Shifted from core course to pool of discipline electives.**

				Applied Geography: Meaning and Methods of Applied Geography; Need of Applied Geography in India. Stencils are to be permitted during the examination **Recommended Books:** **1. Daniels, P., Bradshaw, M., Shaw, D., & Sidaway, J. (2008). *An Introduction to Human Geography: Issues for the 21st Century* (3rd ed.). London, UK: Prentice Hall.** **2. Dikshit, R. D. (2018). *A Contextual History of Ideas* (2nd ed.). New Delhi, India: PHI.** **3. Hussain, M. (2014). *Evolution of Geographical thought* (6thed.). New Delhi, India: Rawat .** **4. Kaushik, S. D., & Rawat. D. S. (2017). *Geographical Thought and Methodology*. Meerut, India: Rastogi.** **5. Martin, G. (2007). *All Possible Worlds. A History of Geographical Ideas* (4th ed.). New York, NY: Oxford University Press.** **6. Maurya, S. D. (2013). *History Of Geographical Thought.* Allahabad, India: Sharda Pustak Bhawan.** **7. Rana, L. (2008). *Geographical thought A systematic record of evolution*. New Delhi, India: Concept.** **8. Singh, M. (2016). *Geographical Thought*. New Delhi, India: Sonali.** **9.** कौशिक, एस. डी., एवं रावत, डी. एस. (2017). ***भौगोलिक विचारधारा एवं विधि तंत्र*** (नवम् सं.). मेरठ, भारत रस्तोगी. **10.** जैन, एस. एम. (2018). ***भौगोलिक चिन्तन का विकास*** (संशोधित सं.). आगरा, भारतः साहित्य भवन. **11.** प्रसाद, गोविन्द (2006). ***भौगोलिक संकल्पनाएँ.*** नई दिल्ली, भारतः डिसकवरी. **12.** मौर्य, एस. डी. (2015). ***भौगोलिक चिन्तन का इतिहास.*** इलाहाबाद, भारतः प्रयाग पुस्तक भवन. **13.** सिंह, जे. (2009). ***भौगोलिक चिन्तन के मूल आधार.*** नई दिल्ली, भारतः वसुन्धरा. **14.** हुसैन, एम. (2006). ***भौगोलिक चिन्तन का इतिहास.*** जयपुर, भारतः रावत. **Suggested e-Learning Materials**	

				1. **Man-Environment relations** https://epgp.inflibnet.ac.in/ahl.php?csrno=17 **P-06,M-12** 2. **Concept of Region** https://epgp.inflibnet.ac.in/ahl.php?csrno=17 **P-06, M-20** 3. **Behaviouralism in Geography** https://epgp.inflibnet.ac.in/ahl.php?csrno=17 **P-06, M-27** 4. **Radicalism** https://epgp.inflibnet.ac.in/ahl.php?csrno=17 **P-06,M-29** 5. **Applied Geography** https://epgp.inflibnet.ac.in/ahl.php?csrno=17 **P-06,M-34**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	**GEOG___ Settlement Geography**	**Learning Outcomes: After the completion of this course, students should be able to:** • **Develop an approach to study settlements.** • **Depict the evolution of settlements and relate it to the geographical factors.** • **Describe rural and urban morphology, its meaning and types.** • **Classify cities functionally into different zones.**		**Unit I** **Settlement Geography: Meaning, Scope, Development and Approaches; Relation of Settlement Geography with Social Sciences; Concepts of Settlement Geography, Importance of Settlement Study in Geography, Techniques and Tools of Settlement Geography.** **Unit II** **Settlement: Meaning and Definition, Factors Affecting Origin and Evolution of Settlements, Sources related to the Origin and Growth of Settlements, Bases, Types and Classification of Settlements.** **Unit III** **Types of Rural Settlements: Compact, Semi-compact, Hamlet and Dispersed; Types of Rural Settlements in India; Rural Morphology: Definition, Factors affecting, Stages of Development and Types – Physical, Functional and Social.** **Unit IV** **Concept of Town and Urban Area: Difference between Rural and Urban Settlements, Definition of a Town; Factors affecting Origin and Evolution of Towns and Cities, Stages of Evolution of Cities according to G. Taylor; Urban Morphology: Definition, Factors Affecting, Stages of Development and their Types.** **Unit V** **Theories of Urban Morphology: Concentric Zone Theory of Burgess, Sector Theory of Hoyt and Multiple Nuclei Theory of Harris & Ullman; Urban Landuse and their Types; Functional Classification of Cities according to C. D. Harris;**	**New course has been introduced in pool of discipline electives.**

				Central Place Theory of Walter Christaller; Concept of Conurbation and Umland. ***Note - Stencils are to be permitted during the examination** **Recommended Books:** 1. **Bansal, S. C. (2015). *Urban Geography* (2nd ed.). Meerut, India: Meenakshi.** 2. **Daniel, P. (2002). *Geography of Settlement.* Jaipur, India: Rawat.** 3. **Ghosh, S. (1999). *Geography of Settlements*. Kolkata, India: Orient Longman.** 4. **Hussain, M. (2003). *Urban Geography*. New Delhi, India: Anmol.** 5. **Mandal, R. B. (2000). *Urban Geography* (2nd ed.). New Delhi, India: Concept.** 6. **Singh, R. Y. (2014). *Geography of Settlements* (2nd ed.). Jaipur, India: Rawat.** 7. तिवारी, आर. सी. (2016). *अधिवास भूगोल* (अष्ट सं.). इलाहबाद, भारतः प्रयाग पुस्तकभवन. 8. बंसल, एस. सी. (2016). *ग्रामीण बस्ती भूगोल* (संशोधित सं.). मेरठ, भारतः मीनाक्षी. 9. मौर्य, एस. डी. (2017). *अधिवास भूगोल* (षष्ठ सं.).इलाहबाद, भारतः शारदा पुस्तक भवन. 10. सिंह, आई. (2008). *अधिवास भूगोल.* नई दिल्ली, भारतः यूनिवर्सिटी. 11. सिंह, आर. (2005). *अधिवास भूगोल.* नई दिल्ली, भारतः रावत. **Suggested e-learning materials:** **1. Settlement patterns** **https://www.britannica.com/place/India/Caste#ref487283** **2. Rural settlement** https://www.jstor.org/stable/150101?seq=1#metadata_info_tab_contents **3.Origin and evolution of towns** **http://www4.brandonu.ca/ebertsd/281/281f17unit02.pdf**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	**GEOG___** World Regional Geography	**Learning Outcomes:** • **After the completion of this course, students should be able to:** • **Elucidate physical aspects of Asia, Europe, Africa, North & South America and Oceania.** • **Describe cultural aspects of Asia, Europe, Africa, North & South America and Oceania.** • **Compare different continents of world.** • **llustrate terrain, drainage, climate, natural vegetation and Industrial regions of studied continents.**		Unit I Asia -Geographical Location and Extension, Unity in Diversity in Asia, Terrain and Drainage, Spatial Distribution of Population, Climate, Natural Vegetation & Soil, Industrial Regions of Japan and China. Unit II Europe-Location, Extension and Geographical Characteristics, Terrain & Drainage, Climate, Natural Vegetation & Soil, Spatial Distribution of Population, Industrial Regions of Britain. Unit III Africa-Location and Extension, Terrain & Drainage, Climate, Natural Vegetation & Soil, Spatial Distribution of Population, Industrial Regions of Africa. Unit IV North & South America-Location, Extension and Geographical Characteristics, Terrain & Drainage, Climate, Natural Vegetation & Soil, Spatial Distribution of Population, Industrial Regions of U.S.A. Unit V Oceania (Australia and New Zealand)-Location, Extension and Geographical Characteristics, Terrain & Drainage, Climate, Natural Vegetation & Soil, Spatial Distribution of Population, Industrial Regions of Australia. ***Note - Stencils are to be permitted during the examination** **Recommended Books:** **1. Cole, J. (1996). *A Geography of the World's Major Regions*. London, UK: Routledge.** **2. Cole, M. M. (1961). *South Africa*. New York, NY: Dutton.** **3. Gourou, R. (1980). *The Tropical World* (5th ed.).London, UK: Longman.**	**Shifted from core course to pool of discipline electives**

4. Hussain, M. (2012). *World Geography* (4th ed.). Jaipur, India :Rawat.
5. Kolb, A. (1977). *Geography of a Cultural Region*. London, UK: Methuen.
6. Manku, D. S. (2017). *A Regional Geography of the World*(6th ed.). Ludhiana, India: Kalyani.
7. Minshull, G. N. (1984). *Western Europe*. New York, NY: Hoddard& Stoughton.
8. Songquiao, Z. (1994). *Geography of China.* New York, NY: John Wiley & Sons.
9. Ward, R. W., & Miller, A. (1989). *World Regional Geography: A Question of Place.* New York, NY: John Wiley & Sons.
10. अग्रवाल, एस. (2011). *विश्वकाभूगोल.*जयपुर, भारतः इशिका.
11. राव, बी. पी., एवंसत्यपति, डी.पी. (2010). *एशिया की भौगोलिकसमीक्षा*(द्वितीय सं.).गोरखपुर, भारतः वसुन्धरा.
12. लोढा, आर. एम. (2010). *औद्योगिकभूगोल* (चतुर्थ सं.). जयपुर, भारतः राजस्थानहिन्दीग्रंथअकादमी.
13. सक्सेना, एच.एम. (2011). *विश्वकाप्रादेशिकभूगोल.* मेरठ, भारतः रस्तोगी.
14. सिंह, जे., एवंराव, बी. पी. (2007). *तीनदक्षिणी महाद्वीप*(सप्तम् सं.). गोरखपुर, भारतः वसुन्धरा.

Suggested e-learning materials:

1. **Drainage of Australia**
   River's in Australia
   https://www.7continentslist.com/australia/rivers-in-australia.php
2. **Drainage of North America**
   https://www.7continentslist.com/north-america/rivers-in-north-america.php
3. **Physical features and climate of Australia**
   https://saylordotorg.github.io/text_world-regional-geography-people-places-and-globalization/s15-australia-and-new-zealand.html
4. **Climate, natural vegetation**
   https://na.unep.net/atlas/africa/downloads/chapters/Africa_Atlas_English_Chapter_1.pdf

Note: Yellow highlighted and bold content illustrate the modification in the syllabus.

Annexure - 3

BANASTHALI VIDYAPITH
SCHOOL OF EARTH SCIENCES

Name of the Programme: B.Sc. (Geology) /B.Sc. B.Ed.

Programme Educational Objectives:

BanasthaliVidyapith is an epitome of tradition and modernity. Vidyapith aims to preserve and inculcate the essential values and ideals of Indian culture. It believes in simple living and high thinking. Our educational ideology is based on the concept of fivefold education focusing on physical, practical, aesthetic, moral and intellectual aspects in order to develop a balanced personality.

Geology is a core as well as applied discipline of Earth Sciences emphasizing on the structure of Earth and other planets and various processes occurring therein along with structures, chemistry, formation processes, interpretation of ancient environment and plate tectonic settings. The subject is also having social relevance due to increase in demand for economic and fuel resources and frequent occurrence of natural hazards, and global climate change.

The student of Geology requires a keen understanding of processes that shaped the Earth, mineralogical variation, correlation between geological sections using lithology, fossils and structures. It requires applications of the fundamental sciences to the Earth system in terms of geochemistry, geomorphology, geophysics, petrology, palaeontology, engineering, stratigraphy, ocean and atmospheric sciences, hydrogeology and environment.

The curriculum has identified essential competencies in the areas of mining, civil engineering, remote sensing and oil and gas exploration by practical, field and industrial training. The curriculum also incorporates the components of problem solving and field exposure wherever possible.

The main objectives of the Bachelor of Sciences in Geology program are:

- **To provide basic information related with the Earth, its origin, various structures, minerals, crystals, landform evolution and tectonics.**
- **To develop a systematic learning approach of economic minerals, fossils and rocks based on their characteristics properties.**
- **To develop skills by providing laboratory based practices/exercises and field training related with landforms, geological structures, rock exposures, bedding and fossil occurrence.**
- **To apply geological information in various aspects/fields including Remote Sensing, Hydrogeology, Mining, Engineering and Environmental Geology**

Programme Outcomes:

PO1: Geology Knowledge: Demonstrate the comprehensive knowledge of geology relevant to understand the fundamental processes of lithosphere, hydrosphere, crustal dynamics in the background of plate tectonics theory and geological timescale in the context of Earth history.

PO2: Planning abilities: Possess effective ability to plan and comprehend the laboratory and field experiment.

PO3: Problem analysis: Develop proficiency in analyzing and critically evaluate data and concepts pertaining to geology and be able to apply three dimensional conceptualization technique while interpreting and constructing geological map and section. Systematically, apply mathematical and critical reasoning approach to the complex geological issues.

PO4: Conduct investigations of complex problems:

An ability to design working 3-D models for complex geological problems utilizing principles of mathematics, natural sciences and engineering sciences to validate theoretical knowledge.

PO5: Modern tool usage: Possess competency in learning, selecting, and appropriate usage of modern analytical instrumentation techniques, ability to apply latest software and computing tool for prediction and modeling of complex geological phenomenon.

PO6: Leadership skills: Demonstrate ability as role model in terms of commitment to work, formulating policies, making appropriate decision, team development, leadership and direction for the geological team.

PO7: Professional Identity: Understand, and value the professional role of geologist in society (e.g. Hydrogeologist, Environmental geologist, Exploration geologist, geoscientist, educators, and employees)

PO8: Geo-Ethics: Critically consider the relevant ethics in Earth resource exploration, extraction and nuclear waste disposal methods.

PO9: Communication: Proficiency in conveying geological concept clearly and coherently through writing and oral skills, providing evidence based arguments, hypothesis, for new finding through a range of modes.

PO10: The Geologist and society: Maintain a global vision in predicting and formulating plan to assess societal impact of natural disaster like landslide, earthquake, flood, complex engineering problems, appropriate legislative, regulatory and normative measures for rational use of natural resources and other geo-environmental issues to avoid undesirable consequences.

PO11: Environment and sustainability: Understand compliance with national mineral policies and procedures for extraction of Earth resources in such a way that maximum benefit is obtained with minimal possible environmental damage.

PO12: Life- long learning: Recognize importance of intellectual, moral character and professional development.

ProgrammeScheme :

Semester I

EXISTING

Course Code	Course Name	L	T	P	C
GEOL ~~102~~	~~Physical Geologyand Plate Tectonics~~	6	0	0	6
GEOL ~~102L~~	~~Physical Geology and Plate Tectonics Lab~~	0	0	4	2

PROPOSED

Course Code	Course Name	L	T	P	C
GEOL__	**PhysicalGeology**	**6**	**0**	**4**	**8**

Semester II

Course Code	Course Name	L	T	P	C
GEOL ~~101~~	~~Mineralogy, Crystallography and Economic Geology~~	6	0	0	6
GEOL ~~101L~~	~~Mineralogy, Crystallography and Economic Geology Lab~~	0	0	4	2

Course Code	Course Name	L	T	P	C
GEOL__	**Structural Geology and Plate Tectonics**	**6**	**0**	**4**	**8**

Semester III

Course Code	Course Name	L	T	P	C
GEOL ~~202~~	~~Petrology and Structural Geology~~	6	0	0	6
GEOL ~~202L~~	~~Petrology and Structural Geology Lab~~	0	0	4	2

Course Code	Course Name	L	T	P	C
GEOL__	**Mineralogy, Crystallography and Geochemistry**	**6**	**0**	**4**	**8**

Semester IV

Course Code	Course Name	L	T	P	C
GEOL ~~201~~	~~Palaeontology and Stratigraphy~~	6	0	0	6
GEOL ~~201L~~	~~Palaeontology and Stratigraphy Lab~~	0	0	4	2

Course Code	Course Name	L	T	P	C
GEOL__	**Petrology and Economic Geology**	**6**	**0**	**4**	**8**

Semester V

Course Code	Course Name	L	T	P	C
~~5.1~~	~~Geochemistry, Geomorphology, Photogeology and Remote Sensing~~	6	0	0	6
~~5.2~~	~~Geochemistry, Geomorphology, Photogeology and Remote SensingLab~~	0	0	4	2

Course Code	Course Name	L	T	P	C
GEOL__	**Discipline Elective I**	**6**	**0**	**4**	**8**

Semester VI

Course Code	Course Name	L	T	P	C
~~6.1~~	~~Hydrogeology, Environmental and Engineering Geology~~	6	0	0	6
~~6.2~~	~~Hydrogeology, Environmental and Engineering GeologyLab~~	0	0	4	2

Course Code	Course Name	L	T	P	C
GEOL__	**Discipline Elective II**	**6**	**0**	**4**	**8**

List of Discipline Electives

Course Code	Course Name	L	T	P	C
GEOL__	**Applied Geology**	**6**	**0**	**4**	**8**
GEOL__	**Field Geology: Tools and Techniques**	**6**	**0**	**4**	**8**
GEOL__	**Geology of Rajasthan**	**6**	**0**	**4**	**8**
GEOL__	**Palaeontology and Stratigraphy**	**6**	**0**	**4**	**8**

***Lecture hrs./week; T-Tutorials hrs./week; P-Project/Practical/Lab/All other non-classroom academic activities, etc. hrs./week; C-Credit Points of the Course**

Note:

- **Semester I -** The courses GEOL 102 Physical Geology and Plate Tectonics &GEOL 102 L Physical Geology and Plate Tectonics Lab have been replaced by new coursePhysical Geology (Theory and Practical).
- **Semester II -**The courses GEOL 101 Mineralogy, Crystallography and Economic Geology &GEOL 101L Mineralogy, Crystallography and Economic Geology Lab have been replaced by new course Structural Geology and Plate Tectonics (Theory and Practical).
- **Semester III -** The courses GEOL 202 Petrology and Structural Geology &GEOL 202L Petrology and Structural Geology Lab have been replaced by new courseMineralogy, Crystallography and Geochemistry(Theory and Practical).
- **Semester IV -** The course **GEOL 201**Palaeontology and Stratigraphy &**GEOL 201L**Palaeontology and Stratigraphy Lab have been shifted to pool of discipline electives. It is replaced by newcoursePetrology and Economic Geology (Theory and Practical).
- **Semester V -** The course **GEOL 5.1**Geochemistry, Geomorphology, Photogeology and Remote Sensing &**GEOL 5.2**Geochemistry, Geomorphology, Photogeology and Remote Sensing Lab have been removed.
- **SemesterVI -**The course **GEOL 6.1**Hydrogeology, Environmental and Engineering Geology &**GEOL 6.2** Hydrogeology, Environmental and Engineering Geology Lab have been removed.
- Pool of **DisciplineElectives (**including **theory** andrespective**practicals)** have been introduced in Semester V and VI

Note: Yellow highlighted and bold content illustrate the modification in the syllabus.

Annexure- 4

Name of the Programme :B.Sc. (Geology) / B.Sc. B.Ed.

Course Details:

FIRSTSEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1	~~**GEOL 102 Physical Geology and Plate Tectonics**~~	~~After the completion of this course, students will be able to:~~ ~~• Elucidate the overall perspective about Earth science.~~ ~~• Explain the underlying physical and chemical concepts governing the earth's processes.~~	~~Unit-1~~ ~~Introduction to geology, its scope, sub disciplines and relationship with other branches of science. Earth in the solar system, origin, size, shape, mass, density, rotational and revolution parameters. Internal constitution of the Earth. Age of the Earth.~~ ~~Unit-2~~ ~~Introduction to minerals, rocks and fossils. Origin of oceans, continents and mountains. Types of mountains. Geosynclines. Theory of Isostasy. Geological Time-scale. Major events in the Earth's history.~~ ~~Plate Tectonics~~ ~~Unit-3~~ ~~Introduction to plate tectonics, types of plates and plate boundaries. Elementary ideas of continental drift and sea floor spreading. Introduction to craton, shields, trenches, mid-oceanic ridges and island arc.~~ ~~Unit-4~~ ~~Earthquake: introduction and terminology, seismic waves, causes, magnitude, intensity and types of Earthquake, locating epicenter. Effects of Earthquakes and distribution of Earthquake belts.~~		Replaced with new course for enrichment of the programme

			~~Seismic zones of India. Case studies of important Earthquakes of India: Sumatra Earthquake (2004), Bhuj Earthquake (2001) and Assam Earthquake (1950).~~ ~~Unit-5~~ ~~Volcano: introduction, terminology, types, volcanic products, causes & effects and distribution of important volcanic belts. Relationship of Earthquakes with volcanic belts. Impact craters, morphology and their formation stages.~~		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	**GEOL_____** **Physical Geology**	**After the completion of this course, students will be able to:** • **Elucidate the overall perspective about Earth science.** • **Explain the underlying physical and chemical concepts governing the earth's processes.** • **Identify tectonic, volcanic, fluvial, glacial and aeolian landforms.** • **Determine the physical, chemical and biological processes that control the evolution of identified landforms.**		**Unit I** **Introduction to geology, its scope, sub disciplines and relationship with other branches of science. Earth in the solar system, origin, size, shape, mass, density, rotational and revolution parameters. Internal constitution of the Earth. Age of the Earth.** **Unit II** **Introduction to minerals, rocks and fossils. Origin of oceans, continents and mountains.Types of mountains. Theory of Isostasy. Geological Time-scale.** **Unit III** **Earthquake: Introduction and terminology, seismic waves, causes, magnitude, intensity and types of Earthquake. Seismic zones of India. Effects of Earthquakes and distribution of Earthquake belts. Volcano: Introduction, terminology, types, volcanic products, causes & effects and distribution of important volcanic belts.** **Unit IV** **Definition, scope and fundamental concept of Geomorphology. Weathering and its types. Soil: Formation, soil profile and soil type.Mass wasting and landslides: An introduction.** **Unit V** **Geological action of rivers, wind, groundwater and glaciers: their associated erosional and depositional landforms.** **Recommended Books:** **1. Bangar, K.M. (2009). *Principals of Engineering Geology*. New Delhi, India: Standard.**	Reviewed learning outcomes and suggested e-learning materials The course has been modified,renamedand considered as a new course

				2. Fletcher, C. (2014). *Physical Geology*(2nd ed.). *The Science of Earth*. New York, NY: John Wiley and Sons. **3. Holmes, A. (1992). *Principles of Physical Geology*. London, UK: Chapman and Hall.** **4. Leet, L.D.,& Judson, S. (1969). *Physical Geology*. Englewood Cliffs, New Jersey, NJ: Prentice Hall.** **5. Mahapatra, G.B. (2009). *A Text Book of Geology*. New Delhi, India: CBS.** **6. Mukherjee, P.K. (2000). *A Text Book of Geology*. Kolkata, India: World Press.** **7. Singh, P. (2010). *Engineering and General Geology*. New Delhi, India: S.K. Kataria& Sons.** **8. Singh, S. (2006). *Physical Geomorphology*. Allahabad, India: PrayagPustakBhawan.** **9. Tarbuck, E.J., Lutgens, F.K. &Tasa, D.G. (2014). *Illustrator Earth: An Introduction to Physical Geology* (11th ed.). New York, NY:Pearson.** **10. Thornbury, W.D. (1980). *Principles of Geomorphology*. New York, NY: Wiley Eastern.** **Suggested e-learning materials:** **1. Introduction to Geology https://www.nature.com/articles/147556a0** **2. Solar system https://www.nationalgeographic.com/science/space/solar-system/earth** **3. Landscape Evolution https://www.sciencedirect.com/topics/earth-and-planetary-sciences/landscape-evolution** 4. **Introduction to geomorphology https://www.cambridge.org/core/books/geomorphology**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	**~~GEOL 102L~~** **~~Physical Geology and Plate Tectonics Lab~~**	~~After the completion of this course, students will be able to:~~ • ~~Illustrate the relationship of earthquake and volcanic zones of the world with respect to plate boundaries.~~ • ~~Delineate the seismic zones of India by studying major palaeo-earthquakes.~~	~~1. Preparation of map showing seismic zones of India~~ ~~2. Marking important Earthquake locations of India~~ ~~3. Earthquake and volcanic zones of the world~~ ~~4. Marking important plate boundaries and orogenic belts~~ ~~5. Exercises based on finding location of Earthquakeepicentre~~ ~~6. Exercises based on Geological Time scale~~ **~~Recommended Books:~~** ~~1. A Text Book of Geology by P.K. Mukherjee (2000) World Press Private Limited-Kolkata~~ ~~2. A Text Book of Geology by G.B. Mahapatra (2009) CBS Publisher, New Delhi~~ ~~3. Charles Fletcher (2014) Physical Geology, The Science of Earth, John Wiley and sons, Inc., New York~~ ~~4. Holmes, Arthur (1992) Principles of Physical Geology, Vol. 1, Chapman and Hall, London.~~ ~~5. K.M. Bangar (2009) Principals of Engineering Geology, Standard Publishers Distributors, New Delhi~~ ~~6. Leet, L.D. and Judson, S. (1969) Physical Geology, Prentice Hall. Englewood Cliffs, NJ~~ 7. ~~Prabin Singh (2010) Engineering and General Geology. S.K.Kataria& Sons, New Delhi~~		Replaced with new course for enrichment of the programme

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	**GEOL ___L Physical Geology Lab**	**After the completion of this course, students will be able to:** • **Illustrate the relationship of earthquake and volcanic zones of the world with respect to plate boundaries.** • **Delineate the seismic zones of India by studying major palaeo-earthquakes.** • **Explain the evolution of life with respect to time as well as the major geological events of the past.** • **Identify various drainage pattern and geomorphic features in the field.**		1. Preparation of map showing seismic zones of India. 2. Marking important Earthquake locations of India. 3. Earthquake and volcanic zones of the world. 4. Exercises based on finding location of Earthquake epicenter. 5. Exercises based on Geological Time scale. **6. Identification of different drainage patterns** **7. Identification of different geomorphological landforms** **Recommended Books:** **1. Bangar, K.M. (2009). *Principles of Engineering Geology*. New Delhi, India: Standard.** **2. Holmes, A. (1992). *Principles of Physical Geology*, London, UK: Chapman and Hall.** **3. Mahapatra, G.B. (2009). *A Text Book of Geology*. New Delhi, India: CBS.** **4. Mukherjee, P.K. (2000). *A Text Book of Geology*. Kolkata, India: World Press.** **5. Singh, P. (2010). *Engineering and General Geology*.NewDelhi,India:S K Kataria and Sons.** **6. Singh, S. (2006). *Physical Geomorphology*. Allahabad, India: PrayagPustakBhawan.** **7. Thornbury, W.D. (1980). *Principles of Geomorphology*. New York,NY: Wiley Eastern.** **Suggested e-learning materials:** **1. Seismic zones: https://www.mapsofindia.com/maps/india/seismiczone.ht** **2. Drainage pattern: https://www.cambridge.org/core/journals/geological-magazine/article/reconstruction-of-**	Reviewed learning outcomes and suggested e-learning materials Systematic arrangement for better understanding of the subjects The course has been modified,renamed and considered as a new course

				ancestral-drainage-patterns-in-an-internally-draining-region. **https://nptel.ac.in/courses/105105106/** **3. Introduction to geomorphological landforms** **https://web.viu.ca/earle/geol111/lecture-notes.html**	

SECONDSEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	**~~GEOL 101 Mineralogy, Crystallography and Economic Geology~~**	~~After the completion of this course, students will be able to:~~ • ~~Recognize and identify the common rock-forming minerals on the basis of their physical properties.~~ • ~~Make systematic descriptions of minerals by observing them in thin sections under polarizing microscope.~~ • ~~Describe the parameters, symmetry, general principles of crystal and molecular structures.~~	~~Mineralogy~~ ~~Unit-1~~ ~~Minerals: definition and classification. Common physical properties of minerals: form and shape, colour, streak, luster, cleavage, fracture, hardness, tenacity, transparency, specific gravity, magnetic nature.Classification of silicate minerals. Common rock forming minerals of igneous, sedimentary and metamorphic rocks.~~ ~~Unit-2~~ ~~Polarizing microscope, its parts and functioning. Ordinary and polarized light. Nicol Prism and its construction.Optical properties of minerals: optically isotropic and anisotropic substances. Pleochroism, Extinction, Birefringence, Interference colours, Optic sign, Twinning.~~ ~~Crystallography~~ ~~Unit-3~~ ~~Introduction: Crystal, definition. Elementary idea of crystal structure. Parts of crystal- face, edge, apex, solid angle and interfacial angle. Crystallographic axes and angles. Parameters and indices. Elements of crystal symmetry. Common crystal forms - dome, prism, pyramid and pinacoid. Introduction to different crystals systems (normal classes).~~ ~~Economic geology~~ ~~Unit-4~~ ~~Definition of ore and gangue minerals, tenor and grade of ore minerals. Introduction to processes of mineral formation: magmatic concentration,~~		Replaced with new course for enrichment of the programme. This course has been modified, renamed and now shifted to Semester III

			~~hydrothermal, Residual and mechanical concentration, Oxidation and Supergene enrichment, metasomatism, evaporation, sedimentary and metamorphic.~~ ~~Unit-5~~ ~~Mode of occurrence, association, uses and Indian occurrences of metallic (iron, manganese, Chromium, copper, zinc, lead, aluminum, tungsten, gold, silver) and nonmetallic (mica, asbestos, graphite, gypsum) minerals.~~ ~~Elementary idea regarding origin, uses and distribution of coal and petroleum in India.~~		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	**GEOL___ Structural Geology and Plate Tectonics**	**After the completion of this course, students will be able to:** • **Recognize and interpret the geological structures of deformed continental regimes, varying from simply deformed to superimposed structures.** • **Interpret the**		**Unit I** **Introduction to structural geology, Clinometer and Bruntoncompass, Strike and dip, Pitch/rake and plunge, Concept of stress: normal stress, shear stress, principal axes of stress, planes of maximum shear stress. Concept of Strain: Nature of Strain, homogeneous and inhomogeneous strain longitudinal and shear strain, Strain ellipsoid, Pure shear and simple shear.** **Unit II** **Topography and its representation. Outcrop patterns of horizontal bed, gentle dipping bed and vertical bed. Rule of V. Outliers and Inliers; Forms of igneous bodies: concordant and discordant.** **Unit III** **Folds: Parts of a fold.Classification of folds: On the**	Reviewed learning outcomes and suggested e-learning materials New course has been introduced

		relative timing of formation of structures, the kinematics of deformation, and the progressive deformation histories in these regimes. • Interpret stress regimes and strain states during continental deformation. • Apply the information of structural geology in the mining and resource exploration.		direction of closure and fold profile, Fleuty and Ramsey's classification. Types of Foliation and Lineation. **Unit IV** Faults: Nomenclature, classification of faults: Gravity fault, Strike slip Fault and Thrust fault, Nappes. Effect of faulting on folded strata. Joints: geometric classification. Unconformities. **Unit V** Plate Tectonics: Continental drift hypothesis; Geological, palaeoclimatological and palaeontological evidence of breakup of Gondwanaland; criticism of continental drift hypothesis. Seafloor spreading, Plate boundary processes: subduction zones - volcanic arcs and island arcs, trenches, accretionary prism, Mid oceanic ridges and spreading rates; Transform fault. Driving mechanism of plate movement. **Recommended Books:** 1. Billings, M.P. (1972). *Structural Geology*(3rd ed.). New York, NY: Prentice Hall. 2. Condie, K.C. (1984). *Plate Tectonics & crustal Evolution*. (4th ed.).London, UK: Pergamon Press. 3. Condie, K.C. (2016). *Earth as an Evolving Planetary System* (3rd ed.). Amsterdam, Netherlands: Elsevier Academic Press. 4. Dennis, G.J. (1987). *Structural Geology An Introduction*. Iowa, IA:Wm. C. Brown. 5. Fossen, H. (2010). *Structural Geology*(2nd ed.). Cambridge, UK: Cambridge University Press. 6. George, H. D., Stephen J. R. & Charles F. K.	

				(2013). *Structural Geology of Rocks and Region* (3rd ed.). Hoboken, NJ:John Wiley and Sons. **7. Ghosh, S. K. (1993). *Structural Geology Fundamentals and Modern Developments*. London, UK: Pergamon Press.** **8. Hobbs, B.E. Means, W.D.,& Williams, P. F. (1976). *An Outline of Structural Geology*. New York, NY: John Wiley and Sons.** **9. Jain, A.K. (2014). *An Introduction to Structural Geology*, Bangalore, India: GSI.** **10. Park, R.G. (1989). *Foundations of Structural Geology* (3rd ed.). New York, NY: Chapman & Hall.** **11. Pluijm B. A.,&Marshak, S. (2004). *Earth Structure An Introduction to Structural Geology and Tectonics(2nd ed.)*. New York, NY:W. W. Norton.** **12. Ramsay, J.G. & Huber, M. I. (1987). *The Techniques of Modern Structural Geology*: *Strain Analysis (*Vol. 1). London, UK: Elsevier Academic Press.** **13. Ramsay, J.G.,& Huber, M. I. (1987). *The Techniques of Modern Structural Geology*):*Folds and Fractures(*Vol. 2).London, UK: Elsevier Academic Press.** **14. Ramsay, J.G. & Lisle, R. J. (2000). *The Techniques of Modern Structural Geology*: *Application of Continuum Mechanics in Structural Geology*(Vol. 3). London, UK: Elsevier Academic**	

				Press. **15. Twiss, R. J.,&Moores, E. M. (2007). *Structural Geology* (2nd ed.). New York, NY: WH Freeman.** **Suggested e-learning materials:** **1. Structural Geology Map Interpretation: https://ocw.tudelft.nl/courses/structural-geology-map-interpretation/** **2. Geologic Structures Part – I: https://nptel.ac.in/courses/105105106/2** **3. Geologic Structures Part - II: https://nptel.ac.in/courses/105104152/18** **4. Structural Geology lecture notes: https://ocw.mit.edu/courses/earth-atmospheric-and-planetary-sciences/12-113-structural-geology-fall-2005/lecture-notes/ :** **5. Field Geology, Structural Geology and Tectonics lecture notes : http://www.uh.edu/~jbutler/anon/anoncoursestructure.html**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	**~~GEOL 101L~~** **~~Mineralogy, Crystallography and Economic Geology Lab~~**	~~After the completion of this course, students will be able to:~~ • ~~Recognize a variety of minerals and gemstones.~~ • ~~Describe chemistry, crystal structure, and physical properties of minerals.~~ • ~~Make systematic descriptions and identifications of minerals by observing their thin-sections under polarizing microscope.~~ • ~~Explain the parameters, lattice structure and symmetry of crystals~~.	~~1. Study of physical properties of minerals: quartz, orthoclase, microcline, albite, labradorite, nepheline, muscovite, biotite, augite, hypersthene, tremolite, hornblende, olivine, serpentine, talc, chlorite, apatite, calcite, dolomite, garnet, kyanite, sillimanite, andalusite, staurolite, topaz, tourmaline, corundum, gypsum, graphite and kaolinite.~~ ~~2. Optical properties of some common rock forming minerals -quartz, orthoclase, microcline, albite, garnet, biotite, muscovite, augite, hypersthene, hornblende, olivine and calcite.~~ ~~3. Study of elements of symmetry of representative crystals~~ ~~4. Study of ore and economic minerals in hand specimens: Magnetite, hematite, limonite, siderite, pyrite, pyrolusite, psilomelane, chromite, chalcopyrite, azurite, malachite, cuprite, sphalerite,galena, wolframite, scheelite, gypsum, barite.~~ ~~5. Preparation of maps showing distribution of important metallic and non-metallic deposits~~ ~~6. Identification of different types of coal (lignite, anthracite and bituminous)~~ ~~7. Distribution of important coal seams and petroliferous basins of India~~ **~~Recommended Books:~~** ~~1. Bateman A.M. (1962) Economic Minerals Deposit, John Willy &Sons, New York~~ ~~2. Dana, E.S. and Ford, W.E. (2002) A textbook of Mineralogy, John Wiley and Sons, New York.~~ ~~3. Dexter Perkins (2010) Mineralogy, Pearson~~		Replaced with new course for enrichment of the programme This course has been modified, renamed and now shifted to Semester III

			Education, US 4. Gokhale, K.Y.G.K. and Rao, T.C. (1978) Ore deposits of lndia their distribution and processing, Tata-McGraw Hill, New Delhi. 5. Nesse, D.W. (1986) Optical Mineralogy, McGraw Hill., CBS publicaltion, New Delhi 6. Paul F. Kerr (1959) Optical Mineralogy, McGraw Hill Book Company, Inc., U.S 7. Phillips, Wm, R. and Griffen, D.T. (1986) Optical Mineralogy, CBS Edition, New Delhi Read, H.H. (1968) Rutley's Element of Mineralogy (Rev. Ed.), Thomas Murby and Co., London.		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	**GEOL__L Structural Geology and Plate Tectonics Lab**	**After the completion of this course, students will be able to:** • **Interpret the toposheets for civil engineering purposes.** • **Predict the geometry and location of structures at depth or in areas of less exposed outcrops.** • **Interpret the geological history of the given area supplemented with structural data in geological maps.** • **Identify the areas prone to geological hazards.**		**1. Reading topographical maps of the Survey of India, Indexing of Toposheets, Determination of Map Scale** **2. Use of Clinometer and Brunton compass to measure the dip and strike of bedding planes** **3. Graphical solution of true dip–apparent dip problems, three-point problems** **4. Completion of outcrops.** **5. Drawing and interpretation of sections across elementary representative geological structures.** **6. Stereographic projection of plane, line and fold (Non plunging and Plunging).** **7. Marking important plate boundaries and orogenic belts.** **Recommended Books:** **1. Lisle, R. J., Brabham P J. & Barnes, J. W. (2011). *Basic Geological Mapping* (5th ed.). England, UK: Wiley Blackwell Publishing.** **2. Ragan, M. D. (2009). *Structural Geology an Introduction to Geometrical Techniques*. Cambridge, UK: Cambridge University Press.** **3. Rowland, S.M., Duebendorfer, E. M. &Ilsa M. S. (2007). *Structural Analysis and Synthesis A Laboratory Course in Structural Geology* (3rd ed.). Victoria, Australia: Blackwell.** **Suggested e-learning materials:** **1.Online stereonet software: https://app.visiblegeology.com/stereonetApp.html** **2.Map Interpretation Techniques: https://ocw.tudelft.nl/courses/structural-geology-**	Reviewed learning outcomes and suggested e-learning materials Introduced as a new course

				map-interpretation/ **3.Field Mapping:** **http://www.geosci.usyd.edu.au/users/prey/FieldTrips/BrokenHillOlary/Mapping.html** **4.Geologic structures:** **https://nptel.ac.in/courses/105105106/**	

THIRDSEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	**~~GEOL 202 Petrology and Structural Geology~~**	~~After the completion of this course, students will be able to~~ • ~~Describe and identify igneous, metamorphic and sedimentary rocks.~~ • ~~Classify magmatic, metamorphic and siliciclastic rocks~~ • ~~Describe the petrogenetic processes and their geologic significance.~~ • ~~Recognize and interpret the geological structure of deformed continental regimes, from mildly deformed upper crustal regimes to complexlydeform~~	~~Unit-1: Igneous Petrology~~ ~~Magma and its composition. Magmatic differentiation and assimilation.Common textures and classification of igneous rocks. Phase rule application to H_2O system. Brief petrographic description of common igneous rocks (granite, diorite, syenite, gabbro, dolerite, basalt, rhyolite, trachyte, dunite, pyroxenite and peridotite)~~ ~~Unit-2: Sedimentary Petrology~~ ~~Sediments and sedimentary rock: Origin of clastic& non-clastic sediments and genesis of sedimentary rocks. Sedimentary structures. Elementary idea about texture and mineral composition of clastic and nonclastic sedimentary rocks. General classification of sedimentary rocks. Description of fundamental rock types such as: conglomerate, breccia, sandstone, shale and limestone.~~ ~~Unit-3: Metamorphic Petrology~~ ~~Definition, types and agents of metamorphism. Classification of metamorphic rocks. Metamorphic textures and structures. Metamorphic zones and isograds. Common metamorphic rocks and their protoliths as given below: slate, phyllite, schist, gneiss, marble and quartzite.~~ ~~Structural Geology~~ ~~Unit-4~~ ~~Concept of dip and strike of beds. Clinometer compass and its uses. Folds: description and classification of folds. Causes of folding.~~ ~~Unit-5~~		Replaced with new course for enrichment of the programme The course is modified, renamed and now shifted to semester-IV

		ed deeper crustal regimes.	Faults: Nomenclature,classification of faults and causes of faulting. Joints: geometric classification. Unconformity: its types and significance. Overlap and offlap. Outlier and inlier. Nappe.		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	**GEOL___ Mineralogy, Crystallography and Geochemistry**	**After the completion of this course, students will be able to:** • **Recognize and identify the common rock-forming minerals on the basis of their physical properties.** • **Make systematic descriptions of minerals by observing them in thin sections under polarizing microscope.** • **Describe the parameters, symmetry, general principles of crystal and molecular structures.** • **Explain the**		**Unit I** **Minerals: definition and classification. Common physical properties of minerals: form and shape, colour, streak, luster, cleavage, fracture, hardness, tenacity, transparency, specific gravity, magnetic nature. Classification of silicate minerals.** **Unit II** **Polarizing microscope, its parts and functioning. Polarization of Light. Nicol Prism and its construction. Optical properties of minerals: optically isotropic and anisotropic substances. Pleochroism, Extinction, Birefringence, Interference colors, Optic sign, Twinning.** **Unit III** **Introduction: Crystal, definition. Elementary idea of crystal structure. Parts of crystal- face, edge, apex, solid angle and interfacial angle. Crystallographic axes and angles. Elements of crystal symmetry.** **Unit IV** **Parameters and indices. Common crystal forms - dome, prism, pyramid and pinacoid. Introduction to different crystals systems. Cubic (Galena Type), Tetragonal (Zircon Type), Hexagonal (Beryl Type), Trigonal (Calcite Type), Orthorhombic (Barite Type), Monoclinic (Gypsum Type), Triclinic (Axinite Type)** **Unit V** **Definition and scope. Geochemical classification of elements. Principles of ionic substitutions in minerals. Radioactivity: Radioactive decay schemes, decay constant, half-life, parent-daughter relations. Radioactive and Stable isotopes: application and**	Reviewed learning outcomes and suggested e-learning materials Shifted from semester-IIand introduced as a new course after modification and renaming

		geochemical distribution of elements and various aspects of radioisotopes including their applications in geology.		**their use in geology.** **Recommended Books:** **1. Dana, E.S.,& Ford, W.E. (2002). *A textbook of Mineralogy*. New York,NY: John Wiley and Sons.** **2. Faure, G. &Mensing, T.M. (2005). *Isotope, principles and applications* (3rd ed.). New York, NY: John Wiley & Sons.** **3. Gribble, C.D. (1991). *Rutley's Element of Mineralogy* (27th ed.). Delhi, India: CBS.** **4. Kerr, P. F. (1959). *Optical Mineralogy*. New York, NY: McGraw Hill.** **5. Mason, B.,& Moore, C.B. (1982). *Introduction to Geochemistry*. New York, NY: Wiley Eastern.** **6. Nesse, D.W. (1986). *Optical Mineralogy*. New Delhi, India:McGraw Hill, CBS.** **7. Perkins, D. (2010). *Mineralogy* (3rd ed.). Edinburgh,UK: Pearson Education.** **8. Phillips, W. R.,&Griffen, D.T. (1986). *Optical Mineralogy*. New Delhi, India: CBS.** **Suggested e-learning materials:** **1. Introduction to minerals and crystals https://epgp.inflibnet.ac.in/ahl.php?csrno=448** **2. Mineral forms http://www.webmineral.com/ http://www.geology.com/mineral gallery**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	**~~GEOL 202L Petrology and Structural Geology Lab~~**	~~After the completion of this course, students will be able to:~~ • ~~Describe the rocks based on mineralogical and textural characteristics and interpret the environment of formation.~~ • ~~Identify various rocks in thin-section under petrological microscope~~ • ~~Interpret the toposheets for civil engineering purposes.~~ • ~~Predict the geometry and location of structures at depth or in areas of less exposed outcrops.~~ • ~~Interpret the geological history of the given area~~	~~1. Megascopic study of the following Igneous rocks: granite, gabbro, rhyolite, basalt, dolerite, trachyte~~ ~~2. Megascopic study of the following Sedimentary rocks: shale, sandstone, limestone, breccia, conglomerate~~ ~~3. Megascopic study of the following Metamorphic rocks: gneiss, schist, quartzite, marble, slate, phyllite~~ ~~4. Microscopic study of granite, gabbro, rhyolite, basalt, dolerite, sandstone, limestone, quartzite, marble.~~ ~~4. Reading topographical maps of the Survey of India~~ ~~5. Determination of Map Scale~~ ~~6. Exercises based on structural problems~~ ~~7. Completion of outcrops~~ ~~8.Drawing and interpretation of sections across elementary representative geological structures.~~ ~~**Recommended Books:**~~ ~~1. Best, Myron G. (2002) Igneous and Metamorphic Petrology, Blackwell Science, Oxford, UK~~ ~~2. Blatt, H. and Tracy, R.J. (1996) Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman and Co., NewYork.~~ ~~3. Collins, J.D. and Thompson, D.B. (1982) Sedimentary Structures, George Allen &Unwin, London~~ ~~4. Ehlers, E.G. and Blatt, H (1982) Igneous, Sedimentary and Metamorphic Petrology, CBS Publ., New Delhi~~		Replaced with new course for enrichment of the programme The course is modified, renamed and now shifted to semester-IV

		supplemented with structural data in geological maps.	5. George H. Davis, Stephen J. Reynolds, Charles F. Kluth (2013) Structural Geology of Rocks and region, 3rd Ed. John Wiley and Sons, New York 6. Huang (1962) Petrology, McGraw Hill Book Co., New York 7. LeMaitre, R.W. (2002) Igneous Rocks: A classification and glossary of Terms, Cambridge University Press, New York 8. Nockold, Knox and Chinner (1978) Petrology for students, Cambridge Univ. Press., Cambridge 9. Pettijohn, F.J. (1975) Sedimentary Rocks, 3rd Ed. Harper and Row Publication, New Delhi 10. Tyrell, G.W. (1978) The Principles of petrology: An Introduction to the Science of Rocks.Springer, London. 11. Winkler, H. G.F. (1967) Petrogenesis of Metamorphic Rocks, Springer-Verlag, New York 12. MP Billings (1972) Structural Geology, Prentice Hall, U.K		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	**GEOL _L Mineralogy, Crystallography and Geochemistry Lab**	**After the completion of this course, students will be able to:** • **Recognize a variety of minerals and gemstones.** • **Describe chemistry, crystal structure, and physical properties of minerals.** • **Make systematic descriptions and identifications of minerals by observing their thin-sections under polarizing microscope.** • **Explain the**		**1. Study of physical properties of following minerals:** **Silicates:Olivine,Garnet, Staurolite, Topaz, Kyanite, Sillimanite, Andalusite, Tourmaline, Beryl, Augite, Hypersthene, Tremolite, Hornblende, Muscovite, Biotite, Chlorite, Serpentine, Talc, Kaolinite, Quartz, Orthoclase, Microcline, Albite, Labradorite, Nepheline.** **Non Silicates: Gypsum, Graphite, Corundum, Apatite, Calcite, Dolomite** **2. Optical properties of some common rock forming minerals -Quartz, Orthoclase, Microcline, Albite, Garnet, Biotite, Muscovite, Augite, Hypersthene, Hornblende, Olivine and Calcite.** **3. Study of elements of symmetry of representative crystals** **4. Calculations based on radioactive method** **Recommended Books:** **1. Dana, E.S.,& Ford, W.E. (2002). *A Textbook of Mineralogy*. New York, NY: John Wiley and Sons.** **2. Faure, G. &Mensing, T.M. (2005). *Isotope, principles and applications* (3rd ed.) New York, NY: John Wiley & Sons.** **3. Gribble, C.D. (1991). *Rutley's Element of Mineralogy* (27th ed.). Delhi, India: CBS.** **4. Kerr, P. F. (1959). *Optical Mineralogy*. New York, NY: USA, McGraw Hill.** **5. Mason, B. & Moore, C.B. (1982). *Introduction to***	Reviewed learning outcomes and suggested e-learning materials The course has been shifted from semester-II and introduced as a new course after modification and renaming.

		parameters, lattice structure and symmetry of crystals.		***Geochemistry*. New York, NY:Wiley Eastern.** **6. Nesse, D.W. (1986). *Optical Mineralogy*. New Delhi, India: McGraw Hill, CBS.** **7. Perkins, D. (2010). *Mineralogy* (3rd ed.). Edinburgh, UK: Pearson.** **8. Phillips, W. R.,&Griffen, D.T. (1986). *Optical Mineralogy*. New Delhi, India: CBS.** **Suggested e-learning materials:** **1. Mineral forms http://www.webmineral.com/** **2. Introduction to Minerals and crystals https://nptel.ac.in/courses/112106227/**	

FOURTHSEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	**GEOL ~~201~~ Palaeontology and Stratigraphy**	~~After the completion of this course, students will be able to:~~ • ~~Transform a stratigraphic cross-section into a historical summary.~~ • ~~Explain Stratigraphy and broad tectono-stratigraphic divisions of India through maps.~~ • ~~Identify different lithotectonic units of India and establish their stratigraphic correlations.~~ • ~~Explain the morphologic~~	Palaeontology Unit-1 Palaeontology: definition, subdivisions and its relationship with stratigraphy. Fossils: definition and mode of preservation of fossils(body and trace fossils). Index fossils. Incompleteness of fossils record. Elementary ideas about origin and evolution of life. Unit-2 Morphology, geological and geographical distribution of the following fossil groups: a. Phylum Mollusca (Class: Lamellibranchia or Bivalvia, Class: Gastropoda and Class Cephalopoda) b. Phylum Brachiopoda c. Phylum Echinodermata (Class Echinodea) d. Phylum Cnidaria (Corals) Unit-3 Morphology, geological and geographical distribution of the following fossil groups: a. Phylum Arthropoda (Class Trilobita) b. Phylum Hemichordata (Class Graptolothina) Introduction to palaeobotany.Brief account of GondwanaSupergroup and its flora. Introduction to Micropaleontology: forminifera. Stratigraphy Unit-4 Stratigraphy: definition and its scope. Principles of stratigraphy.~~Stratigraphiccorrelation.~~Stratigraphiccla		Replaced with new course for enrichment of the programme The course is modified and now shifted to pool of discipline electives.

		~~al characters of different genera of fossils.~~	ssification.Brief account stratigraphic succession, correlation and economic significance of Dharwars, Aravallis, Cuddapah and Vindhyans. Unit-5 Brief account of Phanerozoic stratigraphic successions of Indian subcontinent as mentioned below: Paleozoic (Spiti and Salt Range), Mesozoic (Spiti, Kutch and Jaisalmer) andCenozoic (Assam and Shiwaliks).		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	**GEOL___ Petrology and Economic Geology**	**After the completion of this course, students will be able to:** • **Describe and identify igneous, metamorphic and sedimentary rocks.** • **Classify magmatic, metamorphic and siliciclastic rocks, and understand the petrogenetic processes and their geologic significance.** • **Identify the common ore types, their properties, geological settings to understand the processes and mechanisms of their genesis and devise**		**Unit I** **Magma and its composition. Magmatic differentiation and assimilation. Common textures and classification of igneous rocks. Phaserule,Unicomponent system, Bowen's reaction series.** **Unit II** **Sediments and sedimentary rock: Origin of clasticand non-clasticof sedimentary rocks. Sedimentary structures. Elementary idea about texture and mineral composition of clastic and non-clastic sedimentary rocks. General classification of sedimentary rocks. Sedimentary facies and depositional environment.** **Unit III** **Definition, types and agents of metamorphism. Classification of metamorphic rocks. Metamorphic textures and structures. Metamorphic zones,Isogradsandfacies.** **Unit IV** **Definition of ore and gangue minerals, tenor and grade of ore minerals. Introduction to processes of mineral formation: magmatic concentration, hydrothermal, Residual and mechanical concentration, Oxidation and Supergene enrichment, metasomatism, evaporation, sedimentary and metamorphic.** **Unit V** **Mode of occurrence, association, uses and Indian occurrences of metallic (iron, manganese, Chromium, copper, zinc, lead, aluminum, tungsten, gold, silver) and nonmetallic (mica, asbestos,**	Reviewed learning outcomes and suggested e-learning materials The course has been shifted from semester-III and introduced as a new course after modification and renaming

		strategies for exploration. • **Assess the applicability of different ore exploration methods and their utilization**		**graphite, gypsum) minerals. Elementary idea regarding origin,uses and distribution of coal (Types also) and petroleum in India.** **Recommended Books:** **1. Bateman, A.M. (1962). *Economic Minerals Deposit*(2nd ed.). New York, NY: John Willy & Sons.** **2. Best, M. G. (2002). *Igneous and Metamorphic Petrology*(2nd ed.).Oxford, UK: Blackwell Science.** **3. Blatt, H.,& Tracy, R.J. (1996). *Petrology:Igneous, Sedimentary, Metamorphic*(2nd ed.). New York, NY: W.H. Freeman and Co.** **4. Collins, J.D.,& Thompson, D.B. (1982). *Sedimentary Structures*. London, UK: George Allen &Unwin.** **5. Dana, E.S.,& Ford, W.E. (2002). *A textbook of Mineralogy*. New York, NY: John Wiley and Sons.** **6. Ehlers, E.G.,& Blatt, H. (1982). *Igneous, Sedimentary and Metamorphic Petrology*. New Delhi, India: CBS.** **7. Gokhale, K.Y.G.K.,&Rao, T.C. (1978). *Ore deposits of India: their distribution and processing*. New Delhi, India: Tata-McGraw Hill.** **8. LeMaitre, R.W. (2002). *Igneous Rocks: A classification and glossary of Terms*. New York, NY: Cambridge University Press.** **9. Nockolds, S. R., Knox, R. W. O'B.,&Chinner, G. A. (1978). *Petrology for students*. Cambridge, Cambridge University. Press.** **10. Pettijohn, F.J. (1975). *Sedimentary Rocks* (3rd ed.). New Delhi, India: Harper and Row.** **11. Prasad, U. (2015). *Economic Geology: Economic***	

				***Mineral Deposits*(2nd ed.). New Delhi, India: CBS.** **12. Sen, A.K. &Guha P.K. (1981). *A Handbook of Economic Geology*. Calcutta, India: Modern Book.** **13. Tiwari, S. K. (2010). *Ore Geology, Economic Minerals and Mineral Economics*. New Delhi,India: Atlantic.** **14. Tyrell, G.W. (1978). *The Principles of petrology: An Introduction to the Science of Rocks*. London, UK: Springer.** **15. Winkler, H.G.F. (1967). *Petrogenesis of Metamorphic Rocks*. New York, NY: Springer-Verlag.** **Suggested e-learning materials:** **1. Introduction to rocks and economic minerals https://epgp.inflibnet.ac.in/ahl.php?csrno=448** **2. Introduction to rocks and economic minerals https://nptel.ac.in/courses/105105170/** **3. Introduction to economic geology https://www.oakton.edu/user/4/billtong/eas100/econgeol.htm**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	**GEOL ~~201~~L: Palaeontology and Stratigraphy Lab**	~~After the completion of this course, students will be able to:~~ • ~~Transform a stratigraphic cross-section into a historical summary.~~ • ~~Explain Stratigraphy and broad tectono-stratigraphic divisions of India through maps.~~ • ~~Identify different lithotectonic units of India and establish their stratigraphic correlations.~~ • ~~Explain the morphological characters~~	1. Study of morphological characters of different genera pertaining to Brachiopoda,Lamellibranchia, Cephalopoda,Gastropoda, Trilobita, Echinoidea, and Anthozoa. 2. Preparation of lithostratigraphic maps of India showing distribution of the following: Cuddapah, Vindhyan and GodwanaSupergroup. 3. Study of important rocks of Rajasthan. ~~**Recommended Books:**~~ ~~1. Black, R.M. (1988) The Elements of Palaeontology, Cambridge University Press, Cambridge.~~ ~~2. Boggs, S. (2001) Principles of Sedimentology and Stratigraphy, Prentice Hall, USA.~~ ~~3. Jain, P.C. and Anantharaman, M.S. (1983) Palaeontology: Evolution and Animal Distribution, Vishal Publishing Co, New Delhi.~~ ~~4. Krishnan, M.S. (1968) Geology of India and Burma, Higgibothon, Madras.~~ ~~5. Lehmann, U. and Hilmer G. (1983) Fossil Invertebrate, Cambridge Earth Science Series, UK~~ ~~6. Moore, R.C., Lalicker, C.G. and Fischer, A.G.(1997) Invertebrate Fossils, CBS Publ., New Delhi.~~ ~~7. Nield, E.W. and Tucker, V.C.T. (1985) Palaeontology: An Introduction, Pergmon Press, UK.~~		Replaced with new course for enrichment of the programme The course is modified and now shifted to pool of discipline electives.

		~~of different genera of fossils.~~	~~8. Prothero, D.R. (2004) Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill, New York.~~ ~~9. Ravindra Kumar (1978) Historical Geology and Stratigraphy of India, New Age International Publishers Ltd. New Delhi.~~ ~~10. Shrock, R.R. and Twenhoffel,W.H. (1952) Principles of Invertebrate Paleontology, CBS Publ., New Delhi.~~ ~~11. Wadia, D.N. (1966) Geology of India, English language Publ., London.~~ ~~12. Weller, J.M. (1960) Stratigraphic Principles and Practices, Universal Book, Delhi.~~ ~~13. Woods, H. (1985) Palaeontology Invertebrate, CBS Publ., New Delhi.~~		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	**GEOL ___ L** **Petrology and Economic Geology Lab**	**After the completion of this course, students will be able to:** • **Recognize common ore**		**1. Megascopic study of the following Igneous rocks: Granite, gabbro, rhyolite, basalt, dolerite, trachyte** **2. Megascopic study of the following Sedimentary rocks: Shale, sandstone, limestone, breccia, conglomerate** **3. Megascopic study of the following Metamorphic rocks: Gneiss, schist, quartzite, marble, slate,**	Reviewed learningoutcomes and suggested e-learning materials

		minerals (metallic and nonmetallic) in hand samples, describe their distribution and uses. • **Describe the rocks based on mineralogical and textural characteristics and interpret the environment of formation.** • **Map distribution of economic minerals in India.** • **Identify various rocks in thin-section under petrological microscope.**		**phyllite** **4. Microscopic study of Granite, gabbro, rhyolite, basalt, dolerite, sandstone, limestone, quartzite, marble.** **5.Study of ore and economic minerals in hand specimens: Magnetite, hematite, limonite, siderite, pyrite, pyrolusite, psilomelane, chromite, chalcopyrite, azurite, malachite, cuprite, sphalerite,galena,wolframite, scheelite, gypsum, barite.** **6.Preparation of maps showing distribution of important metallic and non-metallic deposits** **7.Identification of different types of coal (lignite, anthracite and bituminous)** **8.Distribution of important coal seams and petroliferous basins of India** **Recommended Books:** **1. Bateman, A.M. (1962). *Economic Minerals Deposit.* New York, NY: John Willy & Sons.** **2. Best, M. G. (2002). *Igneous and Metamorphic Petrology*. Oxford, UK: Blackwell Science.** **3. Blatt, H.,& Tracy, R.J. (1996). *Petrology: Igneous, Sedimentary, Metamorphic*. NewYork, NY: W.H. Freeman and Co.** **4. Collins, J.D.,& Thompson, D.B. (1982). *Sedimentary Structures*. London, UK: George Allen &Unwin.** **5. Ehlers, E.G.,& Blatt, H. (1982). *Igneous, Sedimentary and Metamorphic Petrology*. New Delhi, India: CBS.** **6. Gokhale, K.Y.G.K.,&Rao, T.C. (1978). *Ore deposits of lndia: their distribution and processing*. New Delhi, India:Tata-McGraw Hill.**	The course has been shifted from semester-III and introduced as a new course after modification and renaming

				7. LeMaitre, R.W. (2002). *Igneous Rocks: A classification and glossary of Terms*. New York, NY: Cambridge University Press. **8. Nockolds, S. R. Knox, R. W. O'B.,&Chinner, G. A. (1978). *Petrology for students*. Cambridge,UK: Cambridge University Press.** **9. Pettijohn, F.J. (1975). *Sedimentary Rocks*(3rd ed.). New Delhi, India: Harper and Row.** **10. Prasad, U. (2015). *Economic Geology: Economic Mineral Deposits*. New Delhi, India: CBS.** **11. Sen, A.K. &Guha P.K. (1981). *A Handbook of Economic Geology*. Calcutta, India: Modern Book.** **12. Tiwari, S. K. (2010). *Ore Geology, Economic Minerals and Mineral Economics*. New Delhi,India: Atlantic.** **Suggested e-learning materials:** **1. Distribution of economic minerals** **https://www.mapsofindia.com/** **2. Igneous rock-slides** **http://funnel.sfsu.edu/courses/geol426/** **slides http://www.geolab.ie/**	

FIFTHSEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	**~~5.1 Geochemistry, Geomorphology, Photogeology and Remote Sensing~~**	~~After the completion of this course, students will be able to:~~ • ~~Describe the composition of the Earth and processes by which the chemical elements have been synthesized over the history of the cosmos.~~ • ~~Determine the physical, chemical and biological processes that control the evolution of identified landforms.~~ • ~~Identify fluvial, glacial, aeolianandoceanic erosional and depositional landforms.~~ • ~~Describe the~~	~~Geochemistry~~ ~~Unit-1~~ ~~Definition and scope. Geochemical classification of elements. Principles of ionic substitutions in minerals. Radioactivity: Radioactive decay schemes,decay constant, half life, parent-daughter relations. Radioactive and Stable isotopes: application and their use in geology.~~ ~~Geomorphology~~ ~~Unit-2~~ ~~Definition and scope. Fundamental concepts.Weathering and its types. Fluvial cycle of erosion. Drainage patterns and their significance. Soil:Formation, soil profile and soil type. Physiographic subdivisions of India and their characteristics.~~ ~~Unit-3~~ ~~Geological work of wind, rivers, glaciers, oceanic current and their associated erosional and depositional landforms.~~ ~~Photogeology and Remote Sensing~~ ~~Unit-4~~ ~~Introduction to Aerial photography.Types of aerial photos. Types of camera, films and filters.Multispectralphotography.Flight plan – location/area, purpose, time and season of photography. Introduction to overlap, sidelap, drift, crab and fiducial marks. Geometric principles of aerial photographs-relief and tilt displacement.Distortion and Vertical exaggeration.~~	**Discipline Elective**	Shifted to pool of discipline electives

		concepts & principles of photogrammetry, remote sensing and their applications in geology.	Taking measurement from aerial photographs: scale, distance, area and height. Elements of interpretation of aerial photograph. Unit-5 Remote Sensing: definition andprinciples.Energy used in remote sensing. Types of electromagnetic radiation (EMR).Energy interaction with Earth surface and atmosphere.Type of sensors: active and passive. Platforms.Scanningmechanism.Orbiting mechanics. Resolutions – Spectral, spatial, radiometric and temporal. Image Interpretation. Application of photo geology and remote sensing.		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	**5.2: Geochemistry, Geomorphology, Photogeology and Remote Sensing Lab**	After the completion of this course, students will be able to: • Interpret geochemistry of isotopes and calculation of age based on radioactive method. • Identify various drainage pattern and geomorphic features in the field.	1. Calculations based on radioactive method 2. Identification of different drainage patterns 3. Elementary study of aerial photographs. 4. Visual interpretation of aerial photograph 5. Stereo-pair interpretation and depth perception 6. Visual interpretation of standard FCC data **Recommended Books:** 1. Bhatia, S.S. (2008) Fundamentals of Remote sensing, Atlantic Publishers and Distributors, New Delhi. 2. David P. Paine and James D. Kiser (2012) Aerial Photography andImage Interpretation, John Wiley and Sons, Inc., New York. 3. Faure, G. and Mensing, T.M. (2005) Isotope,	**Discipline Elective**	Shifted to pool of discipline electives

		• Use the elements and keys of visual image interpretation for aerial photographs and satellite data.	principles and applications. 3rd ed. John Wiley &Sons, New York. 4. George H. Davis, Stephen J. Reynolds, Charles F. Kluth(2013)Structural Geology of Rocks and region, 3rd Ed. John Wiley and Sons, New York. 5. Mason, B. and Moore, C.B. (1982) Introduction to Geochemistry, Wiley Eastern, New York. 6. Pandey SN (2001) Principle and applications of photogeology 7. Patel A.N., Surrender Singh (2011) Principle of remote sensing. Scientific publishers, New Delhi. 8.Rampal, K.K. (1999): Handbook of Aerial Photography and Interpretation, Concept Publishing Company, New Delhi. 9. Sabbins, F.F. (1985) Remote Sensing Principles and applications, Freeman, New York. 1. Singh, S. (2006) Physical Geomorphology. PrayagPustakBhawan, Allahabad. 2. Thornbury, W.D. (2005) Principles of Geomorphology, John Wiley and Sons, New Delhi (India Reprint).		

SIXTHSEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	**~~6.1~~** **~~Hydrogeology, Environmental and Engineering geology~~**	~~After the completion of this course, students will be able to:~~ • ~~Explain the hydrological cycle, aquifer parameters, movement and exploration of groundwater.~~ • ~~Describe various earth processes that create hazards to life and property and~~ • ~~Elucidate the applications of geology in Civil Engineering~~	~~Hydrogeology~~ ~~Unit-1~~ ~~Definition. Hydrological cycle. Hydrological parameters - precipitation, evaporation, transpiration and infiltration. Groundwater provinces of India.~~ ~~Unit-2~~ ~~Darcy's law and its validity, surface and sub-surface explorations of ground water. Ground water level fluctuation. Physical and chemical properties of Ground water. Water quality - dissolved constituent of groundwater.Salinization of groundwater.~~ ~~Unit-3~~ ~~Origin and age of groundwater. Vertical distribution of groundwater. Types of aquifers. Water bearing properties of rocks – Porosity and Permeability. Retention of water in rocks and yield of water from rocks. Different types of springs and their formations.~~ ~~Environmental geology~~ ~~Unit-4~~ ~~Definition and concepts of environmental geology. General idea about components, types of environment and environmental parameters. Composition of different environmental domains such as atmosphere, hydrosphere and biosphere. Types of environmental pollution. Green house effect. Elements of geological hazards.~~ ~~Engineering geology~~ ~~Unit -5~~	**Discipline Elective**	Shifted to pool of discipline electives

			~~Elementary concept of rock and soil mechanics. Role of Geology in civil engineering: Geological site investigations,foundation treatment and geotechnical considerations for construction of dams and reservoirs, tunnels, bridges and highway.~~		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	**~~6.2 Hydrogeology, Environmental and Engineering geologyLab~~**	~~After the completion of this course, students will be able to:~~ • ~~Determine the different hydrological parameters like porosity and permeability of rocks.~~ • ~~Prepare maps showing geological hazards like seismic activities, earthquakes, landslides and floods affecting the different parts of India.~~ • ~~Determine the chemical and physical parameters of water samples.~~	~~1. Groundwater provinces of India~~ ~~2. Major hydro-geochemical provinces of India~~ ~~3. Preparation of water table contour map and their interpretation~~ ~~4. Determination of permeability by falling and constant head method~~ ~~5. Graphical presentation of water quality data~~ ~~6. Exercises based on chemical analysis Groundwater~~ ~~7. Preparation of seismic and flood zonation maps India.~~ ~~**Recommended Books:**~~ ~~1. Bryant, E. (1985) Natural Hazards, Cambridge Univ. Press, Cambridge.~~ ~~2. Davies, S. N. and De Wiest, R. J. N. (1966) Hydrogeology, John Wiley and Sons, New York.~~ ~~3. F.G. Bell (2009) Fundamentals of engineering Geology by BS Publications, Hyderabad.~~ ~~4. HM Raghunath (2010) Groundwater. New Age International Publishers, New Delhi.~~ ~~5. Johnson, R.B. and DeGraft, J.V. (1988) Principle of Engineering Geology, John Wiley,~~	**Discipline Elective**	Shifted to pool of discipline electives

			New York. 6. Karanth, K. R. (1989) Hydrogeology, Tata McGraw Hill Publ., New Delhi. 7. Keller, E.A. (1978) Environmental Geology, Bell and Howell, USA. 8. Luis Gonzalez de Vallejo and Mercedes Ferrer (2011) Geological Engineering,CRC Press, Netherland 9. MT Maruthesha Reddy (2008) A Text Book of Applied Engineering Geology, New Age International Publishers, New Delhi 10. N ChennaKesavulu (2014) Text Book of Engineering Geology, Trinity Press, New Delhi 11. Nagabhushaniah, H. S. (2001) Groundwater in Hydrosphere, CBS Publ., New Delhi. 12. Prabin Singh, (2011) Engineering and General Geology, S.K. Kataria&Sons, New Delhi. 13. Raghunath, H. M. (1990) Groundwater, Wiley Eastern Ltd., New Delhi. 14. SubinoyGangopadhyay(2013) Engineering Geology by, Oxford University Press, New Delhi. 15. Todd, D. K. (1995) Groundwater hydrology, John Wiley and Sons, New York. 16. Tolman, C. F. (1937) Groundwater, McGraw Hill Book Co., New York. 17. Valdiya, K.S. (1987) Environmental Geology – Indian Context, Tata McGraw Hill, New Delhi.		

List of Discipline Electives

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	**GEOL ____** **Applied Geology**	**After the completion of this course, students will be able to:** • **Describe the concepts & principles of photogrammetry, remote sensing and their applications in geology.** • **Explain the hydrologic cycle and theory of plate tectonics as related to natural hazards.** • **Describe earth processes that create hazards to life and property.** • **Explain the applications of geology in Civil Engineering.**		**Unit I** **Introduction to Aerial photography.Types of aerial photos. Types of camera, films and filters.Flight plan. Introduction to forward and lateraloverlap, drift, crab and fiducial marks. Geometric principles of aerial photographs-relief displacement.Taking measurement from aerial photographs: scale, distance, area and height. Elements of interpretation of aerial photograph.** **Unit II** **Remote Sensing: Principles.Energy used in remote sensing.Electromagnetic Spectrum, Atmospheric windows, Energy interaction with Earth surface and atmosphere.Type of sensors: active and passive. Platforms.Resolutions - Spectral, spatial, radiometric and temporal.Applications of photogeologyand remote sensing in geology.** **Unit III** **Hydrological cycle. Darcy's law and its validity, surface and sub-surface explorations of ground water. Physical and chemical properties of Ground water.Types of aquifers. Water bearing properties of rocks - Porosity and Permeability.** **Unit IV** **Definition and concepts of environmental geology. Composition of different environmental domains such as atmosphere, hydrosphere and biosphere. Types of environmental pollution (Air, Water and**	Reviewed learning outcomes and suggested e-learning materials Introduced in pool of discipline electives.

				Soil). Environmental impact of Mining. Green House Effect. Elements of geological hazards (Flood, Landslides, Tsunami, Cyclone). **Unit V** **Elementary concept of rock and soil mechanics. Role of Geology in civil engineering: Geological site investigationsfoundation treatment and geotechnical considerations for construction of dams and reservoirs, tunnels, bridges and highway.** **Recommended Books:** **1. Bell, F.G. (2009). *Fundamentals of Engineering Geology*. New Delhi, India: BS.** **2. Bhatia, S.C. (2018). *Fundamentals of Remote Sensing*. New Delhi, India: Atlantic.** **3. Bryant, E. (2005). *Natural Hazards*. Cambridge, UK: Cambridge University Press.** **4. Gangopadhyay, S. (2013). *Engineering Geology*. New Delhi, India: Oxford University Press.** **5. George, J. (2005). F*undamentals of Remote Sensing*. Hyderabad, India: Universities Press.** **6. Karanth, K. R. (1989). *Hydrogeology*. New Delhi, India: Tata McGraw Hill.** **7. Keller, E.A. (2011). *Environmental Geology*(9th ed.). USA, Amsterdam, Netherland: Pearson.** **8. Kesavulu, C.N. (2014). *Text Book of Engineering Geology*. New Delhi, India: Trinity Press.** **9. Paine, D.P.,& Kiser, J.D. (2012). *Aerial Photography and Image Interpretation*(3rd ed.). New York, NY: John Wiley and Sons.**	

				10. Pandey, S.N. (2001). *Principle and Applications of Photogeology*. M.P.India:New Age International. **11. Patel, A.N.,& Singh, S. (2011). *Principle of Remote Sensing*. New Delhi,India: Scientific.** **12. Sabbins, F.F. (1987). *Remote Sensing-Principles and applications*(3rd ed.). New York, NY: Freeman.** **13. Singh, P. (2011). *Engineering and General Geology*. New Delhi, India: S.K. Kataria& Sons.** **14. Todd, D. K. (1995). *Groundwater Hydrology*(3rd ed.). New York, NY: John Wiley and Sons.** **15. Valdiya, K.S. (1987). *Environmental Geology – Indian Context*. New Delhi, India: Tata McGraw Hill.** **Suggested e-learning materials:** **1. Introduction to hydrology, environment, engineering and remote sensing https://epgp.inflibnet.ac.in/ahl.php?csrno=448** **https://nptel.ac.in/courses/105105106/**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	**GEOL ___L** **Applied Geology Lab**	**After the completion of this course, students will be able to:** • **Use the elements and keys of visual image**		**1. Elementary study of aerial photographs.** **2. Visual interpretation of aerial photograph.** **3. Stereo-pair interpretation and depth perception.** **4. Visual interpretation of standard FCC data.**	Reviewed learning outcomes and

		interpretation for aerial photographs and satellite data. • **Prepare maps showing geological hazards like seismic activities, earthquakes, landslides and floods affecting the different parts of India.** • **Determine the different hydrological parameters like porosity and permeability of rocks.** • **Determine the pH, EC, TDS of water samples**		**5. Graphical presentation of water quality data.** **6. Groundwater provinces of India.** **7. Major hydro-geochemical provinces of India.** **8. Preparation of water table contour map and their interpretation.** **9. Determination of permeability by falling and constant head method.** **10. Preparation of seismic and flood zonation maps of India.** **Recommended Books:** **1. Davies, S. N.,& De Wiest, R. J. N. (1966). *Hydrogeology*. New York, NY: John Wiley and Sons.** **2. Karanth, K. R. (1989). *Hydrogeology*. New Delhi, India: Tata McGraw Hill.** **3. Nagabhushaniah, H. S. (2001). *Groundwater in Hydrosphere*. New Delhi, India: CBS.** **4. Paine, D. P.,& Kiser, J. D. (2012). *Aerial Photography and Image Interpretation*(3rd ed.). New York, NY: John Wiley and Sons.** **5. Pandey, S.N. (2001). *Principle and Applications of Photogeology*. M.P.,India:New Age International.** **6. Raghunath, H.M. (2010). *Groundwater*. New Delhi, India: New Age International.** **7. Rampal, K.K. (1999). *Handbook of Aerial Photography and Interpretation*. Delhi, New Delhi, India: Concept.**	suggested e-learning materials Introduced in pool of discipline electives.

				Suggested e-learning materials: **1. Introduction to hydrology, environment, engineering and remote sensing** **https://epgp.inflibnet.ac.in/ahl.php?csrno=448** **https://nptel.ac.in/courses/105105106/**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	**GEOL_ Field Geology: Tools and Techniques**	**After the completion of this course, students will be able to:** • **Elucidate the uses of tools in field and in lab** • **Describe the structural elements in field** • **Discriminate between the primary and secondary structures** • **Explain the geophysical method of prospecting**		**Unit- I** **Introduction to Geological field work, Orientation of toposheet in field, marking location in toposheet, forward and back Bearing, Essential tools of Field: Compass-clinometer and brunton haversack, hammer, Chisel, measuring tape; topographic sheet, field diary, field observations, collecting of specimens; field photographs.** **Unit- II** **Geological maps, topographic Maps: Classifications of the features, contours, scale; directions; Nature of profile section and its construction. Procedure in Geological mappings; description of Geological maps. Nature of Legend, requisite data of the completed geological map.** **Unit- III** **Types of dip (true and apparent dip) measurement of dip and strike of the rock bed in the field. Field relations of Igneous rocks: flow structure, Pyroclastic rocks, shape of contacts, sharpness of contact, Field study of structure of Igneous rocks,**	Introduced in pool of discipline electives.

				topographic expression of igneous rock; difference between vesicular structure vs. weathering Pits; amygdaloidal vs. porphyritic structure. **Unit- IV** **Field interpretation of sedimentary rocks: nature of parent rock; age relation of sedimentary material, bedding; causes of tilting and folding of beds; amount of tilting and direction of force. Topographic expression of folds; effect of topography on beneath of outcrop, correlation of outcrops. Evidence of faulting; faults in relation to their time of origin, Age of joints; Relation of joints to erosion and topography Interpretation of joints.** **Unit- V** **Prospecting methods: Airborne and ground prospecting methods, Seismic geophysical prospecting methods. Magnetic and gravity prospecting methods. Geophysical logging methods.** **Recommended Books:** **1. Billings, M. P. (1972). *Structural Geology* (3rd ed.). New York, NY: Prentice Hall.** **2. Compton, R. R. (1962). *Manual of field geology*. New York, NY: John Wiley & sons.** **3. Lahee, F. H. (1961). *Field Geology* (6th ed.). New York, NY:McGraw Hills.** **4. Mathur S. M. (2010). *Guide to field Geology*. New Delhi, India: PHI Learning.** **5. Ragan, M. D. (2009). *Structural Geology an Introduction to Geometrical Techniques* (3rd ed.). New York, NY: Cambridge University Press.** **6. Rowland, S.M., Duebendorfer, E. M., &Ilsa, M.**	

				S. (2007). *Structural Analysis and Synthesis A Laboratory Course in Structural Geology* (3rd ed.). Victoria, Australia: Blackwell. **Suggested e-learning materials:** 1. **Field Mapping http://www.geosci.usyd.edu.au/users/prey/FieldTrips/BrokenHillOlary/Mapping.html** 2. **Map interpretation https://ocw.tudelft.nl/courses/structural-geology-map-interpretation/**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	**GEOL_ L Field Geology: Tools and Techniques Lab**	**After the completion of this course, students will be able to:** • **Handle and Use Clinometer, Brunton and Global Positioning System (GPS)** • **Identify the structural elements in field and hand specimen** • **Solve problems related to map scales and toposheet indexing** • **Perform geological mapping**		**1. Introduction to cardinal directions** **2. Uses of clinometers, Brunton compass and Global Positioning System** **3. Numerical exercises based on map scales** **4. Study of symbols used in geological and topographic maps** **5. Indexing of toposheet and exercises based on indexing toposheets** **6. Study of lineation and foliation in hand specimen** **7. Collection of oriented samples** **8. Field mapping** **Recommended Books:** **1. Billings, M. P. (1972). *Structural Geology* (3rd ed.). New York, NY: Prentice Hall.** **2. Compton, R. R. (1962). *Manual of field geology*. New York, NY: John Wiley & sons.**	Introduced in pool of discipline electives.

				3. Lahee, F. H. (1961). *Field Geology* (6th ed.). New York, NY:McGraw Hills. **4. Mathur S. M. (2010). *Guide to field Geology*. New Delhi, India: PHI Learning.** **5. Ragan, M. D. (2009). *Structural Geology an Introduction to Geometrical Techniques* (3rd ed.). New York, NY: Cambridge University Press.** **6. Rowland, S.M., Duebendorfer, E. M., &Ilsa, M. S. (2007). *Structural Analysis and Synthesis A Laboratory Course in Structural Geology* (3rd ed.). Victoria, Australia: Blackwell.** **Suggested e-learning materials:** 1. **Field Mapping** **http://www.geosci.usyd.edu.au/users/prey/FieldTrips/BrokenHillOlary/Mapping.html** 2. **Map interpretation** **https://ocw.tudelft.nl/courses/structural-geology-map-interpretation/**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
5.	**GEOL_ Geology of Rajasthan**	**After the completion of this course, students will be able to:** • **Describe the physiographic features and climate of Rajasthan.** • **Explain the tectono-stratigraphy of the**		**Unit- I** **Geomorphology and climate of Rajasthan. Archean Basement granitoids: Untala Granite, Gingla granite, Berach granite, Ahar river granite. Stratigraphy of BhilwaraSupergroup.** **Unit- II** **Stratigraphy, Tectonics and Economic importance of AravalliSupergroup, Delhi Supergroup, MarwarSupergroup and VindhyanSupergroup.**	Introduced in pool of discipline electives.

		Rajasthan. • **Explore the economic viability of Rajasthan in terms of geological resources.** • **Study saline lakes of Rajasthan in terms of their geological evolution.**		**Unit- III** **Magmatic activities in Rajasthan with special reference to KishangarhSyenite, JahajGovinpura volcanic, Erinpura granite, Balda granite and Malani Igneous suite.** **Unit- IV** **Palaeozoic of Rajasthan: Bap and Badhaura formation. Mesozoic of Rajasthan: Jaisalmer and Barmer. Tertiary of Jaisalmer, Barmer and Bikaner-Nagaur basins.** **Unit- V** **Saline lakes of Rajasthan: Sambhar, Lunkaransar, Didwana and Pachpadra lake. Characteristic features and geological evolution of Saline lakes of Rajasthan.** **Recommended Books:** **1. Kumar, R. (1978). *Historical Geology and Stratigraphy of India*. New Delhi, India: New Age International.** **2. Ramakrishnan, M., &Vaidyanathan, R. (2010). *Geology of India* (Vol. 1). Bangalore, India: Geological Society of India.** **3. Ramakrishnan, M., &Vaidyanathan, R. (2010). *Geology of India* (Vol. 2). Bangalore, India: Geological Society of India.** **4. Roy, A.B. and Jakhar, S.R. (2012). *Geology of Rajasthan (Northwest India) Precambrian to Recent*. Jodhpur, India: Scientific Publisher.** **5. Sharma, R. (2010). *Cratons and Fold belts of***	

				***India*. Berlin, Germany: Springer-Verlag.** **Suggested e-learning materials:** **1. Basins of Rajasthan http://dghindia.gov.in/assets/downloads/56ceb6e098299Rajasthan_Basin_18.pdf** **2. International Commission on stratigraphy http://www.stratigraphy.org/** **3. Petroleum basin in Rajasthan http://petroleum.rajasthan.gov.in/sedimentary-basins.htm** **4. Precambrian sedimentary basins of India https://doi.org/10.1144/M43.3**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
6.	**GEOL_ L Geology of Rajasthan Lab**	**After the completion of this course, students will be able to:** **• Describe the physiographic features and climate of Rajasthan.** **• Explain the tectono-stratigraphy of the Rajasthan.** **• Explore the economic viability of Rajasthan in terms of geological resources.** **• Study saline lakes of**		**1. Preparation of geological map of Rajasthan** **2. Preparation of tectonostratigraphic map of Rajasthan** **3. Preparation of minerals map of Rajasthan – Metallic and Non - Metallic** 4. **Identification of important rocks of Rajasthan**. **Recommended Books:** **1. Kumar, R. (1978). *Historical Geology and Stratigraphy of India*. New Delhi, India: New Age International.** **2. Ramakrishnan, M., &Vaidyanathan, R. (2010). *Geology of India* (Vol. 1). Bangalore, India: Geological Society of India.**	Introduced in pool of discipline electives.

		Rajasthan in terms oftheir geological evolution.		**3. Ramakrishnan, M., &Vaidyanathan, R. (2010). *Geology of India* (Vol. 2). Bangalore, India: Geological Society of India.** **4. Roy, A.B. and Jakhar, S.R. (2012). *Geology of Rajasthan (Northwest India) Precambrian to Recent.* Jodhpur, India: Scientific Publisher.** **5. Sharma, R. (2010). *Cratons and Fold belts of India.* Berlin, Germany: Springer-Verlag.** **Suggested e-learning materials:** **1. Basins of Rajasthan http://dghindia.gov.in/assets/downloads/56ceb6e098299Rajasthan_Basin_18.pdf** **2. International Commission on stratigraphy http://www.stratigraphy.org/** **3. Petroleum basin in Rajasthan http://petroleum.rajasthan.gov.in/sedimentary-basins.htm** **4. Precambrian sedimentary basins of India https://doi.org/10.1144/M43.3**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
7.	**GEOL ___ Palaeontology and Stratigraphy**	**After the completion of this course, students will be able to:** • **Explain the principal elements of fossil**		**Unit I** **Palaeontology: Definition, subdivisions and its relationship with stratigraphy. Fossils: definition and mode of preservation of fossils (body and trace fossils). Index fossils. Incompleteness of fossils record. Elementary ideas about origin and evolution of life.** **Unit II**	Reviewed learning outcomes and suggested e-learning

		preservation. • **Identify fossils based on morphology and evolutionary trends.** • **Identify major lithotectonic units of India.** • **Describe the geological evolution of the Earth and Indian continent**.		**Morphology and geological distribution of the following fossil groups in India:** **a. Phylum Mollusca (Class: Lamellibranchia or Bivalvia, Class: Gastropoda and Class Cephalopoda)** **b. Phylum Brachiopoda** **c. Phylum Echinodermata (Class Echinodea)** **d. Phylum Cnidaria (Corals)** **Unit III** **Morphology and geological distribution of the following fossil groups in India:** **a. Phylum Arthropoda (Class Trilobita)** **b. Phylum Hemichordata (Class Graptolothina)** **Introduction to palaeobotany. Brief account of GondwanaSupergroup and its flora. Introduction to Micropaleontology: forminifera.** **Unit IV** **Stratigraphy: definition and its scope. Principles of stratigraphy. Stratigraphic classification (Lithostratigraphy, Biostratigraphy and Chronostratigraphy) and correlation (Lithostratigraphy, Biostratigraphy and Subsurface). Brief account stratigraphic succession, correlation and economic significance of Dharwars, Aravallis, Cuddapah and Vindhyans.** **Unit V** **Brief account of Phanerozoic stratigraphic successions of Indian subcontinent as mentioned below:** **Paleozoic (Spiti and Kashmir), Mesozoic (Spiti, Kutch and Jaisalmer) and Cenozoic (Assam and Siwaliks). Stratigraphic boundaries: Precambrian-**	materials Introduced in pool of discipline electives. .

				Cambrian, Permian-Triassic and Cretateous-Tertiary **Recommended Books:** **1. Black, R.M. (1988). *The Elements of Palaeontology* (2nd ed.). Cambridge, UK: Cambridge University Press.** **2. Boggs, S. (2001). *Principles of Sedimentology and Stratigraphy*(3rd ed.). New Jersey, NJ: Prentice Hall.** **3. Jain, P.C.,&Anantharaman, M.S. (1983). *Palaeontology: Evolution and Animal Distribution*. New Delhi, India: Vishal.** **4. Krishnan, M.S. (1968). *Geology of India and Burma* (6th ed.). Madras, India: CBS.** **5. Kumar, R. (1978). *Historical Geology and Stratigraphy of India*. New Delhi, India: New Age International.** **6. Lehmann, U.,&Hilmer, G. (1983). *Fossil Invertebrate*.Cambridge, UK: Cambridge Earth Science Series.** **7. Moore, R.C. Lalicker, C.G.,& Fischer, A.G. (1997). *Invertebrate Fossils*. New Delhi, India: CBS.** **8. Nield, E.W.,& Tucker, V.C.T. (1985) *Palaeontology: An Introduction*. London, UK:Pergmon Press.** **9. Prothero, D.R. (2004). *Bringing Fossil to Life – An Introduction to Paleontology* (2nd ed.). New York, NY:McGraw Hill.** **10. Ramakrishnan, M.,&Vaidyanathan, R. (2010). *Geology of India* (Vol. 1). Bangalore, India: Geological Society of India.**	

				11. Ramakrishnan, M.,&Vaidyanathan, R. (2010). *Geology of India* (Vol. 2). Bangalore, India: Geological Society of India. **12. Shrock, R.R.,&Twenhoffel, W.H. (1952). *Principles of Invertebrate Paleontology*. New Delhi, India: CBS.** **13. Wadia, D.N. (1961). *Geology of India*(3rd ed.). London, UK: English language.** **14. Weller, J.M. (1960). *Stratigraphic Principles and Practices*. New Delhi, India: Universal Book.** **15. Woods, H. (2004). *PalaeontologyInvertebrate*(8th ed.). New Delhi, India: CBS.** **Suggested e-learning materials:** **1. Morphology of fossils http://www.ga.gov.au/scientific-topics/disciplines/palaeontology https://www.palaeontologyonline.com/** **2. International Commission on stratigraphy http://www.stratigraphy.org/** **3. International Chronostratigraphic Chart http://www.stratigraphy.org/index.php/ics-chart-timescale**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
8.	**GEOL ___L** **Palaeontology and Stratigraphy Lab**	**After the completion of this course, students will be able to:**		**1. Study of morphological characters of different genera pertaining to Brachiopoda, Lamellibranchia, Cephalopoda, Gastropoda, Trilobita, Echinoidea, and Anthozoa.** **2. Preparation of lithostratigraphic maps of India**	Reviewed learning outcomes and

		• **Transform a stratigraphic cross-section into a historical summary.** • **Explain Stratigraphy and broad tectono-stratigraphic divisions of India through maps.** • **Identify different lithotectonic units of India and establish their stratigraphic correlations.** • **Explain the morphological characters of different genera of fossils.**		**showing distribution of the following: Dharwar,Cuddapah, Vindhyan.** **3. Distribution of Gondwana Rocks in map of India.** **4. Study of important rocks of Rajasthan.** **Recommended Books:** **1. Black, R.M. (1988). *The Elements of Palaeontology* (2nd ed.). Cambridge, UK: Cambridge University Press** **2. Boggs, S. (2001). *Principles of Sedimentology and Stratigraphy*(3rd ed.). New Jersey, NJ: Prentice Hall.** **3. Jain, P.C.,&Anantharaman, M.S. (1983). *Palaeontology: Evolution and Animal Distribution*. New Delhi, India: Vishal.** **4. Krishnan, M.S. (1968). *Geology of India and Burma* (6th ed.). Madras, India: CBS.** **5. Kumar, R. (1978). *Historical Geology and Stratigraphy of India*. New Delhi, India: New Age International.** **6. Lehmann, U.,&Hilmer, G. (1983). *Fossil Invertebrate*.Cambridge, UK: Cambridge Earth Science Series.** **7. Moore, R.C. Lalicker, C.G.,& Fischer, A.G. (1997). *Invertebrate Fossils*. New Delhi, India: CBS.** **8. Nield, E.W.,& Tucker, V.C.T. (1985) *Palaeontology: An Introduction*. London, UK:Pergmon Press.** **9. Prothero, D.R. (2004). *Bringing Fossil to Life – An Introduction to Paleontology* (2nd ed.). New York, NY:McGraw Hill.**	suggested e-learning materials Introduced in pool of discipline electives.

				10. Ramakrishnan, M.,&Vaidyanathan, R. (2010). *Geology of India* (Vol. 1). Bangalore, India: Geological Society of India. **11. Ramakrishnan, M.,&Vaidyanathan, R. (2010). *Geology of India* (Vol. 2). Bangalore, India: Geological Society of India.** **12. Shrock, R.R.,&Twenhoffel, W.H. (1952). *Principles of Invertebrate Paleontology*. New Delhi, India: CBS.** **13. Wadia, D.N. (1961). *Geology of India*(3rd ed.). London, UK: English.** **14. Weller, J.M. (1960). *Stratigraphic Principles and Practices*. New Delhi, India: Universal Book.** **15. Woods, H. (2004). *Palaeontology Invertebrate* (8th ed.). New Delhi, India: CBS.** **Suggested e-learning materials:** **1. Palaeontology http://www.ga.gov.au/scientific-topics/disciplines/palaeontology** **2. International Chronostratigraphic Chart http://www.stratigraphy.org/index.php/ics-chart-timescale** **3. Global standard Section and Points (GSSPs) http://www.stratigraphy.org/index.php/ics-gssps** **4. Fossils https://www.palaeontologyonline.com/**	

BANASTHALI VIDYAPITH
SCHOOL OF EARTH SCIENCES

Name of the Programme : M.A. / M.Sc. (Geography)

Programme Educational Objectives:

Banasthali Vidyapith is an epitome of tradition and modernity. Vidyapith aims to preserve and inculcate the essential values and ideals of Indian culture. It believes in simple living and high thinking. Our educational ideology is based on the concept of fivefold education focusing on physical, practical, aesthetic, moral and intellectual aspects in order to develop a balanced personality.

Geography studies the earth in relation to mankind. Man's lifestyle is influenced by physical aspects in its immediate surroundings and Geography act as a bridge between man and its environment. Geography is also related to human dimension wherein man using the resources and creates its economic dimension. Various arenas of human aspects such as business, trade, commerce, agriculture, industry, navigation, military operations, spacecraft and administration needs Geography as a foundation.

Master's in Geography provides knowledge about scientific methods and facts from physical and human geography, particularly biogeography, climatology, oceanography, remote sensing, economic and resource geography, population geography, morphometric analysis, regional development & planning and geoinformatics. Furthermore students will gain profound knowledge of current research problems, approaches, and insights regarding the interactions between the environment and society in the context of global change. Students learn to integrate scientific theories, findings, and procedures in order to analyze and model human-environmental systems.

The main objectives of the Post Graduate Geography programme are:

- **To illustrate the atmospheric and hydrospheric phenomenon of the earth, geographical dimensions of India, regional development and planning at national & state level.**
- **To explain contribution of various scholars in the evolution and origin of the discipline along with paradigms, concepts, approaches and social relevance revolutions.**
- **To develop skills in surveying and explain standard quantitative methods for research in physical and socio- economic aspects.**
- **To use Geographic Information Systems (GIS), particularly for the purpose of map making, classification, 3D analysis etc.**
- **To minimize negative impacts of agriculture, mining, industries, urbanization etc. by conveying concept of environmental protection and conservation.**
- **To develop gender-neutral attitudes and practices; respect for all races, nations, religions, cultures, languages and traditions.**
- **To raise sensitivity for ethical codes of conduct, social values with help of eco-feminism, gender equality, social balance and respect for each strata of the society.**

Programme Outcomes (PO):

PO1: Geography Knowledge: Explain geomorphic processes involved in landform development, resource distribution, and concept of geographical grid, cosmogony, cosmology and geographical thoughts and concepts; Students have knowledge of atmosphere and hydrosphere as well as the importance of regional planning and associated developmental phenomenon. Analyze drainage basins and their linear, areal and relief aspects. Students can identify, delineate watershed area and extent of erosion to plan for its management.

PO2: Planning abilities: Apply surveying techniques with the help of theodolite, dumpy level, total station and GPS for mapping and planning of any area.

PO3: Design/development of solution for problems: Development is solution oriented. The program enables them to use several research techniques in portraying the problem at regional national and world forums. The capability to generate solution to most common social, economic, and environmental problems is developed among the future handlers of the society.

PO4: Problem analysis: Apply Statistical techniques for data analysis, computation and its representation. Students will become familiar with standard quantitative methods, enabling them to accurately understand the meaning of information and how this information can be used to understand economic and social issues.

PO5: Modern tool usage: Use remote sensing and GIS techniques in medical, urban & rural settlements, environment, agriculture, resource, tourism and several other aspects from a geographical perspective. The applications can further enhance research in the discipline and contribute towards a better living environment.

PO6: Leadership skills: Fieldwork is an essential component and an ideal setting in which teamwork and leadership skills are developed in young geographers. Geographical Investigations test hypothesis and involve spatial and temporal analysis. Geographers are used to manipulating and interpreting data and preparing reports regarding several aspects of human and physical environment.

PO7: Professional Identity: understand, analyze and contribute towards the discipline adopting professions as a researcher, teacher, cartographer, climatologist, meteorologist and planner.

PO8: Geographical Ethics: Apply ethical principles in personal, professional and social levels. Honor personal values and apply ethical principles in professional and social contexts. Demonstrate behavior that recognizes cultural and personal variability in values, communication and lifestyles. Use ethical frameworks; apply ethical principles while making decisions and take responsibility for the outcomes associated with the decisions.

PO9: Communication: Communicate effectively with the Earth Science community and with society at large, such as, being able to comprehend and write effective, make effective presentations and documentation, and give and receive clear instructions.

PO10: The Geographer and society: Create awareness in society about the conservation and management of Resources; Understand spatial distribution, socio-cultural, economic and administrative aspects of various tribes and races at regional and global level and their problems; Describe and understand political, social, agriculture, population and related problems associated with society and environment.

PO11: Environment and sustainability: Understand resource production, distribution and trade at regional and global level and join hands towards sustainable development of the society.

PO12: Life- long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. Self-access and use feedback effectively from others to identify learning needs and to satisfy theses needs on an ongoing basis.

Programme Scheme :

Semester I

EXISTING

Course Code	Course Name	L	T	P	C
GEOG 401	Advance Geomorphology	5	0	0	5
GEOG 404	Economic and Resource Geography	5	0	0	5
GEOG 405	Geographical Thoughts and Concepts	5	0	0	5
GEOG 407	Introduction to Geography	5	0	0	5
GEOG 402L	Cartographic Techniques Lab	0	0	12	6
	Total:	**20**	**0**	**12**	**26**

PROPOSED

Course Code	Course Name	L	T	P	C
GEOG 401	Advance Geomorphology	5	0	0	5
GEOG 404	Economic and Resource Geography	5	0	0	5
GEOG 405	Geographical Thoughts and Concepts	5	0	0	5
GEOG 407	Introduction to Geography	5	0	0	5
GEOG 402L	**Cartographic Techniques Lab**	0	0	12	6
	Total:	**20**	**0**	**12**	**26**

Semester II

Course Code	Course Name	L	T	P	C
GEOG 403	Climatology	5	0	0	5
GEOG 406	Geography of India	5	0	0	5
GEOG 409	Oceanography	5	0	0	5
GEOG 410	Regional Development and Planning	5	0	0	5
GEOG 408L	Morphometric Analysis Lab	0	0	12	6
	Total:	**20**	**0**	**12**	**26**

Course Code	Course Name	L	T	P	C
GEOG 403	Climatology	5	0	0	5
GEOG 406	**Geography of India**	5	0	0	5
GEOG 409	**Oceanography**	5	0	0	5
GEOG 410	Regional Development and Planning	5	0	0	5
GEOG 408L	Morphometric Analysis Lab	0	0	12	6
	Total:	**20**	**0**	**12**	**26**

Semester III

Course Code	Course Name	L	T	P	C
GEOG 504	Political Geography	5	0	0	5
GEOG 507	Research Methodology and Quantitative Techniques	5	0	0	5
GEOG 510	Systematic Agricultural Geography	5	0	0	5
GEOG 509L	Surveying Lab	0	0	12	6
	~~Elective I~~	5	0	0	5
	Total:	**20**	**0**	**12**	**~~26~~**

~~Elective I~~

GEOG ~~505~~	Population Geography	5	0	0	5
GEOG ~~508~~	Social Geography	5	0	0	5

Course Code	Course Name	L	T	P	C
GEOG 504	**Political Geography**	5	0	0	5
GEOG 507	**Research Methodology and Quantitative Techniques**	5	0	0	5
GEOG 510	**Systematic Agricultural Geography**	5	0	0	5
GEOG 509L	**Surveying Lab**	0	0	12	6
GEOG ___	**Discipline Elective I**	5	0	0	5
	Reading Elective I	0	0	0	2
	Total:	**20**	**0**	**12**	**28**

Semester IV

Course Code	Course Name	L	T	P	C
GEOG 501	Environmental Geography	5	0	0	5
GEOG 506	Remote Sensing and GIS	5	0	0	5
GEOG 506L	Remote Sensing and GIS Lab	0	0	12	6
	~~Elective II~~	5	0	0	5
	~~Elective III~~	5	0	0	5
	Total:	**20**	**0**	**12**	**26**

~~Elective II~~

GEOG ~~502~~	Geography of Rural Settlements	5	0	0	5
GEOG ~~511~~	Tourism Geography	5	0	0	5

~~Elective III~~

GEOG	Medical Geography	5	0	0	5

Course Code	Course Name	L	T	P	C
GEOG 501	**Environmental Geography**	5	0	0	5
GEOG 506	**Remote Sensing and GIS**	5	0	0	5
GEOG 506L	**Remote Sensing and GIS Lab**	0	0	12	6
GEOG ___	**Discipline Elective II**	5	0	0	5
	Open Elective	5	0	0	5
	Reading Elective II	0	0	0	2
	Total:	**20**	**0**	**12**	**28**

~~503~~					
GEOG ~~512~~	Urban Geography	5	0	0	5

List of Discipline Electives

Course Code	Course Name	L	T	P	C
GEOG 502	**Geography of Rural Settlements**	5	0	0	5
GEOG 503	Medical Geography	5	0	0	5
GEOG 505	Population Geography	5	0	0	5
GEOG 508	Social Geography	5	0	0	5
GEOG 511	Tourism Geography	5	0	0	5
GEOG 512	**Urban Geography**	5	0	0	5

List of Reading Electives

Course Code	Course Name	L	T	P	C
ENVS_R	Agroforestry	0	0	0	2
ENVS_R	Energy Resources and Conservation	0	0	0	2
ENVS_R	Man and Environment	0	0	0	2
ENVS _R	Water and Sustainable Development	0	0	0	2
GEOG_R	Environmental Challenges and Disaster Management	0	0	0	2
GEOG_R	India: Socio-Political and Environmental Scenario	0	0	0	2
GEOG_R	Rajasthan: Challenges and Prospects	0	0	0	2
GEOG_R	Transforming India	0	0	0	2
GEOL_R	Geo Tourism	0	0	0	2
GEOL_R	Indian Mineral Deposits, Economics and Mining Ethics	0	0	0	2
GEOL_R	Innovation and Entrepreneurship in Earth Sciences	0	0	0	2
GEOL_R	Natural Hazards and Disasters	0	0	0	2

List of Online Reading Electives

S. No.	Course Name	Proposed Alternative On-line Course	Credit point(s)	URL link
1	ENVS__R Energy Resource and Conservation	Non-Conventional Energy Resources	2	https://onlinecourses.nptel.ac.in/noc18_ge09/preview
2	GEOL__R Indian Mineral Deposits, Economics and Mining Ethics	Mineral Resources: Geology, Exploration, Economics and Environment	2	https://onlinecourses.nptel.ac.in/noc18_ce13/preview
3	GEOL__R Natural Hazards and Disasters	Natural Hazards Part 1	2	https://onlinecourses.nptel.ac.in/noc19_ce14/preview

***Lecture hrs./week; T-Tutorials hrs./week; P-Project/Practical/Lab/All other non-classroom academic activities, etc. hrs./week; C-Credit Points of the Course**

Note: Yellow highlighted and bold content illustrate the modification in the syllabus.

Annexure - 6

Name of the Programme : M.A. /M.Sc. (Geography)

Course Details :

FIRST SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	GEOG 401 Advance Geomorphology	**After the completion of this course, students should be able to:** • **Analyze the relation between geomorphological processes and landscape formation.** • **Explain the structure of earth's interior.** • **Describe endogenetic and exogenetic activities transforming the earth.** • **Apply geomorphological knowledge in research related to land-use, mining and agriculture.**	**——**	**——** .	**Reviewed** **Learning outcomes, recommended books &** **e-learning materials** **and rearranged the content.**

				Recommended Books: **1. Bloom, A. L. (2009). *Geomorphology* (3rd ed.). New Delhi, India: Prentice Hall.** **2. Chorley, R. J., Schumm, S. A., & Sugden, D. E. (1984). *Geomorphology*. London, UK: Methuen.** **3. Dayal, P. (2010). *A Text Book of Geomorphology* (5th ed.). New Delhi, India: Kalyani.** **4. Fairbridge, R. W. (Ed.). (1968). *Encyclopedia of Geomorphology*. New York, NY: Reinhold Book Corporation.** **5. Gregory, K. J., & Walling, D. E. (1973). *Drainage Basin Form and Process*. London, UK: Edward Arnold.** **6. Gutierrez, M. (2013). *Geomorphology*. London, UK: Taylor and Francis.** **7. Huggett, R. J. (2018). *Fundamentals of Geomorphology*. New York, NY: Routledge** **8. Husain, M. (2002). *Fundamentals of Physical Geography* (4th ed.). Jaipur, India: Rawat.** **9. Kale, V., & Gupta, A. (2010). *Introduction to Geomorphology*. Hyderabad, India: Orient Longman.** **10. Singh, S. (2013). *Geomorphology* (5th ed.). Allahabad, India: Prayag Pustak Bhawan.** **11. Strahler, A. N. (2016). *Introducing Physical Geography* (6th ed.). New York, NY: John Wiley & Sons.** **12. Thornbury, W. D. (2002). *Principles of Geomorphology* (2nd ed.). New Delhi, India: John Wiley & Sons.** **13.** दयाल, पी. (2010). *भूआकृति विज्ञान* (तृतीय सं.). नई दिल्ली, भारतः राजेश. **14.** शर्मा, एच. एस., शर्मा, एम. एल., एवं मिश्रा, आर. एन. (2014). *भौतिक भूगोल*. जयपुर, भारतः पंचशील. **15.** सिंह, एस. (2008). *भूआकृति विज्ञान* (सप्तम् सं.). गोरखपुर, भारतः वसुन्धरा. **Suggested e-learning materials:** **1. Plate Tectonics, Weathering, Mass Wasting and Erosion** **http://hkss.cedd.gov.hk/hkss/eng/education/GS/eng/hk**	

				g/chapter4.htm 2. Geomorphic Processes http://ncert.nic.in/ncerts/l/kegy206.pdf	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	GEOG 404 Economic and Resource Geography	**After the completion of this course, students should be able to:** • **Describe and develop the approaches to economic and resource geography.** • **Describe the resource related issues, map them systematically.** • **Explain the interference of world trading blocs in international economics.** • **Describe the non-conventional resources and their usability and apprise public about the depletion of resources.**	**——**	**——** **Recommended Books :** **1. Gautam, A. (2010). *Advanced Economic Geography.* Allahabad, India: Sharda Pustak Bhawan.**	**Reviewed Learning outcomes, recommended books &** **e-learning materials** **and rearranged the content.**

				2. Guha, J. L., & Chattoraj, P. R. (2009). *Economic geography – A Study of Resources* (9th ed.). Kolkata, India: The World Press. **3. Hartshorn, T. A., & Alexander, J. W. (2009). *Economic Geography* (8th ed.). New Delhi, India: Prentice Hall.** **4. Leong, G. C., & Morgan, G. C. (2010). *Human and Economic Geography* (2nd ed.). New Delhi, India: Saurabh.** **5. Siddharth, K. (2018). *Economic Geography* (3rd ed.). Allhabad, India: Kitab Mahal.** **6. गौतम, ए. (2015). *आर्थिक भूगोल.* मेरठ, भारतः रस्तोगी.** **7. जाट, बी. सी. (2016). *आर्थिक भूगोल* (चतुर्थ सं.). जयपुर, भारतः पंचशील.** **8. मामोरिया, सी. (2012). *आर्थिक भूगोल* (द्वितीय सं.). आगरा, भारतः साहित्य भवन.** **9. सिंह, के. (1978). *मानव और आर्थिक भूगोल* (द्वितीय सं.). वाराणसी, भारतः तारा.** **10. सिंह, के. (2009). *आर्थिक भूगोल के मूलतत्व : संसाधन उपयोग, संरक्षण एवं आर्थिक विकास का अध्ययन* (11 वाँ सं.). वाराणसी, भारतः ज्ञानोदय.** **11. सिंह, के. एन., एवं सिंह, जे. (2010). *आर्थिक भूगोल के मूलतत्व* (11 वाँ सं.) . गोरखपुर, भारतः ज्ञानोदय.** **12. सिंह, जे. (2009). *संसाधन भूगोल.* नई दिल्ली, भारतः राधा.** **Suggested e-learning materials** **1. International trade** **https://gspp.berkeley.edu/assets/uploads/research/pdf/ssrn-id1783908.pdf** **2. NAFTA** **https://idatd.cepal.org/Normativas/TLCAN/Ingles/North_American_Free_Trade_Agreement-NAFTA.pdf**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	GEOG 405 Geographical Thoughts and Concepts	**After the completion of this course, students should be able to:** • **Analyze the work of several scholars and their contribution to the field.** • **Analyze the historical works and extract geographical information from them.** • **Describe the concepts, paradigms and models in Geography.** • **Develop an individual approach towards the subject.**	___	___	**Reviewed** **Learning outcomes, recommended books &** **e-learning materials** **and rearranged the content.**

				Recommended Books : 1. **Daniels, P., Bradshaw, M., Shaw, D., & Sidaway, J. (2008). *An Introduction to Human Geography: Issues for the 21st Century* (3rd ed.). London, UK: Prentice Hall.** 2. **Dikshit, R. D. (2018). *A Contextual History of Ideas* (2nd ed.). New Delhi, India: PHI.** 3. **Hussain, M. (2014). *Evolution of Geographical thought* (6th ed.). New Delhi, India: Rawat .** 4. **Kaushik, S. D., & Rawat. D. S. (2017). *Geographical thought and Methodology*. Meerut, India: Rastogi.** 5. **Martin, G. (2007). *All Possible Worlds. A History of Geographical Ideas* (4th ed.). New York, NY: Oxford University Press.** 6. **Maurya, S. D. (2013). *History Of Geographical Thought.* Allahabad, India: Sharda Pustak Bhawan.** 7. **Rana, L. (2008). *Geographical thought A systematic record of evolution*. New Delhi, India: Concept.** 8. **Singh, M. (2016). *Geographical Thought*. New Delhi, India: Sonali.** 9. कौशिक, एस. डी., एवं रावत, डी. एस. (2017). *भौगोलिक विचारधारा एवं विधि तंत्र* (नवम् सं.). मेरठ, भारत रस्तोगी. 10. जैन, एस. एम. (2018). *भौगोलिक चिन्तन का विकास* (संशोधित सं.). आगरा, भारतः साहित्य भवन. 11. प्रसाद, जी. (2006). *भौगोलिक संकल्पनाएँ.* नई दिल्ली, भारतः डिसकवरी. 12. मौर्य, एस. डी. (2015). *भौगोलिक चिन्तन का इतिहास.* इलाहाबाद, भारतः प्रयाग पुस्तक भवन. 13. सिंह, जे. (2009). *भौगोलिक चिन्तन के मूल आधार.* नई दिल्ली, भारतः वसुन्धरा. 14. हुसैन, एम. (2006). *भौगोलिक चिन्तन का इतिहास.* जयपुर, भारतः रावत. **Suggested e-learning materials** **1. Dualism** **https://epgp.inflibnet.ac.in/ahl.php?csrno=17 P-06, M-16** **2. System Analysis** **https://epgp.inflibnet.ac.in/ahl.php?csrno=17 P-06, M-26**	

				3. Quantitative Revolution **https://epgp.inflibnet.ac.in/ahl.php?csrno=17 P-06, M-25** **4. Explanation in Geography** **https://epgp.inflibnet.ac.in/ahl.php?csrno=17 P-06, M-32** **5. Gender Geography** **https://epgp.inflibnet.ac.in/ahl.php?csrno=17 P-06, M-33**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	GEOG 407 Introduction to Geography	**After the completion of this course, students should be able to:** • **Describe the nature of the subject and understand the geographical knowledge in ancient civilizations.** • **Develop an understanding of latitudes, longitudes, rotation, revolution, day and night and seasons.** • **Explain human dimensions in geography in context of several tribes and their economic activities.** • **Know the human adaptation to the environment in relation to several tribes.**	___	___ Recommended Books : 1. **Chauniyal, D. D. (2010). *Remote sensing and Geographical Information System*. Allahabad, India: Sharda Pustak Bhawan.** 2. **Dikshit, R. D. (2019). *Geographical Thought- A contextual History of Ideas* (2nd ed.). Delhi, India: Prentice Hall.** 3. **Haq, M. (1995). *Reflection on Human Development*. New Delhi, India: Oxford University Press.** 4. **Husain, M. (2002). *Fundamentals of Physical Geography* (2nd ed.). New Delhi, India: Rawat.** 5. **Husain, M. (2014). *Evolution of Geographical Thought*. Jaipur, India: Rawat.** 6. **Jean, D., & Sen, A. (1995). *Economic Development and Social Opportunity*. New Delhi, India: Oxford University press.** 7. **Johnston, R. J. (Ed.). (1983). *Philosophy and Human Geography: An Introduction to Contemporary Approaches*. London, UK: Edward Arnold.**	**Reviewed Learning outcomes, recommended books &** **e-learning materials** **and rearranged the content.**

				8. **Lownsburg, J. F., & Aldrich, F. T. (1979). *Introduction to Geographical Methods and Techniques*. Columbus, OH: Charles Marrili.** 9. **Matthews, J. A., & Herbert, D.T. (2008). *Geography: A very short introduction*. New York, NY: Oxford University Press.** 10. **Singh, L. R. (2009). *Fundamentals of Human Geography* (2nd ed.). Allahabad, India: Sharda Pustak Bhawan.** 11. **Singh, S. (2006). *Physical Geography*. Allahabad, India: Prayag Pustak Bhawan.** 12. कौशिक, एस. डी. (2011). *मानव भूगोल के सरल सिद्धांत* (12वाँ सं.).मेरठ, भारत: रस्तोगी. 13. मौर्य, एस. डी. (2010). *भौगोलिक चिन्तन का इतिहास* (तृतीय सं.). इलाहाबाद, भारत: प्रयाग पुस्तक भवन. 14. हुसैन, एम. (2012). *मानव भूगोल* (चतुर्थ सं.). जयपुर, भारत: रावत. **Suggested e-learning materials:** 1. **Human adaptation to the environment with special reference to Bushman http://www.newworldencyclopedia.org/entry/Bushmen** 2. **Solar and Lunar eclipse https://spaceplace.nasa.gov/eclipses/en/**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
5.	GEOG 402L Cartographic Techniques Lab	**After the completion of this course, students should be able to:** • **Diagrammatically display secondary and primary data through diagrams for all three dimensions** • **Have an understanding of map projections which further helps in cartography** • **Interpret toposheets and open series maps for applied aspects** • **Use the tools of cartography for research purpose**	a) Cartography – Techniques and Tools of Cartography. b) Introduction and Interpretation of Topographical maps, calculate Nearest neighbour analysis. c) Profiles – The method of drawing a profile, Types of profiles – serial, superimposed, projected, composite. d) Mathematical Construction of Map Projections:- i) Conical Projections: - Simple conical projection with one standard Parallel - Conical projection with two standard parallel. - Bonne's Projection - Polyconic Projection ii) Cylindrical Projections: - Cylindrical equidistant projection - Mercator's projection iii) Zenithal Projections: - Polar zenithal equal area projection - Orthographic polar Zenithal projection Conventional Projection: - Mollweide's Projection e) Representation of Statistical data: - ~~One dimensional, Two dimensional and Three dimensional diagrams (6 Diagrams 2 from each).~~ f) Geological Maps: Determination of Dip and Strike.	Cartography – Techniques and Tools of Cartography. 1. Introduction and Interpretation of Topographical maps, calculate Nearest neighbour analysis. 2. Profiles – The method of drawing a profile, Types of profiles – serial, superimposed, projected, composite. 3. Mathematical Construction of Map Projections:- 4. Conical Projections: - Simple conical projection with one standard Parallel - Conical projection with two standard parallel. - Bonne's Projection - Polyconic Projection 5. Cylindrical Projections: - Cylindrical equidistant projection - Mercator's projection 6. Zenithal Projections: - Polar zenithal equal area projection - Orthographic polar Zenithal projection 7. Conventional Projection: - Mollweide's Projection 8. Representation of Statistical data **using Microsoft Excel** 9. Geological Maps: Determination of Dip and Strike.	**Reviewed Learning outcomes, recommended books & e-learning materials and added topic for enrichment** .

			Non – scientific calculators are allowed during the examination. Recommended Books : ~~1. Ahmed, K. S. (1971) Simple map projections, Friends Book House, Aligarh.~~ ~~2. Mishra, R. P. and A. Ramesh (2002) Fundamentals of Cartography, Concept Publishing Company, New Delhi.~~ ~~3. Singh, R. L. (2011) Elements of Practical Geography, Kalyani Publishers, New Delhi~~ ~~4. Singh, R. L. and Dutt, P. K. (1960) Elements of Practical Geography, Students Friends, Allahbad.~~ ~~5. भल्ला, एल. आर. (2006) प्रयोगात्मकभूगोल, के. डी. प्रकाशन, अजमेर।~~ ~~6. शर्मा, जे.पी. (2012) प्रायोगिकभूगोल, रस्तोगीप्रकाशन, मेरठ।~~ 7. ~~सिंह, एल. आर. (2011) मानचित्र एवंप्रयोगात्मकभूगोल, सेन्ट्रलबुकडिपो, इलाहबाद।~~	Non – scientific calculators are allowed during the examination. **Recommended Books :** **1. Mishra, R. P., & Ramesh, A. (2002). *Fundamentals of Cartography*. New Delhi, India: Concept.** **2. Saha, P., & Basu, P. (2011). *Advanced Practical Geography*. Kolkatta, India: Books and Allied.** **3. Singh, L. R. (2011). *Fundamentals of Practical Geography*. Allahabad, India: Sharda Pustak Bhawan.** **4. Singh, R. L. (2011). *Elements of Practical Geography*. New Delhi, India: Kalyani.** **5. तिवारी, आर. सी., एवं त्रिपाठी, एस. (2014). *अभिनव प्रयोगात्मक भूगोल.* इलाहाबाद, भारतः प्रवालिका.** **6. भल्ला, एल. आर. (2006). *प्रयोगात्मक भूगोल.* अजमेर, भारतः कुलदीप.** **7. शर्मा, जे. पी. (2012). *प्रायोगिक भूगोल* मेरठ. भारतः रस्तोगी.** **8. सिंह, एल. आर. (2011). *मानचित्र एवं प्रयोगात्मक भूगोल.* इलाहबाद, भारतः सेन्ट्रल बुक डिपो.** **Suggested e-learning materials** **1. Map Projection https://www.gislounge.com/map-projection/** **2. Dip & Strike http://www.jsu.edu/dept/geography/mhill/phylabtwo/lab4/dipf.html**	

SECOND SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	GEOG 403 Climatology	**After the completion of this course, students should be able to:** • **Describe climate and climatic factors such as temperature, pressure, insolation and their distribution.** • **Describe the origin and location of winds with world map.** • **Explain Air masses, fronts, Jet streams and their impacts.** • **Explain the relation of climate with agriculture, urban planning and health.**	———	——— Recommended Books : 1. **Agarwal, S. K. (2013). *Global Warming and Climate Change (Past, Present and future)*. New Delhi, India: A. P. H.** 2. **Critchifield, J. H. (2009). *General Climatology* (4th ed.). Delhi, India: Prentice Hall.** 3. **Hussain, M. (2003). *Climatology*. New Delhi, India: Anmol.** 4. **Lal, D. S. (2014). *Climatology*. Allahabad, India: Sharda Pustak Bhawan.** 5. **Malhotra, R. (2010). *Climatology*. New Delhi, India: Global Vision.** 6. **Mehtani, S., & Sinha, A. (2010). *Climatology*. New Delhi, India: Commonwealth.** 7. **Singh, S. (2006). *Physical Geography*. Allahabad, India: Prayag.** 8. **Strahler, A. N. (2016). Introducing Physical Geography (6th ed.). New york, NY: John Wiley & Sons.** 9. **Strahler, A. N., & Strahler, A. H. (1977). *Geography and Man's environment*. New York, NY: John Wiley & Sons.**	**Reviewed Learning outcomes, recommended books &** **e-learning materials** **and rearranged the content.**

				10. लाल, डी. एस. (2009). *जलवायु विज्ञान.* इलाहाबाद, भारतः शारदा पुस्तक भवन. 11. शर्मा, एच. एस. (2014). *भौतिक भूगोल.* जयपुर, भारतः पंचशील. 12. सिंह, एस. (2013). *जलवायु विज्ञान* (अष्ट सं.). इलाहबाद, भारतः प्रयाग पुस्तक भवन. **Suggested e-learning materials:** **1. Cyclones https://www.imdtvm.gov.in/index.php?option=com_content&task=view&id=15&Itemid=30** **2. EL Nino https://www.nationalgeographic.org/encyclopedia/el-nino/**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	GEOG 406 Geography of India	**After the completion of this course, students should be able to:** • **Demarcate India physiographically into major divisions and understand seasons prevailing in the country.** • **Locate the several mineral, energy and industrial resources on country's map.** • **Describe demographic structure of India.** • **Describe the geography of Rajasthan, its resources and problems.**	Section – A : Physical Features a) Physiographic divisions of India: Evolution, Division and Significance of each division. b) Major river systems of India: Himalayan and the Peninsular river systems. c) Seasons of India: detail study of Monsoon. d) Climatic regions of India: Koeppen's climatic regions. e) Soils of India, major problems and methods of soil conservation. Section – B : Economic & Human Resources a) Major mineral resources: Iron ore, manganese and mica. b) Energy resources: conventional (coal) and non-conventional (solar, wind). c) Major industries: Iron-steel, cotton textile inustries and Industrial regions of India and their problems. d) Population: Growth, distribution, Composition: density, sex ratio e) Means of Transport: Road and Rail. Section – C : Geography of Rajasthan a) Physiographic Divisions ~~of Rajasthan~~. b) Climate ~~of Rajasthan~~ c) Drainage System of Rajasthan. ~~d) Irrigation Projects: Indira Gandhi Canal, Chambal Valley and Mahi Project.~~ e) Dairy development in Rajasthan. f) ~~Problem of Desertification~~. * Note – Stencils are to be permitted during the examination.	Section A Physical Features Physiographic divisions of India: Evolution, Division and Significance of each division; Major river systems of India: Himalayan and the Peninsular river systems; Seasons of India: detail study of Monsoon; Climatic regions of India: Koeppen's climatic regions; Soils of India, major problems and methods of soil conservation. Section B Economic & Human Resources Major mineral resources: Iron ore, manganese and mica; Energy resources: conventional (coal) and non-conventional (solar, wind); Major industries: Iron-steel, cotton textile industries and Industrial regions of India and their problems; Population: Growth, distribution, Composition: density, sex ratio; Means of Transport: Road and Rail. Section C Geography of Rajasthan Physiographic Divisions; Climate; Drainage System; **New comprehensive system of Soil Classification**; **Live stock (Sheep and Camel)** and Dairy development. Stencils are to be permitted during the examination. Recommended Books : 1. **Bhalla, L. R. (2016). *Geography of Rajasthan* (12th ed.). Jaipur, India: Kuldeep.**	**Reviewed Learning outcomes, recommended books & e-learning materials and rearranged the content.** **Addition of new content for enrichment and specification.**

			Recommended Books : ~~1. Bhalla, L. R. (2015) Geography of Rajasthan, Kuldeep Publications, Jaipur.~~ ~~2. Khullar D.R. (2014) India : A Comprehensive Geography, Kalyani Publication, Ludhiyana~~ ~~3. Krishnan, M.S.(2012) Geology of India and Burma, CBS Publication, New Delhi.~~ ~~4. Mishra, V.C. (1967) Geography of Rajasthan, National Book Trust, New Delhi.~~ ~~5. Puri, G. S.(1960) Indian forest Ecology, Oxford Book and Stationary, New Delhi.~~ ~~6. Raychaudhary. S.P. (1966) Land and Soil, National Book Trust, New Delhi.~~ ~~7. Singh Gopal, (2010) Geography of India, Atma Ram Publication, Delhi~~ ~~8. Wadia, D. N., (1957) Geology of India, Macmillan, London.~~ ~~9. हुसैन मजिद, सिंह रमेश (2015) भारत का भूगोल, टाटा मैक्ग्राहिल प्रकाशन, नई दिल्ली।~~ ~~10. मामोरिया चतुर्भुज (2009) भारत का वृहत भूगोल, साहित्य भवन आगरा।~~ ~~11. बंसल सुरेश चन्द्र (2011) भारत का भूगोल, मीनाक्षी प्रकाशन, मेरठ।~~ ~~12. सिंह गोपाल (2006) भारत का भूगोल, आत्माराम, दिल्ली।~~ ~~13. डॉ. हरिमोहन सक्सैना (2014) राजस्थान का भूगोल, राजस्थान हिन्दी ग्रंथ अकादमी प्रकाशन।~~ ~~14. डॉ. राजकुमार शर्मा (2010) राजस्थान का भूगोल, हिमाशुं पब्लिकेशंन, उदयपुर।~~ ~~15. एच. एस. शर्मा एवं डॉ. एम.एल. शर्मा (2015) राजस्थान का भूगोल, पचंशील प्रकाशन, जयपुर~~ 16. ~~मुर्जर आर. के. (2010) इन्दिरा गाँधी नहर के क्षेत्र का भूगोल, राजस्थान हिन्दी ग्रंथ अकादमी जयपुर।~~	**2. Khullar, D. R. (2014). *India, A Comprehensive Geography* (3rd ed.). Ludhiyana, India: Kalyani.** **3. Mishra, V. C. (1967). *Geography of Rajasthan*. New Delhi, India: National Book Trust.** **4. Singh, G. (2010). *Geography of India* (9th ed.). Delhi, India: Atma Ram.** **5. बंसल, एस. सी. (2015). *भारत का भूगोल* (तृतीय सं.). मेरठ, भारत: मीनाक्षी.** **6. मामोरिया, सी. (2018). *भारत का वृहत भूगोल.* आगरा, भारत: साहित्य भवन.** **7. शर्मा, आर. (2014). *राजस्थान का वृहत भूगोल* (द्वितीय सं.). उदयपुर, भारत: हिमाशुं.** **8. शर्मा एच. एस., एवं शर्मा, एम. एल. (2017). *भारत का नूतन भूगोल.* जयपुर, भारत: आर. बी. डी.** **9. शर्मा, एच. एस., एवं शर्मा, एम. एल. (2017). *राजस्थान का भूगोल* (13वाँ सं.). जयपुर, भारत: पचंशील.** **10. सक्सैना, एच. (2014). *राजस्थान का भूगोल* (12वाँ सं.). जयपुर, भारत: राजस्थान हिन्दी ग्रंथ अकादमी.** **11. सक्सैना, एच. एम., सक्सैना, आर., एवं सक्सैना, पी. (2017). *भारत का भूगोल.* जयपुर, भारत: रावत.** **12. सिंह, जी. (2006). *भारत का भूगोल.* दिल्ली, भारत: आत्माराम.** **13. हुसैन, एम. (2018). *भारत का भूगोल* (सप्तम् सं.). नई दिल्ली, भारत: टाटा मैक्ग्राहिल.** **Suggested e-learning materials:** **1. Detail study of Monsoon** **http://www.imd.gov.in/pages/monsoon_main.php** **2. Climate of India** **http://www.indiaenvironmentportal.org.in/files/climate_profile.pdf**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	GEOG 409 Oceanography	**After the completion of this course, students should be able to:** • **Describe the scope of oceanography and morphology of ocean bottoms of Pacific, Atlantic and Indian oceans.** • **Have a knowledge about the density, salinity, temperature and its distribution in the oceans.** • **Explain Coral Reefs, its types and origin.** • **Describe the dynamics of the ocean and marine resources.**	Section – A : Introduction to Oceanography a) Oceanography: Definition and Scope. b) The morphology of the Ocean Bottom: Hypsometric Curve; Bottom Reliefs of Pacific, Atlantic and Indian Oceans. c) Temperature of the Ocean: Factors affecting the Horizontal distribution of surface Temperature of the oceans, Importance of the ocean water Temperature, d) Heat Budget of the Oceans, Annual and Diurnal Range of Temperature. e) Horizontal and Vertical distribution of Temperature. Section - B : Oceanic Salinity, Density and Deposits a) Salinity of Ocean Water: Meaning, Sources and Controlling factors. b) Horizontal and Vertical distribution of Salinity. c) Density of Ocean Water: Meaning & controlling factors d) Horizontal and Vertical distribution of Density. e) Ocean Deposits: Meaning and Types Section – C : Circulation Of Oceanic Water And Coral Reefs a) Ocean Currents: Definition, Types of ocean Currents. Generating and Modifying factors of Ocean Currents	Section A Introduction to Oceanography Oceanography: Definition and Scope; The morphology of the Ocean Bottom: Hypsometric Curve; Bottom Reliefs of Pacific, Atlantic and Indian Oceans; Temperature of the Ocean: Factors affecting the Horizontal distribution of surface Temperature of the oceans, Importance of the ocean water Temperature; Heat Budget of the Oceans, Annual and Diurnal Range of Temperature, Horizontal and Vertical distribution of Temperature. Section B Oceanic Salinity, Density and Deposits Salinity of Ocean Water: Meaning, Sources and Controlling factors; Horizontal and Vertical distribution of Salinity; Density of Ocean Water: Meaning & controlling factors; Horizontal and Vertical distribution of Density; Ocean Deposits: Meaning and Types Section C Circulation of Oceanic Water and Coral Reefs Ocean Currents: Definition, Types of ocean Currents. Generating and Modifying factors of Ocean Currents; The Currents of the Pacific, Atlantic and Indian Ocean; Tides: Tide producing Forces, Types of Tides, Theories of Ocean Tides: Equilibrium Theory, Progressive Wave Theory and Stationary Wave Theory; Coral Reefs: Required Conditions of Coral Growth, Types of Coral Reefs; Theories of Coral Reef Formation: Darwin's Subsidence Theory, The Non- Subsidence - Theory of Murry; Man and Marine Resources, Marine Pollution: causes, effects measures; **Laws of Ocean Protection (UNEP).** Stencils are to be permitted during the examination. Recommended Books : **1. Gohchengleong. (2011). *Certificate Physical and Human Geography*. New Delhi, India:Oxford University Press.** **2. King, C. A. (1965). *Oceanography for Geographers*. London, UK:**	**Reviewed Learning outcomes, recommended books &** **e-learning materials** **and rearranged the content.** **Addition of new topic for enrichment of the content.**

			b) The Currents of the Pacific, Atlantic and Indian Ocean. c) Tides: Tide producing Forces, Types of Tides, Theories of Ocean Tides: Equilibrium Theory, Progressive Wave Theory and Stationary Wave Theory. d) Coral Reefs: Required Conditions of Coral Growth, Types of Coral Reefs; Theories of Coral Reef Formation: Darwin's Subsidence Theory, The Non- Subsidence - Theory of Murry. e) Man and Marine Resources, Marine Pollution: causes, effects and measures. * Note – Stencils Stencils are to be permitted during the examination. Recommended Books : ~~1. Davis, R.J.A. (1986), Oceanography- An introduction of the marine Environment, Win C. Brown, Iowa.~~ ~~2. King, C.A., (1962) Oceanography for Geographers, Edward Arnold Pub., London~~ ~~3. Murray, S.J., (1913), Ocean, A General account of the Science of the sea, Thorton Butter Worth, London.~~ ~~4. Sharma, R.C. & Vatal, M., (2011), Oceanography for Geographers, Chaitanya publishing house, Allahabad.~~ ~~5. Siddhartha, K. (1999), Oceanography, A Brief Introduction, Kisalaya Pub. Pvt. Ltd., New Delhi.~~ ~~6. Thurnman, H.V., (1978), Introduction to oceanography, Charles E. Merrill Pub. Co., London.~~ ~~7. Weyl, P.K. (1970), Oceanography and Introduction of the Marine Environment, John Wiley and Sons Ltd., London.~~ ~~8. लाल. डी. एस.(2013) समुद्र विज्ञान,शारदा पुस्तक भवन, इलाहाबाद।~~	**Edward Arnold.** **3. Khullar, D. R. (2014). *Physical Geography.* Ludhiana, India: Kalyani.** **4. Murray, S. J. (1913). Ocean, *A General account of the Science of the sea.* London, UK: Thorton Butter Worth.** **5. Sharma, R. C., & Vatal, M. (2011*). Oceanography for Geographers*. Allahabad, India: Chaitanya.** **6. Siddartha, K. (2010). *The Earth's Dynamic surface:A textbook on Geomorphology*. New Delhi, India: Kisalya.** **7. Siddhartha, K. (2014). *Oceanography. A Brief Introduction*. New Delhi, India: Kisalaya.** **8. Singh, S. (2004).*Geomorphology*. Allahabad, India: Prayag.** **9. Strahler, A. N., & Strahler, A. H. (2008). *Modern Physical Geography* (4th ed.). New Jersey, NJ:John Wiley & Sons.** **10.** लाल. डी. एस. (2013). *समुद्र विज्ञान.* इलाहाबाद, भारतः शारदा पुस्तक भवन . **11.** शर्मा एच. एस. (2008). *भौतिक भूगोल.* जयपुर, भारतः पंचशील. **12.** सिंह, एस. (2005). *भौतिक भूगोल का स्वरूप.* गोरखपुर, भारतः वसुन्धरा. **Suggested e-learing materials:** **1. Tides** **https://www.britannica.com/science/tide** **2. Coral reefs** **https://www.britannica.com/science/coral-reef** **Ocean bottom reliefs** **3. https://www.britannica.com/place/Pacific-Ocean**	

			9. ~~सिंह सविन्द्र (2002) भौतिक भूगोल का स्वरूप, वसुन्धरा प्रकाशन, गोरखपुर।~~ 10. ~~शर्मा एच. एस. (2008) भौतिक भूगोल, पंचशील प्रकाशन, जयपुर।~~		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	GEOG 410 Regional Development and Planning	**After the completion of this course, students should be able to:** • **Describe planning, its types and need.** • **Explain region as a concept and describe its types.** • **Delineate and demarcate regions with statistical techniques.** • **Measure development statistically and have an understanding of development programmes currently existing in the county.**	—	— Recommended Books : 1. **Bhalla, L. R. (2015).** ***Geography of Rajasthan*****. Jaipur, India:**	**Reviewed Learning outcomes, recommended books &** **e-learning materials** **and rearranged the content.**

				Kuldeep. **2. Chand, M. , & Puri. V. K. (1983). *Regional Planning in India.* New Delhi,India: Allied.** **3. Chandana, R. C. (2000). *Regional Planning*. Ludhiana, India: Kalyani.** **4. Chandana, R. C. (2014). *Regional Planning and Development*. New Delhi, India: Kalyani.** **5. Chaudhuri, R. J. (2009). *An Introduction to Development and Regional Planning with special reference to India*. Hyderabad, India: Orient Blackswan.** **6. Mishra, R. P. (2002). *Regional Planning concepts, Techniques, Policies and Case studies.* New Delhi, India: Concept.** **7. Nath, V. (Ed.). (2009). *Regional Development and Planning in India* New Delhi, India: Concept.** **8. Nath,V. (2011). *Administration and Development Planning in India.* New Delhi, India: Concept.** **9. Shekhar, S. (2004). *Regional Planning in India.* New Delhi, India: Anmol.** **10. Singh, G. (2017). *Regional Planning and Sustainable Development.* Jaipur, India: Shruti.** **Suggested e-learning materials:** **1. Desert Development Programmes** **http://dolr.gov.in/desert-development-programme-ddp** **2. Five year plans in India** **http://planningcommission.nic.in/plans/planrel/fiveyr/welcome.html**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
5.	GEOG 408L Morphometric Analysis Lab	**After the completion of this course, students should be able to:** • **Relate river actions and the topography of the region.** • **Calculate linear, areal, relief and slope related parameters.** • **Analyse the nature of river, its structure, direction of flow.**	___	___ Recommended Books : **1. Singh, R. L. (2011). *Elements of Practical Geography* (8th ed.). New Delhi, India: Kalyani.** **2. Singh, S. (2010). *Geomorphology*. Allahabad, India: Prayag Pustak Bhawan.** **3. Yadav, K. P. (2008). *Applications of Morphometry in Geomorphology*. New Delhi, India: Radha.** **4. तिवारी, वी. (2010). *प्रायोगिक भूगोल.* आगरा, भारतः रामप्रसाद एण्ड संस.** **5. पाण्डेय, ए. (2010). भूआकृतिक विश्लेषण की अभिनव प्रवृत्तियां. नई दिल्ली, भारतः डिस्कवरी.**	**Reviewed Learning outcomes, recommended books &** **e-learning materials** **and rearranged the content.**

		• **Analyse the drainage basin, erosional work of any river and its impact over the landscape.**		6. मिश्रा, पी. एल. (2013). *प्रयोगात्मक भूगोल. नई दिल्ली, भारतः विश्व भारती.* 7. वर्मा, एल. एन., एवं लोढा, आर. एम. (1999). *प्रयोगात्मक भूगोल.* जयपुर, भारतः राजस्थान हिन्दी ग्रंथ अकादमी. 8. शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल* (पंचम् सं.). मेरठ, भारत: रस्तोगी. **Suggested e-learning materials:** 1. **Watershed Atlas of India** **http://cgwb.gov.in/watershed/about-ws.html**	

THIRD SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	GEOG 504 Political Geography	**After the completion of this course, students should be able to:** • **Develop an approach to study political geography** • **Describe growth of the states and concept of Geopolitics.** • **Differentiate between state and nation and also explain geopolitical issues with special reference to Sino India and Indo Pak.** • **Discuss world political and environmental issues.**	Section – A : Introduction to Political Geography and Geopolitics a) Definition and scope of political geography and its relation with other social sciences. b) Development of Political Geography. c) Approaches to the study of Political Geography – Political-Environmental approach, Power analysis approach and Functional approach. d) Laws of Spatial Growth of states. e) Concept of Geopolitics. Section – B : Concept of States and Nation a) States and Nation: A historical perspective. b) The elements of a State and difference between Nation and State. c) Concept and classification of Frontiers and Boundaries. d) Buffer ~~zones~~. e) Concept of core areas. Section – C : Global Strategies and International Problems a) Geo Strategic Hypothesis-Theory of Heartland and Rimland. b) The round world perspective: Global strategies in Air age. c) Concept of Federalism and Politico-Geographic factor in rise of Indian federalism. d) International problems related with boundaries: Sino-India and India- Pakistan border.	Section A Introduction to Political Geography and Geopolitics Definition and scope of political geography; Approaches to the study of Political Geography – Political-Environmental approach, Power analysis approach, Functional approach and **A unified Field Theory;** Laws of Spatial Growth of states; Concept of Geopolitics. Section B Concept of States and Nation States and Nation: A historical perspective; The elements of a State and difference between Nation and State; Concept and classification of Frontiers and Boundaries; Buffer **states: Nepal and Bhutan**; Concept of core areas. Section C Global Strategies and International Problems Geo Strategic Hypothesis-Theory of Heartland and Rimland; The round world perspective: Global strategies in Air age; Concept of Federalism and Politico- Geographic factor in rise of Indian federalism; International problems related with boundaries: Sino-India and India- Pakistan border; Environmental problems and world politics * Note –Stencils are to be permitted during the examination. Recommended Books : **1. Blacksell, M. (2005). *Political Geography*. London, UK: Routledge.**	**Reviewed Learning outcomes, recommended books &** **e-learning materials and** **rearranged the content.** **Addition of relevant topic for enrichment and specification of content.**

			e) Environmental problems and world politics * Note –Stencils are to be permitted during the examination. Recommended Books : ~~1. Agnew, John A., Mitchell, Katharye., Tuathail, GearÓid Ó. (2003) A Companion to Political Geography. Wiley-Blackwell.~~ ~~2. Alexander, J. L. M. (1966) World Political Patterns, John Murray and Co., London.~~ ~~3. Blacksell, Mark (2005) Political Geography. Routledge. London~~ ~~4. Boggs, S.W. (1940) International Boundaries, Columbia University Press, New York.~~ ~~5. Borman, I. (1921) : The New World Problem in Political Geography, World Co., Yonkers, on Hudson.~~ ~~6. Chopra, Girish (2006) Political Geography. Commonwealth Publishers.~~ ~~7. Dixit, R.D. (1999): Political geography, the Spatiality of Politics, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.~~ ~~8. Goblet, Y.M. (1955) : Political Geography and world Map, Alfred A. Knob, New York.~~ ~~9. Fahrer, Chuck, Glassner, Martin Ira (2003) Political Geography, Wiley.~~ ~~10. Flint, Colin., Taylor, Peter James (2007) Political Geography: World-economy, nation-state, and locality (5th ed.). Pearson/Prentice Hall.~~ ~~11. Gallaher, Carolyn., Dahlman, Carl T., Gilmartin, Mary and Mountz, Alison (2009) Key Concept in Political Geography. Sage Publications Ltd.~~ ~~12. Huntington, E. (2009) World Power and Evolution, Yale University Press, New Haven.~~ ~~13. Jones, Rhys., Woods, Michael and Jones, Martin (2009): An Introduction to Political Geography:~~	**2. Chopra, G. (2006). *Political Geography*. New Delhi, India: Commonwealth.** **3. Dixit, R. D. (2006). *Political geography, the Spatiality of Politics*. New Delhi, India: Tata McGraw-Hill.** **4. Flint, C., & Taylor, P. J. (2018). *Political Geography: World-economy, nation-state, and locality* (6th ed.). New Jersey, NJ: Pearson/Prentice Hall.** **5. Gallaher, C., Dahlman, C. T., Gilmartin., M., & Mountz., A. (2012). *Key Concept in Political Geography*. California, CA: Sage.** **6. Jones, R., Woods., Michael., & Jones., M. (2009). *An Introduction to Political Geography: Space, Place and Politics*. Abingdon, UK: Routledge.** **7. Painter., Joe., Jeffrey., & Alex (2010). *Political Geography* (2nd ed.). California, CA: Sage.** **8. Singh, I. (2006). *Political Geography*. New Delhi, India: Alfa.** **9. Sukhwal, B. L. (1971). *India-A Political Geography*. New Delhi, India: Allied.** **10. चौहान, पी. आर. (2010). *राजनीतिक भूगोल.* गोरखपुर, भारत: वसुन्धरा.** **11. तिवारी, आर. सी. (2017). *राजनीतिक भूगोल.* इलाहाबाद, भारत: प्रवालिका.** **12. सक्सैना, एच. (2010). *राजनीतिक भूगोल* (पंचम् सं.). मेरठ, भारत: रस्तोगी.** **Suggested e-learning materials:** **1. Geopolitics https://epgp.inflibnet.ac.in/ahl.php?csrno=17 P-03; M-24** **2. International problems related with boundaries: India- Pakistan border http://www.newworldencyclopedia.org/entry/Indo-Pakistani_Wars**	

			Space, Place and Politics. Routledge. 14. Moodie, A. E. (1963) Geography behind Politics, Hutchinson's University Library, London. 15. Painter, Joe and Jeffrey, Dr. Alex (2009) Political Geography. Sage publications Ltd; 2nd ed. 16. Singh, I. (2006) Political Geography. Alfa Publication. 17. Sukhwal, B. L. (1971) India-A Political Geography, Allied Publishers, New Delhi. 18. चौहान, पी. आर. (2010) राजनीतिक भूगोल, वसुन्धरा प्रकाशन, गोरखपुर। 19. सक्सैना, हरिमोहन (2010) राजनीतिक भूगोल, रस्तोगी पब्लिकेशन्स, मेरठ।		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	GEOG 507 Research Methodology and Quantitative Techniques	**After the completion of this course, students should be able to:** • **Analyse the importance of research in geography.** • **Design a research proposal and have an understanding about its structure and collection techniques for primary and secondary data.** • **Calculate measures of central tendency, dispersion and correlate two phenomenon.** • **Test the hypothesis of varied samples sizes and nature.**	Section – A : Significance of Research a) Significance of Research in Geographical Studies. b) Research – Selection & Identification of Research Problem c) Research Design-Meaning, characteristics, steps and types. d) Hypothesis-Meaning, characteristics, types and testing e) Data- sources, collection techniques, processing and analysis. Section – B : Measures of Central Tendency a) Frequency distribution: Histogram and Graphical Representation. b) Measures of Central tendency: mean, median and mode; coefficient of variation. c) Measures of Dispersion: Mean deviation, Standard deviation and quartile deviation. d) Correlation analysis: Karl Pearson's & Spearman's Rank Correlation. e) Sampling and its types. Section – C : Test of Significance a) Student 't' test b) Mann – Whitney U – Test c) 'F' test d) Chi Square test e) Analysis of variance Non – scientific calculators are allowed during the examination. BooksRecommended: ~~1. Chorley R. J. and Haggett, P., (1967), Model in Geography: Physical and information, University paper backs. Methuen, London.~~ ~~2. Ebdon, D., (1977), Statistics in Geography, Basil~~	Section A Significance of Research Significance of Research in Geographical Studies; Research – Selection & Identification of Research Problem; Research Design-Meaning, characteristics, steps and types; Hypothesis-Meaning, characteristics, types and testing; Data- sources, **levels**, collection techniques, processing and analysis. Section B Measures of Central Tendency Frequency distribution: Histogram and Graphical Representation; Measures of Central tendency: mean, median and mode; coefficient of variation; Measures of Dispersion: Mean deviation, Standard deviation and quartile deviation; Correlation analysis: Karl Pearson's & Spearman's Rank Correlation; **Composite Index**; Sampling and its types. Section C Test of Significance Student 't' test; Mann – Whitney U – Test ; 'F' test ; Chi Square test; Analysis of variance Non – scientific calculators are allowed during the examination. Recommended Books : **1. Ahuja, R. (2014). *Research Methods.* Jaipur, India: Rawat.** **2. Alvi, Z. (2005). *Statistical Geography Methods and Applications.* Jaipur and New Delhi, India: Rawat.** **3. Dadson, S. J. (2017). *Statistical Analysis of Geographical Data An Introduction.* New Jersey, NJ: John Wiley & Sons.** **4. Gupta, S. P. (2012). *Statistical methods*. New Delhi, India:**	**Reviewed Learning outcomes, recommended books & e-learning materials and rearranged the content.** **Addition of new topic for enrichment of the content.**

			~~Blackwell.~~ ~~3. Flowerdew, R. and Martin, D., (1999), Methods in Human Geography: a guide for students doing research project, Longman.~~ ~~4. Frank, H. and Althoen, S. C., (1994), Statistic : Concepts and Applications, Cambridge University Press.~~ ~~5. Gregory, S., (1978), Statistical Methods for Geographers, Longman.~~ ~~6. Hammond, R. and McCullagh, P., (1991), Quantitative Techniques in Geography, Clarendon Press, Oxford.~~ ~~7. Har Prasad, (1992), Research Method and Techniques in Geography, Rawat Publications.~~ ~~8. Mishra, H. N. and Singh, V. P. (Eds), (1998), Research Methodology : Social, spatial and policy dimensions, Rawat Publications.~~ ~~9. डॉ. आर. एन. त्रिवेदी एवं डॉ. डी. पी. शुक्ला (2012) रिसर्च मैथ्डोलॉजी, सी. बी. डी., जयपुर।~~ ~~10. हीरालाल यादव (2008) शोध – प्रविधि एवं मात्रात्मक भूगोल, सधा प्रकाशन, नई दिल्ली।~~ ~~11. श्रीवास्तव एवं प्रसाद (2008) भूगोल की सांख्यिकीय विधियाँ, वसुन्धरा प्रकाशन, गोरखपुर।~~ 12. ~~कैलाश नाथ नागर (2013) सांख्यिकीय के मूल तत्व, मीनाक्षी प्रकाशन, मेरठ।~~	**Sultan Chand and sons.** **5. Jackson, L. S. (2009). *Research Methods and Statistics*. New Delhi, India: Cengage Learning.** **6. Kothari, C. R., & Garg, G. (2014). *Research Methodology Methods and Techniques* (3rd ed.). New Delhi, India: New age International.** **7. Kumar, R. (2016). *Research Methods A step-by-step Guide for Beginners* (2nd ed.). Sydney, Australia: Pearson Education and Dorling Kindersley.** **8. Mahmood, A. (2017). *Statistical Methods in Geographical studies* (6th ed.). New Delhi, India: Rajesh.** **9. Mishra, H. N., & Singh, V. P. (Eds.). (1998). *Research Methodology : Social, spatial and policy dimensions*. Jaipur, India: Rawat.** **10. Rao, G. N. (2012). *Research Methodology and quantitative Methods.* Hyderabad, India: B.S.** **11. Sarkar, A. (2013). *Quantitative Geography- Techniques and Presentations.* New Delhi, India: Orient Blackswan.** **12. नागर, के. एन. (2018). *सांख्यिकीय के मूलतत्व.* मेरठ, भारत: मीनाक्षी.** **Suggested e-learing materials:** **1. Chi-square test - http://ocw.jhsph.edu/courses/fundepiii/PDFs/Lecture17.pdf** **2. Measures of Dispersion https://sol.du.ac.in/mod/book/view.php?id=1317&chapterid=1066**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	GEOG 510 Systematic Agricultural Geography	**After the completion of this course, students should be able to:** • **Describe approaches to study agricultural geography.** • **Apprise farmers about new farming techniques, influencing patterns and environmental degradation caused by agriculture.** • **Demarcate any region according to world classification systems through statistical techniques.** • **Classify land on several parameters and discuss the nature of agricultural problems of the nation.**	Section – A : Nature & Scope of Agricultural Geography a) Nature, scope and significance of Agricultural Geography. b) Approaches to the study of Agricultural Geography – Commodity Approach, Regional Approach and systematic approach. c) Factors influencing patterns and farm techniques. d) Soils – Major soil types, distribution & their characteristics. e) Environmental degradation – Causes and consequences. Section – B : Agricultural Regions &Typology a) Whittleseys's classification of Agricultural systems of the world. b) Agricultural location theory of Von-thunen and their limitations. c) Concept of Agricultural regions and delimitation. d) Agricultural Typology. e) Methods of Delimitations of crop combination Region – J.C. Weaver's minimum deviation and K. Doi's least square method. Section – C : Modern Concepts of Agricultural Geography a) Concepts in Agricultural geography – Sustainable development. Social forestry, Agribusiness, and dryland farming. b) Land classification and land capability. c) Agricultural transformation in India posts Independence – Land reforms and land use policy. d) Green revolution its implications in India and impact of white revolution in India. e) Food deficiet and surplus regions of India,	Section A Nature & Scope of Agricultural Geography Nature, scope and significance of Agricultural Geography; Approaches to the study of Agricultural Geography – Commodity Approach, Regional Approach and systematic approach; Factors influencing patterns and farm techniques; Soils – Major soil types, distribution & their characteristics; Environmental degradation – Causes and consequences. Section B Agricultural Regions &Typology Whittleseys's classification of Agricultural systems of the world; Agricultural location theory of Von-thunen and their limitations; Concept of Agricultural regions and delimitation; Agricultural Typology-**Kostrowicki;** Methods of Delimitations of crop combination Region – J.C. Weaver's minimum deviation and K. Doi's least square method. Section C Modern Concepts of Agricultural Geography Concepts in Agricultural Geography– Sustainable development, Social forestry, Agribusiness, and dryland farming; Land classification and land capability; Agricultural transformation in India posts Independence – Land reforms and land use policy; Green revolution its implications in India and impact of white revolution in India; Food deficit and surplus regions of India, Problems of Indian Agriculture, management and planning, National Agriculture Policy. Stencils and non-scientific calculators are to be permitted during the examination.	**Reviewed Learning outcomes, recommended books & e-learning materials and rearranged the content.** **Addition of content for specification**

			Problems of Indian Agriculture, management and planning, National Agriculture Policy. * Note – Stencils and non-scientific calculators are to be permitted during the examination Recommended Books : ~~1. Ali, Mohammad (1981): Situation of Agricultural Geography, Rajesh publication, New Delhi,~~ ~~2. Ali, Mohammad (1979) Dynamics of Agriculture Development in India, Concept Publication Co. Delhi.~~ ~~3. Chauhan Dharmendra Singh (2010) Agricultural Geography, Ritu Publications. Jaipur~~ ~~4. Chopra Girish (2006) Agricultural Geography, Commonwealth Publishers.~~ ~~5. Hanif M. (2005) Encyclopedia of Agriculture Geography, Anmol Publications PVT Ltd.~~ ~~6. Kostowickie, 2 (1983): Agricultural Typology, Polish Academy Warsaw.~~ ~~7. Leong, Gon Cheng & Morgan, Gilliam C. (1982) Human and Economic Geography, Oxford University Press.~~ ~~8. Raina J. L. (2008) Agriculture Geography, Pointer Publishers.~~ ~~9. Rummey A Thomas (2005) The study of Agriculture Geography: A Scholarly guide & Bibliography, The Scarecrow press, Lnc.~~ ~~10. Shafi Mohammed (2000) Agricultural Geography of South Asia., Macmillan Publishers India.~~ ~~11. Singh & Dhillon (2004) Agriculture Geography(3rd Edition), Tata McGraw – Hill.~~ ~~12. Singh, R.L. (Ed.) (1968) Applied Geography, BHU press, Varanasi.~~ ~~13. हुसैन, मजिद (2000) कृषि भूगोल, रावत पब्लिकेशन, जयपुर।~~ ~~14. कुमार, प्रमीला एवं शर्मा, श्री कमल (2008) कृषि भूगोल,~~ ~~15. मध्य प्रदेश हिन्दी ग्रन्थ अकादमी, भोपाल।~~	Recommended Books : 1. **Chauhan, D. S. (2010). *Agricultural Geography*, Jaipur, India: Ritu.** 2. **Gautam, A. (2012). *Agricultural Geography*, Allahabad, India: Sharda Pustak Bhawan.** 3. **Hussain, M. (2010). *Agricultural Geography*, New Delhi, India: Rawat.** 4. **Kostowickie (1983). *Agricultural Typology*, Warsaw, Poland: Polish Academy.** 5. **Leong, G. C., & Morgan, G. C. (2010). *Human and Economic Geography* (2nd ed.). New Delhi, India: Saurabh.** 6. **Ali, M., & Hanafi, Y. S. (2013). *Agricultural Geography* .Gorakhpur, India: Vasundhra.** 7. **Ali, M. (1979). *Dynamics of Agriculture Development in India*, Delhi, India: Concept.** 8. **Ali, M. (1981). *Situation of Agricultural Geography*. New Delhi, India: Rajesh.** 9. **Shafi, M. (2006). *Agricultural Geography*. Delhi, India: Baba Barkha Nath.** 10. **Singh, J., & Dhillon, S. S. (2004). *Agriculture* Geography (3rd ed.). New Delhi, India: Tata McGraw – Hill.** 11. कुमार, पी., एवं शर्मा, के. (2008). *कृषि भूगोल* (अष्ट सं.). भोपाल, भारत: मध्य प्रदेश हिन्दी ग्रन्थ अकादमी. 12. गौतम, ए. (2009). *कृषि भूगोल.* इलाहबाद, भारतः शारदा पुस्तक भवन. 13. हुसैन, एम. (2010). *कृषि भूगोल* (द्वितीय सं.) जयपुर, भारत: रावत. **Suggested e-learning materials:** **1.White Revolution in India** **http://lnweb90.worldbank.org/oed/oeddoclib.nsf/fb71ec897615187985256885007b6ad0/1bdd436f3bb1c0d68525684800767e4e/$FILE/India_Dairy.pdf** **2.Agribusiness** **http://www.isapindia.org/uploads_isap/annual_report/1010_Report-2016-17.pdf**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	GEOG 509L Surveying Lab	**After the completion of this course, students should be able to:** • **Handle the surveying instruments- Theodolite, dumpy level and Indian Clinometer.** • **Measure the angles and survey different areas through triangulation and traverse method.** • **Plot the longitudinal profile of any region through dumpy level.** • **Conduct a Field survey of any region**.	1. Surveying: Definition ~~and History of surveying,~~ 2. Theodolite and Total Station Surveying: Introduction of Theodolite andTotal Stationsurveying, Measurement of angles, Triangulation and Traverse method of Theodolite surveying. 3. Dumpy level and Auto Level Surveying: Introduction of Dumpy and Auto level surveying observation of staff reading, recording of staff reading. Methods of leveling, Plotting of longitudinal profile 4. Indian clinometer: Brief introduction of Indian clinometer, method of use and determining the heights of distant points. 5. Field ~~Study: - Village Survey based on specially designed questionnaire as per the identified variables as per the objectives.~~ Scientific calculators are allowed during the examination. Recommended Books : ~~1. Kanetkar, T. P.(1985) : Surveying and Leveling, Vol. I, A. V. Griha Prakashan, Bombay.~~ ~~2. Mishra, R. P. and A. Ramesh, (2014): Fundamentals of Cartography, Concept Publishers, New Delhi.~~ ~~3. Monkhouse, F. J., (1952) : Maps and Diagrams, Methuen & Co. Ltd., London.~~ ~~4. Punmia, B.C., Jain, A.K. & Jain, A.K., (2005): Surveying, Laxmi Publication P. Ltd., New Delhi.~~ ~~5. Raize, E. (1948): General Cartography, McGraw Hill Book Co., London.~~ ~~6. Robinson, A. R., (1953) : Elements of Cartography, Chapman & Hall.~~ ~~7. Singh, R. L. (2009): Elements of Practical Geography, Kalyani Publishers.~~ ~~8. Singh, R. N. and Kanaujia L. R. S.,~~	**1.** Surveying: Definition, **Classification, Principles and Errors.** 2. Theodolite and Total Station Surveying: Introduction of Theodolite andTotal Stationsurveying, Measurement of angles, Triangulation and Traverse method of Theodolite surveying; **Surface generation and contour mapping by Total station; GPS** **3.** Dumpy level and Auto Level Surveying: Introduction of Dumpy and Auto level surveying. **Observation and recording of staff reading.** Methods of leveling, Plotting of longitudinal profile **by Dumpy level data**. **Cut & fill and Line Leveling by Auto level.** 4. Indian clinometer: Brief introduction of Indian clinometer, method of use and determining the heights of distant points. 5. **Field Survey.** Scientific calculators are allowed during the examination. Recommended Books : **1. Duggal, S. K. (2015). *Surveying* (4th ed., Vol. I). New Delhi, India: McGraw Hill.** **2. Ghilani, C. D., & Wolf, P. R. (2015). *Elementary surveying an introduction to geomatics* (14th ed.). New Jersey, NY: Pearson.** **3. Kanetkar, T. P. (1985). *Surveying and Leveling* (23rd ed., Vol. I). Pune, India: Pune Vidyarthi Griha.** **4. Mishra, R. P. (2014). *Fundamentals of Cartography* (2nd ed.). New Delhi, India: Concept.** **5. Punmia, B. C., Jain, A. K., & Jain, A. K. (2016). *Surveying* (17th ed., Vol. I). New Delhi, India: Laxmi.** **6.** पुनमिया, बी. सी., जैन, ए. के., एवं जैन, ए. के. (2016). ***सर्वेक्षण एवं क्षेत्रकार्य*** (अष्ट सं., प्रथम भाग). नई दिल्ली, भारतः लक्ष्मी. **7.** पुनमिया, बी. सी., जैन, ए. के., एवं जैन, ए. के. (2017). ***सर्वेक्षण एवं क्षेत्रकार्य*** (अष्ट सं., द्वितीय भाग). नई दिल्ली, भारतः लक्ष्मी.	**Reviewed Learning outcomes, recommended books &** **e-learning materials and rearranged the content.** **Addition of relevant topics for specification and enrichment**.

			~~(1998): Map Work & Practical Geography, Central Book Depot, Allahabad.~~ ~~9. शर्मा, जे.पी. (2009) प्रायोगिक भूगोल, रस्तोगी प्रकाशन, मेरठ।~~ 10. ~~वर्मा, एल एन.व आर. एम लोढा (1999) प्रयोगात्मक भूगोल, राजस्थान हिन्दी ग्रन्थ अकादमी, जयपुर।~~	**8. शर्मा, जे. पी. (2013). *प्रायोगिक भूगोल* (चतुर्थ सं.). मेरठ, भारतः रस्तोगी.** **Suggested e-learing materials:** **1. Introduction to Surveying** **https://nptel.ac.in/courses/105107122/1** **2. Introduction to Theodolite** **https://nptel.ac.in/courses/105107122/20** **3. Theodolite Measurement** **https://nptel.ac.in/courses/105107122/22** **4. Leveling basics** **https://nptel.ac.in/courses/105107122/13** **5. Profile leveling** **https://nptel.ac.in/courses/105107122/14** **6. Introduction to total station** **https://nptel.ac.in/courses/105107158/17**	

~~Elective I~~

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	GEOG-~~505~~ Population Geography	**After the completion of this course, students should be able to:** • **Map the world in terms of density, distribution and other demographic aspects.** • **Differentiate between demographic characteristics of developing and developed nations and factors posing that difference.** • **Have a theoretical background about population growth and migration** • **Depict the trends of urbanization and demographic structure of India.**	Section - A : Scope of Population Geography & Demographic Characteristics of the World a) Definition and scope of Population Geography and its relation with other sciences. b) Recent trends in Population Geography. c) Factors affecting the distribution and density of the world's population. d) Population growth and distribution in the world. e) Recent demographic characteristics of developed and developing nations. Section - B : Theories of Population Growth and Migration a) Theories of Population Growth - Malthusian theory, Optimum population theory and Theory of demographic transition. b) Factors affecting population change, Population resource regions of the world. c) Migration: Major factors, consequences and types of migration. d) Theories of migration: Lee, Rewensteen and Zelinsky's model. e) Important migration of the world. Section - C : Population Geography in India a) Development of Population Geography in India. b) Population change (birth rate and death rate), Population growth and internal migration c) Demographic structure (sex ratio, literacy rate and occupation structure). d) Trends of urbanization in India e) Population policy of India 2000. * Note – Stencils are to be permitted during the examination.	**Discipline Elective** Recommended Books : **1. Ahmad A., Noin, D., & Sharma, H. N. (Ed). (1997). *Demographic Transition- The third World Scenario*. Jaipur, India: Rawat.** **2. Bhende, A. A & Kanitkar, T. (2008). *Principles of Population Studies (19th ed.)*. Mumbai, India: Himalaya** **3. Chaubey, P.K. (2011). *Population Policy for India- prespectives, issues and challenges*. New Delhi, India: Kanishka.** **4. Chandana, R. C. (2014). *A Geography of population* (11th ed.). New Delhi, India: Kalyani.** **5. Chopra, G. (2006). *Population Geography*. New Delhi, India: Commonwealth.** **6. Cox, P. R. (1993). *Demography* (5th ed.). New Delhi, India: Universal Book Stall.** **7. Jay, W., & Pillai, V. K. (2017). *Demography- The Science of Population* (2nd ed.). Jaipur, India: Rawat.** **8. Jhingon, M. L., Bhatt, B. K., & Desai, J. N. (2011).**	**Shifted to pool of Discipline Electives.**

			Books Recommended: 1. ~~Ahmad A., Noin D., Sharma H.N. (1997): Demographic Transition- The third World Scenario (ed.) Rawat Publication~~ 2. ~~Chandana, R. C (2008): A Geography of population, Kalyani Publishers, New Delhi.~~ 3. ~~Chopra, Girish (2006): Population Geography. Commonwealth Publishers.~~ 4. ~~Gary, L., Peters, Robert, P. Larkin (2008): Population Geography: Problems, Concepts and Prospects. Kendall Hunt Publishing.~~ 5. ~~Graham, David (2009): Population Geography. Routledge.~~ 6. ~~Hassan, Mohd Izhar (2005): Population Geography. Rawat Publications.~~ 7. ~~Jhingon M.L., Bhatt B.K., Desai J.N. (2011): Demography, Vrinda Publishers Pvt. Ltd.~~ 8. ~~K. Bruce Newbold (2010): Population Geography: Tools and Issues. Rowman and Littlefield Publishers, Inc.~~ 9. ~~Khullar.D.R. (2012) India A comprehensive Geography, Kalyani Publishers~~ 10. ~~Kumar S. (2014): An introduction to Population Geography, ABD Publishers, New Delhi~~ 11. ~~Kumar S. (2014): Basic Principles of Population Geography, ABD Publishers, New Delhi~~ 12. ~~Kumar S. (2014): Elements of Population Geography, ABD Publishers, New Delhi~~ 13. ~~Qazi, S.A. (2006): Population Geography. APH publishing corporation.~~ 14. ~~Ranade P.S. (1990): Population Dynamics in India, Ashish Publishing House, New Delhi.~~ 15. ~~Tripathi, R.K. (2007): Population Geography. Commonwealth Publishers.~~ 16. ~~Wilson, (1968): Population Geography, Nelsen Publication.~~ 17. ~~Woods (1982/2000): Theoretical Population Geography, Longman Publication, USA.~~	***Demography*** **(2nd ed.). New Delhi, India: Vrinda.** **9. Premi, K. M. & Das, D. N. (2012).** ***Population of India 2011*****. Delhi, India: B.R.** **10. Qazi, S. A. (2010).** ***Population Geography*****. New Delhi, India: APH.** **11. Srivastava S. C. & Srivastava, S. (2004).** ***Studies in Demography*****. New Delhi, India: Anmol.** **12. Tripathi, R. K. (2007).** ***Population Geography*****. New Delhi, India: Commonwealth.** **13. Weinstein, J., Pillai, A., & Vijayan, K. (2017).** ***Demography-The Science of Population*** **(2nd ed.). Jaipur, India: Rawat.** **14.** पडां, बी. पी. (2007). *जनसंख्या भूगोल.* भोपाल, भारत: मध्यप्रदेश हिन्दी ग्रंन्थ अकादमी. **15.** बंसल, एस. सी. (2015). जनसंख्या भूगोल (द्वितीय सं.). नई दिल्ली, भारतः आर. के. **Suggested e-learing materials:** **1. Migration http://www.un.org/en/development/desa/population/migration/publications/migrationreport/docs/MigrationReport2017_Highlights.pdf** **2. Demographic Data of India http://censusindia.gov.in/2011-prov results/data_files/india/Final_PPT_2011_chapter3.pdf** **3. National Population Policy 2000 https://mohfw.gov.in/sites/default/files/2695375564141094946 9%20%281%29.pdf**	

			18. Yadav J.P. (2004): Population Geography, Anmol Pub. Pvt. Ltd. पटं, बी. पी. (2007) जनसंख्या भूगोल, मध्यप्रदेश हिन्दी ग्रंन्थ अकादमी, भोपाल।		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	GEOG ~~508~~ Social Geography	**After the completion of this course, students should be able to:** • **Develop an approach to study social geography.** • **Describe social processes, social strata's, and organizations.** • **Relate society and culture, understand cultural realms and regions.** • **Analyze the current status of women in India and suggest measures for improvement.**	Section – A : Introduction to Social Geography a) Meaning, Scope and Aims of Social Geography. b) Approaches to the study of social geography: Ecological approach, Regional approach, Historical approach, Welfare approach, System approach and Behavioral approach. c) Society: Definition, Origin and Classification of Society. d) Social Process: Forms of Social Interaction (Cooperation, Accommodation, Assimilation, Competition, and Conflict). e) Social Stratification, Caste and Class. Social Organization and Groups. Section – B : Society and Culture a) Society and Culture. b) Cultural Hearths. c) Cultural Diffusion: Definition, Elements, and causes of diffusion. Barriers of diffusion, Effects and Types of diffusion. Hagerstand's model of diffusion. d) Cultural Realms: Meaning of Cultural Realms ,Basis of delimitation of cultural realms, Modern classification of the cultural realms. e) Cultural Regions of the world: Meaning and Bases of delimitation of cultural regions, Cultural Regions United States, U.K., Mesopotamia and Indian. Section – C : Social Geography in India a) Social Geography of India: Indian Society in Historical Perspective. b) Status of Women in India. c) Social Change in India. d) Human Development in India. e) Social Planning in India: Meaning, Importance and	**Discipline Elective** —— **Recommended Books :** **1. Ahmad, A. (2006). *Social Geography* (Reprint). Jaipur, India: Rawat.** **2. Hamnett, C. (Ed.). (1996). *Social Geography : A Reader*. New York, NY: John Wiley & Sons.** **3. Majid, H. (2006). *Human Geography* (3rd ed.). Jaipur, India: Rawat.** **4. Mehtani, S. & Sinha, A. (2010). *Social Geography*. New**	**Shifted to pool of Discipline Electives**

			Major aspects of Social planning. Social Welfare Programmes in Planned Period (Child Welfare Programme, Women Welfare Programme, Labour Welfare Programme, Family Planning and Family Welfare Programme, Adult Education Programme). * Note – Stencils are to be permitted during the examination. <u>Books Recommended:</u> ~~1. Ahmad, Aijazuddin (1999): Social Geography, Rawat Publications, Jaipur And New Delhi.~~ ~~2. Chris Hamnett (1996): Social Geography (Ed.) : A Reader, Wiley – Blackwell, A John Wiley & Sons Lit., Publication, New York.~~ ~~3. Ghurye, B. S. (1957): Caste and Class in India, Popular Book Depot, Bombay.~~ ~~4. Guha, B.S. (1944): Racial Elements in India's Population, Oxford University Press, UK~~ ~~5. Jones, E & Eyles, J. (1979) : An Introduction to Social Geography, Oxford University Press, UK~~ ~~6. Jones, E. (ed.) (1975) : Readings in Social Geography, Oxford University Press, UK~~ ~~7. Mohanty, G. S. (2005): Social & Cultural Geography (Ed.), Isha Books Publication, Adharsh Nagar, Delhi.~~ ~~8. Vincent J. Del Casino Jr (2009): Social Geography – A Critical Introductions, Wiley – Blackwell, A John Wiley & Sons Lit., Publication. New York~~ ~~9. डॉ. श्रीकान्त दीक्षित एवं डॉ. रामदेव त्रिपाठी (2008) सांस्कृतिक भूगोल, वसुन्धरा प्रकाशन, गोरखपुर।~~ ~~10. डॉ. एस. डी. मौर्य, सामाजिक भूगोल (2010)शारदा पुस्तक भवन, इलाहाबाद।~~	**Delhi, India: Commonwealth.** **5. Mohanty, G. S. (Ed.). (2005). *Social & Cultural Geography*. Delhi, India: Isha Books.** **6. दीक्षित, एस. एवं त्रिपाठी, आर. (2008). *सांस्कृतिक भूगोल.* गोरखपुर, भारत: वसुन्धरा.** **7. मौर्य, एस. डी. (2010). *सामाजिक भूगोल.* इलाहाबाद, भारत: शारदा पुस्तक भवन.** **Suggested e-learning materials:** **1. Society: Definition, origin and Classification, Society and Culture http://egyankosh.ac.in/bitstream/123456789/41246/1/Unit-1.pdf** **2. Family welfare programmes https://humdo.nhp.gov.in/about/national-fp-programme/**	

FOURTH SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	GEOG 501 Environmental Geography	**After the completion of this course, students should be able to:** • **Describe approaches to study environment** • **Describe several environmental cycles, food chain, pyramids and energy flow.** • **Depict the consequences of pollution and hazards and suggest measures to control them.** • **Create awareness about the need of biodiversity conservation.**	Section - A : Introduction to Environmental Geography a) Definition and scope of Environmental Geography ~~and its relation with environmental science.~~ b) Approaches to study of environment,~~ Types of environment~~. c) Factors of the environment: Physiographic, Climatic, Edaphic, Biotic and Anthropogenic. d) Bio Geochemical Cycles: The Carbon cycle, the Oxygen cycle, the Nitrogen cycle. e) The Hydrological cycle. Section – B : Concept of Ecology and Ecosystem a) Concept of Ecosystem: With special reference to desert, forest and aquatic ecosystem. b) Food chain, Food web & succession. c) Ecological Pyramids and their types. d) Energy flow in ecosystem. e) Concepts of Biomes. Major biomes of the world: Tropical forest, Temperate forest, Grassland and Tundra. Section – C : Environmental Pollution and Hazards a) Environmental Pollution-Pollutants and sources: 1. Water pollution, 2. Soil pollution, 3. Air pollution and, 4. Noise pollution. b) Environmental Hazards : a. Natural hazards: i. Soil erosion, ii. Landslides, iii. Droughts and floods. b.Man-made hazards: i. Technological hazards: Nuclear and Industrial, ii. Green house effects and Global warming,	Section A Introduction to Environmental Geography Definition and scope of Environmental Geography; Approaches to study of environment, **Factors of the environment: Abiotic (Physiographic, Climatic, Edaphic)**; **Factors of the environment: Biotic (Flora & Fauna)**; Bio Geochemical Cycles: The Carbon cycle, the Oxygen cycle, the Nitrogen cycle; The Hydrological cycle. Section B Concept of Ecology and Ecosystem Concept of Ecosystem: With special reference to desert, forest and aquatic ecosystem; Food chain, Food web & succession; Ecological Pyramids and their types; Energy flow in ecosystem; Concepts of Biomes. Major biomes of the world: Tropical forest, Temperate forest, Grassland and Tundra. Section C Environmental Pollution and Hazards Environmental Pollution-Pollutants and sources:Water pollution,Soil pollution,Air pollution and,Noise pollution; Environmental Hazards- Natural hazards:Soil erosion, Landslides,Droughts and floods.Man-made hazards:Technological hazards: Nuclear and Industrial,Green house effects, Global warming and Ozone depletion; Biodiversity : Threats and conservation; Need of Environmental Management and Planning; Major **environmental Movements (Chipko Movement, Silent Movement, Vishnoi Movement) and National Green Tribunal (NGT) Act, 2010;** Concept of Environmental impact assessment (EIA).	**Reviewed Learning outcomes, recommended books &** **e-learning materials and rearranged the content.** **Addition of the relevant topics for specification .**

			iii. Ozone depletion. c) Biodiversity : Threats and conservation d) Need of Environmental Management and Planning e) Concept of Environmental impact assessment (EIA). Stencils are to be permitted during the examination. <u>Recommended Books :</u> ~~1. Anjuneyulu, Y. (2002): Environmental Impact Assessment Methodologies. B. S. Publications, Hyderabad.~~ ~~2. Bharucha, E., (2013) Textbook of Environmental Studies for Undergraduate Courses, Universities Press, Hyderabad~~ ~~3. Desombre, R.E. (2007) The Global Environment and World Politics, Continuum International Publishing Group, New York~~ ~~4. Gautam, A (2007): Environmental Geography, Sharda Pustak Bhawan, Allahabad.~~ ~~5. Gautam, A. (2005): Resource and Environment (in Hindi), Sharda Pushtak Bhawan, Allahabad.~~ ~~6. Hughs, Foreman (2010): Biogeography & Geomorphology. Apple academics.~~ ~~7. Jadhav, S.B., (2012) Environmental Geography,Chandralok Prakashan, Kanpur~~ ~~8. Mathur, H.S.(1998) : Essentials of Biogeography, Pointer Publishers, Jaipur.~~ ~~9. Mehtani, S. & Sinha, A. (2010): Biogeography. Commonwealth Publisher.~~ ~~10. Odum, E.P.(1968) : Fundamentals of Ecology, W.B. Sanders. Company, Philadelphia and London.~~ ~~11. Rajagopalan, R. (2005): Environmental Studies: From Crisis to Cure, Oxford University Press, New Delhi.~~ ~~12. Reddy, M. A. (2004): Geoinformatics for Environmental Management. B. S. Publishers., Hyderabad.~~ ~~13. Sarkar, S., and Chaudhary, S. K., (2014) Textbook of Environmental Science, APH Publishing Corporation, New Delhi.~~	Stencils are to be permitted during the examination. Recommended Books : **1. Bharucha, E. (2013). *Textbook of Environmental Studies for Undergraduate Courses*. Hyderabad, India: Universities Press.** **2. Desombre, R. E. (2007). *The Global Environment and World Politics*. New York, NY: Continuum International Publishing Group.** **3. Gautam, A. (2010). *Environmental Geography*. Allahabad, India: Sharda Pustak Bhawan.** **4. Jadhav, S. B. (2012). *Environmental Geography*. Kanpur, India: Chandralok.** **5. Mehtani, S., & Sinha,A. (2010). *Biogeography*. New Delhi, India: Commonwealth.** **6. Odum, E. P. (2005). *Fundamentals of Ecology* (5th ed.). Philadelphia and London, UK: W.B. Sanders Company.** **7. Rajagopalan, R. (2005). *Environmental Studies: From Crisis to Cure.* New Delhi, India: Oxford University Press.** **8. Saxena, H. M. (2007). *Environmental Geography* (2nd ed.). Jaipur, India: Rawat.** **9. Singh, R. B. (Ed.). (1990). *Environmental Geography*. New Delhi, India: Heritage.** **10. Singh, R. B. (Ed.). (1995). *Studies in Environment and Development.* Varanasi, India: Rakesh.** **11. Singh, S. (2012). *Environmental Geography*. Allahabad, India: Prayag Pustak Bhawan.** **12. William, M.W., & John, G. (2004). *Environmental Geography-Science, Landuse and Earth system* (3rd**	

			14. Saxena, K.K. (2004): Environmental Studies. University Book House Private Ltd., Jaipur. 15. Singh, O., Kumra V. K. and Singh J. (1988): India's Urban Environment. Pollution, Perception and Management. Tara Book Agency, Varanasi. 16. Singh, R. B. (ed) (1995): Studies in Environment and Development. Rakesh Prakashan, Varanasi. 17. Singh, R. B. (ed.) (1990): Environmental Geography. Heritage Publication, New Delhi. 18. Singh, S. (2007): Paryavaran Bhugol. Prayag Pustak Bhawan, Allahabad. 19. Singh, S. N. (1993): Elements of Environmental Geography and Ecology (in Hindi), Tara Book Agency, Varanasi. 20. Singh, S., (2012) Environmental Geography,Prayag Pustak Bhawan, Allahabad 21. Valdiya, K. S. (1987): Environmental Geology: Indian Context. Tata McGraw Hill Publishing Company. Ltd., New Delhi 22. William, M.W. and John, G (1996): Environmental Geography Science, Landuse and Earth system, John Wiley and sons, New York. 23. बाकरे, बाकरे, वाधवा (2005-06) पर्यावरणीय अध्ययन, रस्तोगी पब्लिकेशन्स, गंगोत्री, शिवाजी रोड़ मेरठ। 24. एस. सी. कलवार (2007) पर्यावरण संरक्षण, पोइन्टर पब्लिशर्स, दिल्ली। 25. बी. सी. जाट (2011) पर्यावरण भूगोल, सवत पब्लिशर्स, जयपूर। 26. वीणा वाना (2002) पर्यावरण शिक्षा, रिसर्च पब्लिशस, जयपुर। 27. अवस्थी, एन. एम. और तिवारी आर. पी. एल., (1995) पर्यावरण भूगोल, हिन्दी हिन्दी ग्रन्थ अकादमी, भोपाल। 28. गुर्जर राजकुमार और जाट बी.सी. (2010) संस्थान एवं पर्यावरण, पंचशील प्रकाशन, जयपुर 29. प्रसाद गायत्री और नौटियाल राजेश (2008) पर्यावरण भूगोल, शारदा पुस्तक भवन, इलाहाबाद	ed.). New York, NY: John Wiley & sons. 13. नेगी, पी. एस. (2014). *पारिस्थितिकी एवं पर्यावरण भूगोल* (चतुर्थ सं.). मेरठ, भारत: रस्तोगी. **Suggested e-learning materials:** 1. **Ozone depletion** **https://www.epa.gov/ozone-layer-protection/health-and-environmental-effects-ozone-layer-depletion** 2. **Global Warming** **https://www.nationalgeographic.com/environment/global-warming/global-warming-overview/**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	GEOG 506 Remote Sensing and GIS	**After the completion of this course, students should be able to:** • **Describe the concepts of aerial photography, Remote sensing and GIS.** • **Develop a background knowledge of platforms, sensors, thermal and microwave remote sensing.** • **Apply Geospatial techniques in fields of cartography, environmental management, vegetation monitoring, forest cover depletion etc.**	Section-A : Aerial Photograph a) Aerial Photographs: Definition,Basic Terms and Scale and Overlapping in aerial photographs b) Classification of aerial photographs, their utility and Factors affecting the quality of an aerial photo c) Fundamental of aerial photographs- Aerial camera, Time and season of photography, Planning and execution of photographic flight, Completion of photographic task d) Elements of air photo interpretation and interpretation keys e) Difference between aerial photograph and Topogarphical maps; Aerial photo mosaics Section- B : Remote Sensing a) Remote sensing: Definition, process and stages; historical development b) Remote sensing platforms and sensors c) Remote sensing programmes of India d) Electromagnetic Radiation (EMR) - Properties, Interaction of EMR with the earth's surface and atmosphere, Spectral signatures. e) Basic principles and applications of Thermal and Microwave Remote Sensing Section- C : GIS and GPS a) GIS: Meaning and concept, historical development; Components of GIS b) Data Structure and Data Models; Data Base Management System (DBMS), GIS manipulation and analysis c) Basic Principles of GPS; GPS segments:GPS receivers d) Application of GIS and GPS Non – scientific calculators are allowed in the examination. <u>Recommended Books :</u> ~~1. Abbasi, S. A. (2005): 'Application of GIS & Remote Sensing in Environment Managements', Discovery~~	Section A Aerial Photograph Aerial Photographs: Definition,BasicTerms and Scale and Overlapping in aerial photographs; Classification of aerial photographs, their utility and Factors affecting the quality of an aerial photo; Fundamental of aerial photographs- Aerial camera, Time and season of photography, Planning and execution of photographic flight, Completion of photographic task; Elements of air photo interpretation and interpretation keys; Difference between aerial photograph and Topographical maps; Aerial photo mosaics Section B Remote Sensing Remote sensing: Definition, process and stages; historical development; Remote sensing platforms and sensors; Remote sensing programmes of India; Electromagnetic Radiation (EMR) - Properties, Interaction of EMR with the earth's surface and atmosphere, Spectral signatures; Basic principles and applications of Thermal and Microwave Remote Sensing Section C GIS and GPS GIS: Meaning and concept, historical development; Components of GIS; Data Structure and Data Models; Data Base Management System (DBMS), GIS **Data** manipulation and analysis; Basic Principles of GPS; GPS Segments:GPS receivers; Application of GIS and GPS Non – scientific calculators are allowed in the examination.	**Reviewed Learning outcomes, recommended books & e-learning materials and rearranged & redefined the content.**

			Publishing House, New Delhi. 2. American Society of Photogrammtry (1993): Manual of Remote Sensing Publishers', Falls Church Virginia. 3. Avery, T. E. & Berlin, G. L. (1985): Interpretation of Aerial photographs, Burgess, Minneapolis. 4. Bhatta B. (2014): Remote Sensing and GIS, Oxford University Press 5. Burrough P.A. and Rachael A. McDonnell (2010): Principles of Geographic Information Systems', 2nd Ed. 6. Ciciarelli John A (1991): A Practical Guide to Aerial Photography- with an introduction to surveying, Van Nostrand 7. Curran P. J. (1985): 'Principles of Remote Sensing, Longman, London. 8. Fazal S., (2008): GIS Basics, New Age international Publishers 9. Ganesh A and Narayanakumat R. (2006): GPS Princiles and applications, Satish Serial Publishing House 10. George Joseph (2008): Fundamentals of Remote Sensing, Universities Press (India) Pvt Ltd. Hyderabad. 11. Heywood I, Cornelius S, Carver S. (2000): Introduction to GIS, Addison Wesley Longman, New York 12. Kumar S. (2014): Basics of Remote Sensing and GIS, University Science Press 13. Lillesand T.M., Kiefer, R.W. and Chipman J.W., (2011): Remote Sensing and Image interpretation, Wiley and Sons 14. Lo CP & Yeung AKW(2004): Concepts and Techniques of GIS, Prentice-Hall of India, New Delhi 15. Paine David P. and Kiser James D (2012): Aerial Photograph and Image interpretation, John Wiley and Sons 16. Palet, A.N, (1992): Remote Sensing Principles & Application, Scientific Publishers, Jodhpur. 17. चौनियाल देवी दत्त (2010), सुदूर सर्वेदन एवं भौगेलिक सूचना प्रणाली, शारदा पुस्तक भवन	**Recommended Books :** **1. Bhatta, B. (2011). *Remote Sensing and GIS (2nd ed.)*. New Delhi, India: Oxford University Press.** **2. Campbell, J. B., & Wynne, R. H. (2011). *Introduction to Remote Sensing* (5th ed.). New york, NY: Guilford** **3. Ciciarelli, J. A. (1991). *A Practical Guide to Aerial Photography with an introduction to surveying*. New York, NY: Van Nostrand Reinhold.** **4. Cracknell, A. P., & Hayer, L. (2009). *Introduction to Remote Sensing*, New York, NY: Taylor and Francis.** **5. Ganesh, A., & Narayanakumar, R. (2006). *GPS Principles and Applications.* Delhi, India: Satish Serial.** **6. George, J., & Jeganathan, C. 2018). *Fundamentals of Remote Sensing* (3rd ed.). Hyderabad, India: Universities Press.** **7. Gopi, S. (2013). *Global Positioning System-Principles and Applications.* New Delhi , India: McGraw Hill.** **8. Kumar, S. (2014). *Basics of Remote Sensing and GIS*, New Delhi, India: University Science Press Laxmi.** **9. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2008). *Remote Sensing and Image Interpretation* (6th ed.). New York, NY: Wiley & Sons.** **10. Lo, C. P., & Albert, K. W. Y. (2002). *Concepts and Techniques of Geographic Information System* (2nd ed.). New Delhi, India: Prentice-Hall.** **11. Michael, N. D. (2000). *Fundamentals of Geographic information Systems*. New York,**	

				NY: John Wiley & Sons. 12. Nag, P., & Kudrat, M. (1998). *Digital Remote Sensing*. New Delhi, India. Concept 13. Paine, D. P., & Kisher, J. D. (2012). *Aerial Photography and Image Interpretation* (3rd ed.). Victoria, Australia: John Wiley & Sons. 14. Palet, A. N. (1992). *Remote Sensing Principles & Application*. Jodhpur, India: Scientific. 15. चौनियाल, डी. डी. (2010). *सुदूर सर्वेदन एवं भौगोलिक सूचना प्रणालीं.* इलाहबाद, भारतः शारदा पुस्तक भवन. **Suggested e-learning materials:** 1. Concept of Aerial Photography https://www.nrcan.gc.ca/earth-sciences/geomatics/satellite-imagery-air-photos/air-photos/about-aerial-photography/9687 2. Principles And applications of GIS https://www.environmentalscience.org/principles-applications-gis	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	GEOG 506L Remote Sensing and GIS Lab	**After the completion of this course, students should be able to:** • **Perceive the depth through pocket stereoscope.** • **Interpret the aerial photographs and generate Land use and Land cover map with the help of mirror stereoscope.** • **Determine height, scale of aerial photographs.** • **Georeference any map, create thematic maps, generate DEM and slope maps.**	Photogrammetry : a. Stereoscopic Vision Test: Zeiss test for depth perception b. Orientation of Aerial Photographs under mirror Stereoscope. c. Identification of object/features using aerial photograph d. Determination of Scale, Stereoscopic Area, Principal point, Conjugate principal point, Direction of Flight line and Air base. e. Calculation of number of strips and number of photographs f. Height Determination using vertical aerial photographs. ~~g. Preparation of Map~~ GIS : 1. Basic software and ~~operating system~~ Introduction to Arc View's GIS softwareGeorefencing and creation of spatial dataJoining attribute data with spatial data, Creation of thematic maps. 2. Spatial Analysis, Classification, Proximity and Buffer analysis. 3D analysis in GIS: ~~Generation~~ of DEM and Slope * Note – Non- scientific calculators are allowed in the examination. Recommended Books : ~~1. American Society of Photogrammetry, (1993). Manual of Remote Sensing (2nd Edition), ASP, Falls church, Virginia.~~ ~~2. Burnside, C. D., (1979) Mapping from Aerial photographs, Graeda, London.~~	Photogrammetry: 1. Stereoscopic Vision Test: Zeiss test for depth perception 2. Orientation of Aerial Photographs under mirror Stereoscope. 3. Determination of Scale, Stereoscopic Area, Principal point, Conjugate principal point, Direction of Flight line and Air base. **4. Identification and Interpretation of objects/features from aerial photograph through mirror stereoscope** 5. Calculation of number of strips and number of photographs 6. Height Determination using vertical aerial photographs. GIS: Basic software 1. Introduction to GIS software; Georefencing; **Downloading of Satellite Imageries; Mosaicing; Subsetting**; digitization Joining attribute data with spatial data, Creation of thematic maps. 2. Spatial Analysis, Classification **(Supervised, Unsupervised and Accuracy Assessment),** Proximity and Buffer analysis. 3D analysis in GIS: creation of **aspect**, Slope and DEM Non- scientific calculators are allowed in the examination. Recommended Books : **1. Ciciarelli, J. A. (1991).*A Practical Guide to Aerial Photography with an Introduction to Surveying*.(1st ed.). New York, NY: Van Nostrand Reinhold.** **2. Kang-tsung, C. (2007). *Geographic Information System*. (4th ed.).New Delhi, India: Tata-McGraw Hill.**	**Reviewed Learning outcomes, recommended books & e-learning materials and rearranged the content.** **Addition of new content for enrichment and specification.**

			3. Hord, R. M., (1982) Digital Image Processing of Remotely Sensed DAT, Academic Press, New York. 4. Lillisand, T. M. & Kiefer, P. W., (1998) Remote Sensing & Image Interpretation, John Wiley & Sons, New York. 5. Moffit, H. F. & Edword M.M., (1980) Photogrammetry, Harperand Row Publishers, New York. 6. Paine, D. P., (1981) Aerial Photography & Interrelation for Resource Management, Willey, New York. 7. Waag, Bu – Chin, (2008) Digital Signal Processing Techniques & Applications in Radar Image Processing, John Willey, New Jersey. 8. Wolf. P. R., (1974) Elements of Photogrammetry McGraw Hill Books Co., London.	**3. Lillisand, T. M., & Kiefer, P. W. (2015). *Remote Sensing & Image Interpretation* (7th ed.).New York, NY: John Wiley & Sons.** **4. Michael N. D. (2001). *Fundamentals of Geographic information Systems* (1st ed.).New York, NY: John Wiley & Sons.** **5. Paine, D. P., & kisher, J.D. (2012). *Aerial Photography and Image Interpretation* (3rd ed.). Victoria, Australia: John Wiley & Sons.** **6. Sarkar, A. (2015). *Practical Geography A Systematic Approach* (3rd ed.). Kolkata, India: Orient Blackswan.** **7. Singh, L. R. (2011), *Fundamentals of Practical Geography.* Allahabad, India: ShardaPustak Bhawan.** **8. Wolf, P. R., Dewitt, B. A., & Wilkinson, B. E. (2014). *Elements of Photogrammetry with Applications in GIS* (4th ed.). New York, NY: Mc. Graw Hill Education.** **Suggested e-learning materials:** **1. Principles of Aerial Photography http://www.sfu.ca/~hickin/Maps/Chapter%208.pdf** **2. Image classification http://www.csre.iitb.ac.in/~avikb/GNR401/DIP/DIP_401_lecture_7.pdf**	

~~**Elective II**~~

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	GEOG ~~502~~ Geography of Rural Settlements	**After the completion of this course, students should be able to:** • **Develop an approach to study rural settlements.** • **Depict the evolution of settlements and relate it to the geographical factors.** • **Describe Rural morphology, its mining and types.** • **Describe house types, hierarchy of rural settlements and rural centers.**	Section - A : Introduction to Geography of Rural settlements a) Meaning, definitions and scope of geography of rural settlements ~~b) Development of the concept of geography of rural settlements with special reference to India~~ c) Approaches to geography of rural settlements. ~~d)~~ The relationship of geography of rural settlements with other branches of geography ~~and social sciences.~~ e) Origin and Evolution of settlemens. Section B – Morphology and Types of rural settlements ~~a)~~ Rural settlements: Types, factors of development ~~and distribution.~~ b) Types of rural settlements in India. ~~c)~~ Rural Morphology: Meaning, definitions and Types ~~of Rural morphology in India~~ d) Process of development of rural morphology and affecting forces. e) Size and Spacing of rural settlements. Section – C : Rural Dwellings and Service Centres a) Houses: Definitions, factors affecting and classification ~~(basis of shape, size & functional use)~~ b) Distribution of houses in India on the basis of building material. ~~c) House types and their characteristics in different regions: Himalayan region, Ganga plain, Peninsular plateau and Coastal regions~~ d) Rural service centres and their identification, periodic markets, characteristics and their types. e) Hierarchy of rural settlements and methods for the determination of hierarchy	**Discipline Elective**	**Shifted to pool of Discipline Electives**

			* Note – Stencils are to be permitted during the examination. Recommended Books : ~~1. Ambrose, P., Settlement Patterns, Longmans, London, 1970.~~ ~~2. Chisholm, M. (1967): Rural Settlements and Land use, john Wiley, New York~~ ~~3. Chisholm, M., Rural Settlement and Land Use, Hutchinson University Library, London, 1962.~~ ~~4. Daniel, P. (2002): Geography of Settlement. Rawat Publications., Jaipur and New Delhi.~~ ~~5. Ghosh, S. (1999): Geography of Settlements. Orient Longman, Kolkata.~~ ~~6. Ghosh, Sumita, Introduction to Settlement Geography, Orient Longman, Calcutta, 1998.~~ ~~7. Hudson, F. S. (1976): A Geography of Settlements. MacDonald and Evans, New York.~~ ~~8. Mandal R.B. (2001): Introduction to Rural Settlement,~~ ~~9. Mosley, M.J. (2005): Rural Development: Principles and Practice. Sage Publication, London.~~ 10. ~~Mukerji, R.K., Man and His Habitation, Popular Prakashan, Bombay, 1968~~. ~~11. Oliver, P. (1987): Dwellings. The House across the World. University of Texas Press, Austin.~~ ~~12. Rykwert, J. (ed.) (2004): Settlements. University of Pennsylvania Press, University Park,~~ ~~13. Sauer, C.O., Land and Life, University of California Press, Berkely, 1963.~~ ~~14. Sing W. L. and Singh, K.N. (ed) (1975): Readings in Rural Settlement Geography, NGSI,~~ ~~15. Singh R. L. Rural Settlements in Monsoon Asia, Varanasi, Banaras Hindu University, 1972~~ ~~16. Singh, R.Y. (2005): Geography of Settlements. Rawat Publications, Jaipur and New Delhi.~~ ~~17. Singh, S.B. (1977): Rural Settlement Geography. U.B.B.P., Publications, Gorakhpur.~~ ~~18. Tiwari, R. C. (2000): Settlement Geography; in Hindi. Prayag Pustak Bhawan Allahabad.~~ ~~19. Wanmali, S. (1983): Service Centres in Rural India. B.R. Publications Corporation, New Delhi.~~	**Recommended Books:** **1. Chishlom, M. (2009). *Rural Settlement and Land Use*. New Jersey, NJ: Transaction.** **2. Daniel, P. (1989). *The Geography of Settlement* (2nd ed.). Edinburg, Scotland: Oliver & Boyd.** **3. Ghosh, S. (1998). *Geography of Settlements*. Kolkata, India: Orient Longman.** **4. Mandal, R. B. (2001). *Introduction to RuralSettlement* (2nd ed.). New Delhi, India: Concept.** **5. Mourya, S. D. (2014). *Settlement Geography*. Allahabad, India: ShardaPustakBhawan.** **6. Oliver, P. (1987). *Dwellings: The House across the World*. Austin, TX: University of Texas Press.** **7. Singh, R. Y. (2015). *Geography of Settlements*. New Delhi, India: Rawat.** **8. Wanmali, S. (1983). *Service Centres in Rural India: policy, theory, and practice*. New Delhi, India: B. R.** **9. तिवारी, आर. सी. (2016). *अधिवासभूगोल*(अष्ट सं.). इलाहबाद, भारतः प्रयागपुस्तकभवन.** **10. बंसल, एस. सी. (2016). *ग्रामीणबस्तीभूगोल*(संशोधित सं.). मेरठ, भारतः मीनाक्षी.** **11. मौर्य, एस. डी. (2017). *अधिवासभूगोल*(षष्ठ सं.).इलाहबाद, भारतः शारदापुस्तकभवन.** **12. सिंह, आई. (2008). *अधिवासभूगोल.*नईदिल्ली, भारतः यूनिवर्सिटी.** **13. सिंह, आर. (2005). *अधिवासभूगोल.* नईदिल्ली, भारतः रावत.** **Suggested e-learning materials:** **1. Introduction to rural settlement** **https://books.google.co.in/books?id=SYQ1yydbDlwC&printsec=frontcover&dq=Introduction+to+rural+settlement&hl=hi&sa=X&ved=0ahUKEwiF1rOw55zhAhUZA3IKHRZpCUAQ6AEIKTAA#v=onepage&q=Introduction%20to%20rural%20settlement&f=false** **2. Settlement patterns** **https://www.britannica.com/place/India/Caste#ref487283**	

			20. मौर्य एस.डी.(2009) : अधिवास भूगोल, शारदा पुस्तक भवन, इलाहबाद। 21. बंसल सुरेश चन्द्र (2009) : ग्रामीण बस्ती भूगोल, मिनाक्षी प्रकाशन, मेरठ। 22. तिवारी आर. सी. (2006) : अधिवास भूगोल, प्रयाग पुस्तक भवन, इलाहबाद। 23. सिंह समयज्ञ (2005) : अधिवास भूगोल, रावत पब्लिकेशन, जयपुर एव नई दिल्ली 24. सिंह इन्दिरा (2008) : अधिवास भूगोल, यूनिवर्सिटी पब्लिकेशन, नई दिल्ली।		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	GEOG ~~511~~ Tourism Geography	**After the completion of this course, students should be able to:** • **Propagate the idea of ecotourism and sustainable tourism.** • **Depict the social and economic benefits of tourism in any tourist site.** • **Explain tourism potential of deprived places.** • **Describe the tourism on national and state level.**	Section-A : Concept of Tourism Geography a) Concept of Tourism: Definition, Evolution and types of Tourism. b) Tourism Geography: Definition, Key Concepts; Scale, Geographical components and spatial interaction between components. c) Geography of demand and suppy for tourism d) Development of tourism in India Section-B: Geographic Foundation of Tourism a) Introduction of geographic foundation of Tourism. b) Physical geography of Tourism: Resources and barriers c) Human Geography of Tourism: Resources and barriers d) Concept of Eco tourism Section-C: Geographical factors affecting Tourism a) Economic and Social benefits & cost of Tourism. b) Environmental benefits, cost of Tourism and emerging implications. c) Tourism in India: Demand, supply, organization and Tourism Resources d) Ecological and cultural tourism resources of Rajasthan. *Note – Stencils are to be permitted during the examination. <u>Books Recommended:</u> 1. ~~Bhatia A.K.(2002): Tourism Development: Principles and Practices. Sterling pub. New Delhi.~~ 2. ~~Burkarl, A.J.(1974): Tourism, Past, present and future Heineman London.~~ 3. ~~Cooper C., Cooper R.(2012): Worldwide Destinations: The Geography of Trevel and Tourism. Routledge, New~~	**Discipline Elective**	**Shifted to pool of Discipline Electives.**

~~York.~~

~~4. Garg Deepa (2009): Geography of Tourism, Mohit Punlication, New Delhi.~~

~~5. Gearing Charles, E. (1976): planning for Tourism development Praeger Pub, New York~~

~~6. Jayapalan, N.(2013): An Introduction to Tourism. Atlantic Publishers & Distributors, New Delhi.~~

~~7. Kamra, K. K. (2104): Tourism An Overview, Kanishka publishers, Distributors New Delhi~~

~~8. Kaushal, P. & Sharma, S.P.(2011) Ecological and Environmental Impact of Tourism. Kanishka publishers, Distributors New Delhi~~

~~9. Lawbon, F & Bauet B.(1977): Tourism and recreation Development mass, CBI pub.~~

~~10. Micheal Hall C. & Page J.S. (2014): Geography of Tourism and Receration, Routledge, New York.~~

~~11. Ministry of Tourism Govt. of India (1992): Report on National Action Plan on Tourism, New Delhi.~~

~~12. Ministry of tourism Govt. of India (1996): Report on National strategy for development of tourism New Delhi.~~

~~13. Ministry of Tourism Govt. of India (1999): Report on National Tourism.~~

~~14. Nelson V. (2013): An Introduction to the Geography of Tourism. Rawat Publication, Jaipur.~~

~~15. Pathania Kulwant Singh and Kumar Arun (2008) : Tourism in India, Regal Publication, New Delhi~~

~~16. Robinson H.(1976): A geography of Tourism. Mac Donald and Evans Ltd; London.~~

~~17. Sharma, S. P. (2011) : Tourism Education Principales, Theories and Practices. Kanishka publishers, Distributors New Delhi~~

~~18. Stephen L.J. Smoth (1989): Tourism Analysis : A Handbook- Longman Scientific of Technical.~~

~~19. शुक्ला राजेश एवं शुक्ला रश्मि (2009) : पर्यटन मे भूगोल, अर्जुन पब्लिशिंग हाऊस, दिल्ली।~~

~~20. नेगी जगमोहन (2007) पर्यटन एवं यात्रा के सिद्धान्त, तक्षशिला प्रकाशन, नई दिल्ली।~~

~~21. नेगी जगमोहन (2006): सम्पूर्ण भारत के सास्कृतिक पर्यटन स्थल, तक्षशिला प्रकाशन, नई दिल्ली।~~

~~22. दीक्षित एवं गुप्ता (2009) : पर्यटन के विविध आयाम।~~

~~23. रावत एवं ताज (2002): पर्यटन विकास के विविध आयाम, तक्षशिला प्रकाशन, नई दिल्ली।~~

~~24. हरिमोहन (2007): सास्कृति, पर्यावरण और पर्यटन, तक्षशिला प्रकाशन, नई दिल्ली।~~

Recommended Books :

1. **Bhatia, A. K. (2012). *Tourism Development: Principles and Practices* (2nd ed.). New Delhi, India: Sterling.**
2. **Boniface, B., Cooper, C., & Cooper, R. (2016). *Worldwide Destinations: The Geography of Trevel and Tourism* (7th ed., vol. I). New York, NY: Routledge.**
3. **Garg, D. (2009). *Geography of Tourism*. New Delhi, India: Mohit.**
4. **Jayapalan, N. (2013). *An Introduction to Tourism.* New Delhi, India: Atlantic.**
5. **Kamra, K. K. (2014). *Tourism An Overview*. New Delhi, India: Kanishka.**
6. **Kaushal, P., & Sharma, S. P. (2011). *Ecological and Environmental Impact of Tourism*. New Delhi, India: Kanishka.**
7. **Hall, M. C., & Page, J. S. (2014). *Geography of Tourism and Receration: Environment, Place and Space* (4th ed.). New York, NY: Routledge.**
8. **Nelson, V. (2017). *An Introduction to the Geography of Tourism* (2nd ed.). New York, NY: Rowman & Littlefield.**
9. **Sharma, S. P. (2011). *Tourism Education Principles, Theories and Practices* (2nd ed.). New Delhi, India: Kanishka.**
10. अग्रवाल, वी. (2012). *भौगोलिक पर्यटन.* नई दिल्ली, भारतः अर्जुन.
11. नेगी, जे. (2013). *आधुनिक पर्यटन एवं यात्रा के आधारभूत सिद्धान्त* (चतुर्थ सं.). नई दिल्ली, भारतः तक्षशिला.
12. शर्मा, ए. (2012). *पर्यटन भूगोल.* जयपुर, भारतः इशिका.
13. शुक्ला, आर., एवं शुक्ला, आर. (2009). *पर्यटन भूगोल.* नई दिल्ली, भारतः अर्जुन.
14. सारण, बी. आर. (2008). *पर्यटन उत्पाद एवं प्रबन्ध.* नई दिल्ली, भारतः कनिष्क.

Suggested e- learning materials:

1. **Cultural tourism in Rajasthan http://www.tourism.rajasthan.gov.in/**
2. **Economic benefits of Tourism http://pib.nic.in/newsite/PrintRelease.aspx?relid=175628**
3. **Tourist resources of India**

~~Elective III~~

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	GEOG ~~503~~ Medical Geography	**After the completion of this course, students should be able to:** • **Depict spatial and temporal development of medical geography.** • **Relate the course with other social sciences and develop an interdisciplinary approach.** • **Relate natural, social and environmental factors with human health and diseases.** • **Use statistical methods for assessing health.**	Section – A : Introduction to Medical Geography a) Meaning, definitions and scope of Medical Geography b) Spatio-temporal development of Medical Geography with special reference to India c) Relationship of Medical geography with other disciplines – sociology, psychology, economics, political science, law, natural science d) Approaches to study Medical geography e) Meaning of health (physical, mental and social health), health and hygiene, disease cycle, causes of ill health, disease ecology Section – B : Geographical Factors Affecting Human Health and Diseases a) Natural factors – climate, relief, soil, vegetation b) Social factors – population density, literacy, social customs and traditions and poverty c) Economic Factors – occupation, standard of living, food security and nutrition d) Environmental Factors – urbanization and congesting, water, air and noise pollution and solid waste. e) Factors influencing health in India f) WHO classification of diseases and their distribution (major diseases) in world. Section – C: Human Health in India a) Indicators of health - changes in Birth and death rates, Infant mortality rates, life Expectancy, changes in sex ratio, population growth, Population Control b) Food: classification, food stuffs, balanced diet and Basal Metabolic Rate (BMR) c) Nutrition – mal nutrition & under nutrition – causes & consequences, status of food and nutrition in India and personal health d) Heath care delivery system : areas of health	**Discipline Elcective** Recommended Books : **1. Akhtar, R. (1991). *Environment and Health:Themes in Medical Geography*. New Delhi, India: South Asia Books.** **2. Akhtar, R. (Ed). (2016). C*limate Change and Human Health Scenario in South and Southeast Asia.* New Delhi, India: Springer Nature.** **3. Hussain, M. (Ed). (1994). *Medical Geography*. New Delhi, India: Anmol.** **4. May, J. M. (1970). *The World Atlas of Diseases*. New Delhi, India: Nat Book Trust.** **5. Mayer, A. I. (2007). *Medical Geography*. New Delhi, India: APH.** **6. Meade, M. S., & Earickson, R. J. (2006). *Medical Geography* (2nd ed.). New Delhi, India: Rawat** **7. Mishra, R. P. (1969). *The Medical Geography of India*. New Delhi, India: National Book Trust.** **8. Park, J. E., & Park, K. (2014). *Text Book of Community Health for Nurses*. Jabalpur, India: Ansari.**	**Shifted to pool of Discipline Electives**

			education, tools for health education, Health Planning (aim, district level, block level, local level organizations) e) Health Care Programmes, Family Welfare Programmes, Family Planning Association of India (FPAI) * Note – Stencils are to be permitted during the examination. Books Recommended : ~~1. Akhtar, Rais (1991): Environment and Health Themes and Medical Geography, Ashish Publishing House, New Delhi.~~ ~~2 .Bedi Yash Pal and Ram Atma (1979) : Social and Preventive Medicine, Anand Publishing Co. Amritsar.~~ ~~3. Cliff, A. and Haggett, P.: (1989) Atlas of Disease Distribution Basil Blackwell, Oxford.~~ ~~4. Deer S. Basu Mitra Kamal R. (1991): Introduction to health education, Friends Publications, Delhi.~~ ~~5. Hussain Majid (1994): Medical Geography, Anmol pub. New Delhi.~~ ~~6. Learmon, A.T.A. (1976) "So you want to be a Medical Geographer? An open letter to students".In: Prakashan~~ ~~7. Rao, V.L.S.etal.(Eds).The Golden Jubliee Volume.Madras.The Indian Geographical Society. Pp.280-85~~ ~~8. Learmonth A.T.A.: (1978) Patterns of Disease and Hunger: A Study in Medical Geography, David & Charles, Victoria.~~ ~~9. Learmonth, A.T.A. (1976) "Models and Medical Geography"in Mishra, V.C.(Ed)Essays in Applie Geography.Saugor.University of Saugar, pp. 17-38.~~ ~~May J.M.: (1970) The World Atlas of Diseases, Nat Book Trust, New Delhi.~~ ~~10. Mayer, A. Ishtiq (2007) : Medical Geography~~	**9. Park, J. E., & Park, K. (2007). *Preventive and Social Medicine.*(19th ed.).Jabalpur, India: M/s Banarsidas** **10. सिंघई, जी. सी. (2010). *चिकित्सा भूगोल* (द्वितीय सं.). गोरखपुर, भारतः वसुन्धरा.** **Suggested e-learning materials:** **1. Indicators of Health** **https://www.who.int/gho/publications/world_health_statistics/EN__WHS2015_Part2.pdf** **2. Family Welfare programme in India** **http://planningcommission.nic.in/plans/mta/mta-9702/mta-ch17.pdf**	

			APH Publishing Corporation, New Delhi. 11. Mc Glashan,N.D.(Ed) (1972) Medical Geography Techniques and Field studies.London Methuen. 12. Meade M. S., Earickson R. J. (2006) : Medical Geography, Rawat Publications, Jaipur, New Delhi, Bangalore, Mumbai. 13. Mishra,R.P. (1969) The Medical Geography of India,New Delhi National Book Trust. 14. Park, J.E. and Park, K. (1979) – Text Book of Community Health for Nurses, Ansari Publishers, Jabalpur 15. Park, J.E. and Park.,K.(2007) Preventive and Social Medicine- M/s Banarsidas Bhanot Publisher, Jabalpur 16. Pyle G.F. (1979): Applied Medical Geography John wifey 53ashington. 17. Pyle, G.: (1979) Applied Medical Geography, Winston Halsted Press, Silver Springs, Md. U.S.A. 18. Pyle.G.W.and Alan Dever,G.E.(1974)Health care Delivery:Spatialperspectives,NewYork,McGraw 19. Shannon G.W. & Dever G.E.A.(1974): Health care Delivery McGraw Hill New York 20. Stamp,L.D. (1964) Some Aspects of Medical Geography.Oxford,University press,1964. 21. Stamp,L.D. (1964) The Geography of Life and Death London,Fontana. 22. Vashist S. R. (1997) : A Textbook of Health education and child development Book Enclave, Jaipur. 23. Woods E.J. (1983): Social Geography of Medicine & health, Croon Helm, London 24. सिंधई, जी. सी. (2010) : चिकित्सा भूगोल, वसुन्धरा प्रकाशन, गोरखपुर।		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	GEOG ~~512~~ Urban Geography	**After the completion of this course, students will be able to:** • **Depict the development of cities and relate with the classical theories of growth of cities.** • **Describe the evolution and origin of cities.** • **Classify cities functionally into different zones.** • **Describe models in Urban geography with special reference to the work of Christaller and Losch.**	Section – A: Introduction to Urban Geography a) Meaning and scope of Urban Geography. Approaches to the study of Urban Geography. b) Development of Urban Geography. c) Stages of Evolution of Cities. d) Origin and evolution of towns: Origin, and growth of Ancient, Medieval and Modern towns (one example from each). e) Urbanization: Trends of Urbanization in World and India. Section – B: Urban Morphology a) Urban Morphology: Meaning, affecting factors and stages of Development of Urban Morphology. b) Theories of Urban growth: Concentric zone theory of Burgess, Sector theory of Homer Hoyt and Multiple Nuclei theory of Harris& Ullman. c) Morphology of Indian Cities (one example.) d) Urban land use and functional zones of a city (CBD). e) Functional Classification of Cities according to C.D. Harris. Section – C: Models of Urban Geography a) Concept of Urban Hierarchy: ~~Base and~~ Methods of determination (on the basis of numbers and level of work). b) Rank size rule and the law of the Primate City. c) Central place theory of Walter Christaller and August losch. d) Rural urban fringe: Conceptual explanation, internal structure, characteristic features. e) Introduction of Conurbation and umland, methods of delimitation of umland (breaking point theory). * Note – Stencils are to be permitted during the	**Discipline Elcective**	**Shifted to pool of Discipline Electives**

			examination. Recommended Books : 1. Alam, S.M., (1965)Hyderabad – Secundrabad Twin Cities, Asia Publishing House, Bombay. 2. Barry. B.J.L and Horton, F.F., (1970) Geographic perspectives on Urban Systems, Petrentice Hall, Englewood Cliff, New Jersy. 3. Beaujeu-Garnier, J., Chabot, G., (1969) Urban Geography, London. 4. Carter, Harold, (1995)The study of Urban Geography, Edward Arnold Publishers, London. 5. Dickinson, R.E., (1964) City and Region, Routledge, London. 6. Gibbs, J.P., (1961) Urban Research Methods, New Jersy. 7. Hall, T., (1988) Urban Geography, London. 8. Johnson, J.H., (1967) An Introductory Analysis, London 9. Mayer, H.M. & Kohn, C.F., (1967) Reading in Urban Geography, Allahabad. 10. Murphy, R.E., (1966) The American city : An Urban Geography, Macgra Hill Book Co., New York. 11. Rao, V.L.S.P. (1984) Urbanization in India: Spatial Dimensions, Concept Publishing Company, New Delhi. 12. Smailes, A. E. (1953) The Geography of Towns, London. 13. Singh, K. and Steinberg, F. (eds.), (1996)Urban India in Crisis, New Age Interns, New Delhi.	Recommended Books : **1. Bansal, S. C. (2015). *Urban Geography* (2nd ed.). Meerut, India: Meenakshi.** **2. Daniel, P. (2002). *Geography of Settlement.* Jaipur, India: Rawat.** **3. Ghosh, S. (1999). *Geography of Settlements*. Kolkata, India: Orient Longman.** **4. Hussain, M. (2003). *Urban Geography*. New Delhi, India: Anmol.** **5. Mandal, R. B. (2000). *Urban Geography* (2nd ed.). New Delhi, India: Concept.** **6. Singh, R.Y. (2014). *Geography of Settlements* (2nd ed.). Jaipur, India: Rawat.** **7.** तिवारी, आर. सी. (2016). *अधिवास भूगोल* (अष्ट सं.). इलाहबाद, भारतः प्रयाग पुस्तक भवन. **8.** बंसल, एस. सी. (2009). *नगरीय भूगोल.* मेरठ, भारतः मीनाक्षी. **9.** मौर्य, एस. डी., एवं सिंह, आर.एन. (2013). *नगरीय भूगोल* (द्वितीय सं.). इलाहबाद, भारतः शारदा पुस्तक भवन. **10.** सिंह, आई. (2008). *अधिवास भूगोल.* नई दिल्ली, भारतः यूनिवर्सिटी. **11.** सिंह, आर. (2005). *अधिवास भूगोल.* जयपुर, भारतः रावत. **Suggested e-learning materials:** **1. Origin and evolution of towns http://www4.brandonu.ca/ebertsd/281/281f17unit02.pdf** **2. Functional Zones of a city http://egyankosh.ac.in/bitstream/123456789/27649/1/Unit-11.pdf**	

List of Discipline Electives

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	GEOG 502 Geography of Rural Settlements	**After the completion of this course, students should be able to:** • **Develop an approach to study rural settlements.** • **Depict the evolution of settlements and relate it to the geographical factors.** • **Describe Rural morphology, its mining and types.** • **Describe house types, hierarchy of rural settlements and rural centers.**		Section A Introduction to Geography of Rural settlements Meaning, definitions and scope of geography of rural settlements; The relationship of geography of rural settlements with other branches of geography, Approaches to geography of rural settlements; **Factors affecting** origin and evolution of settlements; **Principles of Settlement Formation** Section B Morphology and Types of rural settlements Rural settlements: Types and factors of development; Types of rural settlements in India **and their Distribution**; Rural Morphology: Meaning, definitions and Types; Process of development of rural morphology and affecting forces; Size, **Density**, Spacing and **Dispersion** of rural settlements. Section C Rural Dwellings and Service Centres Houses: Definitions, factors affecting, classification and **morphology**; Distribution of houses in India on the basis of building material; Rural service centres: **Definition**, Identification and methods for the determination of hierarchy; Periodic markets: **Definition**, Characteristics and types.	**Reviewed Learning outcomes, recommended books &** **e-learning materials and rearranged the content.** **Addition of new topics, reshuffling of topics for enrichment and specification and Shifted from elective I to pool of discipline electives**

				Stencils & Non-Scientific calculators are to be permitted during the examination. Recommended Books : **Recommended Books:** **14. Chishlom, M. (2009). *Rural Settlement and Land Use*. New Jersey, NJ: Transaction.** **15. Daniel, P. (1989). *The Geography of Settlement* (2nd ed.). Edinburg, Scotland: Oliver & Boyd.** **16. Ghosh, S. (1998). *Geography of Settlements*. Kolkata, India: Orient Longman.** **17. Mandal, R. B. (2001). *Introduction to RuralSettlement* (2nd ed.). New Delhi, India: Concept.** **18. Mourya, S. D. (2014). *Settlement Geography*. Allahabad, India: ShardaPustakBhawan.** **19. Oliver, P. (1987). *Dwellings: The House across the World*. Austin, TX: University of Texas Press.** **20. Singh, R. Y. (2015). *Geography of Settlements*. New Delhi, India: Rawat.** **21. Wanmali, S. (1983). *Service Centres in Rural India: policy, theory, and practice*. New Delhi, India: B. R.** **22. तिवारी, आर. सी. (2016). *अधिवासभूगोल*(अष्ट सं.). इलाहबाद, भारतः प्रयागपुस्तकभवन.** **23. बंसल, एस. सी. (2016). *ग्रामीणबस्तीभूगोल*(संशोधित सं.). मेरठ, भारतः मीनाक्षी.** **24. मौर्य, एस. डी. (2017). *अधिवासभूगोल*(षष्ठ सं.).इलाहबाद, भारतः शारदापुस्तकभवन.** **25. सिंह, आई. (2008). *अधिवासभूगोल.*नईदिल्ली, भारतः यूनिवर्सिटी.** **26. सिंह, आर. (2005). *अधिवासभूगोल.* नईदिल्ली, भारतः रावत.** **Suggested e-learning materials:** **3. Introduction to rural settlement** **https://books.google.co.in/books?id=SYQ1yydbDlwC&printsec=frontcover&dq=Introduction+to+rural+settlement&hl=hi&sa=X&ved=0ahUKEwiF1rOw55zhAhUZA3IKHRZpCUAQ6AEIKTAA#v=onepage&q=Introduction%20to%20rural%20settlement&f=false** **4. Settlement patterns** **https://www.britannica.com/place/India/Caste#ref487283**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	GEOG 503 Medical Geography	**After the completion of this course, students should be able to:** • **Depict spatial and temporal development of medical geography.** • **Relate the course with other social sciences and develop an interdisciplinary approach.** • **Relate natural, social and environmental factors with human health and diseases.** • **Use statistical methods for assessing health.**	———	**Section A** **Introduction to Medical Geography** Meaning, definitions and scope of Medical Geography; Spatio-temporal development of Medical Geography with special reference to India; Relationship of Medical geography with other disciplines – sociology, psychology, economics, political science, law, natural science; Approaches to study Medical geography; Meaning of health (physical, mental and social health), health and hygiene, disease cycle, causes of ill health, disease ecology **Section B** **Geographical Factors Affecting Human Health and Diseases** Natural factors – climate, relief, soil, vegetation; Social factors – population density, literacy, social customs and traditions and poverty; Economic Factors – occupation, standard of living, food security and nutrition; Environmental Factors – urbanization and congesting, water, air and noise pollution and solid waste; Factors influencing health in India; WHO classification of diseases and their distribution (major diseases) in world. **Section C** **Human Health in India** Indicators of health - changes in Birth and death rates, Infant mortality rates, life Expectancy, changes in sex ratio, population growth, Population Control; Food: classification, food stuffs, balanced diet and Basal Metabolic Rate (BMR); Nutrition – mal nutrition & under nutrition – causes & consequences, status of food and nutrition in India and personal health; Heath care delivery system : areas of health education, tools for health education, Health Planning (aim, district level, block level, local	**Reviewed Learning outcomes, recommended books &** **e-learning materials and rearranged the content and Shifted from elective III to pool of discipline electives**

				level organizations); Health Care Programmes, Family Welfare Programmes, Family Planning Association of India (FPAI) Stencils are to be permitted during the examination. Recommended Books : **1. Akhtar, R. (1991). *Environment and Health:Themes in Medical Geography.* New Delhi, India: South Asia Books.** **2. Akhtar, R. (Ed). (2016). C*limate Change and Human Health Scenario in South and Southeast Asia.* New Delhi, India: Springer Nature.** **3. Hussain, M. (Ed). (1994). *Medical Geography*. New Delhi, India: Anmol.** **4. May, J. M. (1970). *The World Atlas of Diseases*. New Delhi, India: Nat Book Trust.** **5. Mayer, A. I. (2007). *Medical Geography*. New Delhi, India: APH.** **6. Meade, M. S., & Earickson, R. J. (2006). *Medical Geography* (2nd ed.). New Delhi, India: Rawat** **7. Mishra, R. P. (1969). *The Medical Geography of India*. New Delhi, India: National Book Trust.** **8. Park, J. E., & Park, K. (2014). *Text Book of Community Health for Nurses*. Jabalpur, India: Ansari.** **9. Park, J. E., & Park, K. (2007). *Preventive and Social Medicine.*(19th ed.).Jabalpur, India: M/s Banarsidas** **10.** सिंधई, जी. सी. (2010). ***चिकित्सा भूगोल*** (द्वितीय सं.). गोरखपुर, भारतः वसुन्धरा. **Suggested e-learning materials:** **1. Indicators of Health** **https://www.who.int/gho/publications/world_health_statistics/EN__WHS2015_Part2.pdf** **2. Family Welfare programme in India** **http://planningcommission.nic.in/plans/mta/mta-9702/mta-ch17.pdf**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	GEOG 505 Population Geography	**After the completion of this course, students should be able to:** • **Map the world in terms of density, distribution and other demographic aspects.** • **Differentiate between demographic characteristics of developing and developed nations and factors posing that difference.** • **Have a theoretical background about population growth and migration** • **Depict the trends of urbanization and demographic structure of India.**	——	**Section A** **Scope of Population Geography & Demographic Characteristics of the World** Definition and scope of Population Geography and its relation with other sciences; Recent trends in Population Geography; Factors affecting the distribution and density of the world's population; Population growth and distribution in the world; Recent demographic characteristics of developed and developing nations. **Section B** **Theories of Population Growth and Migration** Theories of Population Growth - Malthusian theory, Optimum population theory and Theory of demographic transition; Factors affecting population change, Population resource regions of the world; Migration: Major factors, consequences and types of migration; Theories of migration: Lee, Rewenstein and Zelinsky's model; Important migration of the world. **Section C** **Population Geography in India** Development of Population Geography in India; Population change (birth rate and death rate), Population growth and internal migration; Demographic structure (sex ratio, literacy rate and occupation structure); Trends of urbanization in India; Population policy of India 2000. Stencils are to be permitted during the examination. Recommended Books : **1. Ahmad A., Noin, D., & Sharma, H. N. (Ed). (1997). *Demographic Transition- The third World Scenario*. Jaipur, India: Rawat.** **2. Bhende, A. A & Kanitkar, T. (2008). *Principles of Population***	**Reviewed Learning outcomes , recommended books & e-learning materials and rearranged the content and Shifted from elective I to pool of discipline electives**

				Studies (19th ed.). **Mumbai, India: Himalaya** **3. Chaubey, P.K. (2011).** ***Population Policy for India- prespectives, issues and challenges***. **New Delhi, India: Kanishka.** **4. Chandana, R. C. (2014).** ***A Geography of population*** **(11th ed.). New Delhi, India: Kalyani.** **5. Chopra, G. (2006).** ***Population Geography***. **New Delhi, India: Commonwealth.** **6. Cox, P. R. (1993).** ***Demography*** **(5th ed.). New Delhi, India: Universal Book Stall.** **7. Jay, W., & Pillai, V. K. (2017).** ***Demography- The Science of Population*** **(2nded.). Jaipur, India: Rawat.** **8. Jhingon, M. L., Bhatt, B. K., & Desai, J. N. (2011).** ***Demography*** **(2nded.). New Delhi, India: Vrinda.** **9. Premi, K. M. & Das, D. N. (2012).** ***Population of India 2011***. **Delhi, India: B.R.** **10. Qazi, S. A. (2010).** ***Population Geography***. **New Delhi, India: APH.** **11. Srivastava S. C. & Srivastava, S. (2004).** ***Studies in Demography***. **New Delhi, India: Anmol.** **12. Tripathi, R. K. (2007).** ***Population Geography***. **New Delhi, India: Commonwealth.** **13. Weinstein, J., Pillai, A., & Vijayan, K. (2017*). Demography- The Science of Population*** **(2nd ed.). Jaipur, India: Rawat.** **14.** पडां, बी. पी. (2007). ***जनसंख्या भूगोल.*** भोपाल, भारत: मध्यप्रदेश हिन्दी ग्रंन्थ अकादमी. **15.** बंसल, एस. सी. (2015). जनसंख्या भूगोल (द्वितीय सं.). नई दिल्ली, भारतः आर. के. **Suggested e-learing materials:** **1. Migration http://www.un.org/en/development/desa/population/migration/publications/migrationreport/docs/MigrationReport2017_Highlights.pdf** **2. Demographic Data of India http://censusindia.gov.in/2011-prov results/data_files/india/Final_PPT_2011_chapter3.pdf** **3. National Population Policy 2000 https://mohfw.gov.in/sites/default/files/26953755641410949469%20%281%29.pdf**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	GEOG 508 Social Geography	**After the completion of this course, students should be able to:** • **Develop an approach to study social geography.** • **Describe social processes, social strata's, and organizations.** • **Relate society and culture, understand cultural realms and regions.** • **Analyze the current status of women in India and suggest measures for improvement.**	—	**Section A** **Introduction to Social Geography** Meaning, Scope and Aims of Social Geography; Approaches to the study of social geography: Ecological approach, Regional approach, Historical approach, Welfare approach, System approach and Behavioral approach; Society: Definition, Origin and Classification of Society; Social Process: Forms of Social Interaction (Cooperation, Accommodation, Assimilation, Competition and Conflict); Social Stratification, Caste and Class; Social Organization and Groups. **Section B** **Society and Culture** Society and Culture; Cultural Hearths; Cultural Diffusion: Definition, Elements and causes of diffusion. Barriers of diffusion, Effects and Types of diffusion.Hagerstand model of diffusion; Cultural Realms: Meaning of Cultural Realms, Basis of delimitation of cultural realms, Modern classification of the cultural realms; Cultural Regions of the world: Meaning and Bases of delimitation of cultural regions, Cultural Regions United States, U.K., Mesopotamia and Indian. **Section C** **Social Geography in India** Social Geography of India: Indian Society in Historical Perspective; Status of Women in India; Social Change in India; Human Development in India; Social Planning in India: Meaning, Importance and Major Aspects of social planning; Social Welfare Programmes in Planned Period (Child Welfare Programme, Women Welfare Programme, Labour Welfare Programme, Family Planning	**Reviewed Learning outcomes , recommended books & e-learning materials and rearranged the content and Shifted from elective I to pool of discipline electives**

				and Family Welfare Programme, Adult Education Programme). Stencils are to be permitted during the examination. **Recommended Books :** **1. Ahmad, A. (2006). *Social Geography* (Reprint). Jaipur, India: Rawat.** **2. Hamnett, C. (Ed.). (1996). *Social Geography : A Reader*. New York, NY: John Wiley & Sons.** **3. Majid, H. (2006). *Human Geography* (3rd ed.). Jaipur, India: Rawat.** **4. Mehtani, S. & Sinha, A. (2010). *Social Geography*. New Delhi, India: Commonwealth.** **5. Mohanty, G. S. (Ed.). (2005). *Social & Cultural Geography*. Delhi, India: Isha Books.** **6. दीक्षित, एस. एवं त्रिपाठी, आर. (2008). *सांस्कृतिक भूगोल.* गोरखपुर, भारत: वसुन्धरा.** **7. मौर्य, एस. डी. (2010). *सामाजिक भूगोल.* इलाहाबाद, भारत: शारदा पुस्तक भवन.** **Suggested e-learning materials:** **1. Society: Definition, origin and Classification, Society and Culture http://egyankosh.ac.in/bitstream/123456789/41246/1/Unit-1.pdf** **2. Family welfare programmes https://humdo.nhp.gov.in/about/national-fp-programme/**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
5.	GEOG 511 Tourism Geography	**After the completion of this course, students should be able to:** • **Propagate the idea of ecotourism and sustainable tourism.** • **Depict the social and economic benefits of tourism in any tourist sight.** • **Explain tourism potential of deprived places.** • **Describe the tourism on national and state level.**	——	**Section A** **Concept of Tourism Geography** Concept of Tourism: Definition, Evolution and types of Tourism; Tourism Geography: Definition, Key Concepts; Scale, Geographical components and spatial interaction between components; Geography of demand and supply for tourism; Development of tourism in India. **Section B** **Geographic Foundation of Tourism** Introduction of geographic foundation of Tourism; Physical geography of Tourism: Resources and barriers; Human Geography of Tourism: Resources and barriers; Concept of Ecotourism. **Section C** **Geographical factors affecting Tourism** Economic and Social benefits & cost of Tourism; Environmental benefits, cost of Tourism and emerging implications; Tourism in India: Demand, supply, organization and Tourism Resources; Ecological and cultural tourism resources of Rajasthan. Stencils are to be permitted during the examination.	**Reviewed Learning outcomes, recommended books & e-learning materials and rearranged the content and Shifted from elective II to pool of discipline electives**

Recommended Books :

1. **Bhatia, A. K. (2012). *Tourism Development: Principles and Practices* (2nd ed.). New Delhi, India: Sterling.**
2. **Boniface, B., Cooper, C., & Cooper, R. (2016). *Worldwide Destinations: The Geography of Trevel and Tourism* (7th ed., vol. I). New York, NY: Routledge.**
3. **Garg, D. (2009). *Geography of Tourism*. New Delhi, India: Mohit.**
4. **Jayapalan, N. (2013). *An Introduction to Tourism*. New Delhi, India: Atlantic.**
5. **Kamra, K. K. (2104). *Tourism An Overview*. New Delhi, India: Kanishka.**
6. **Kaushal, P., & Sharma, S. P. (2011). *Ecological and Environmental Impact of Tourism*. New Delhi, India: Kanishka.**
7. **Hall, M. C., & Page, J. S. (2014). *Geography of Tourism and Receration: Environment, Place and Space* (4th ed.). New York, NY: Routledge.**
8. **Nelson, V. (2017). *An Introduction to the Geography of Tourism* (2nd ed.). New York, NY: Rowman & Littlefield.**
9. **Sharma, S. P. (2011). *Tourism Education Principales, Theories and Practices* (2nd ed.). New Delhi, India: Kanishka.**
10. अग्रवाल, वी. (2012). *भौगोलिक पर्यटन.* नई दिल्ली, भारतः अर्जुन.
11. नेगी, जे. (2013). *आधुनिक पर्यटन एवं यात्रा के आधारभूत सिद्धान्त* (चतुर्थ सं.). नई दिल्ली, भारतः तक्षशिला.
12. शर्मा, ए. (2012). *पर्यटन भूगोल.* जयपुर, भारतः इशिका.
13. शुक्ला, आर., एवं शुक्ला, आर. (2009). *पर्यटन भूगोल.* नई दिल्ली, भारतः अर्जुन.
14. सारण, बी. आर. (2008). *पर्यटन उत्पाद एवं प्रबन्ध.* नई दिल्ली, भारतः कनिष्क.

Suggested e- learning materials:

1. **Cultural tourism in Rajasthan**
   http://www.tourism.rajasthan.gov.in/
2. **Economic benefits of Tourism**
   http://pib.nic.in/newsite/PrintRelease.aspx?relid=175628

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
6.	GEOG 512 Urban Geography	**After the completion of this course, students will be able to:** • **Depict the development of cities and relate with the classical theories of growth of cities.** • **Describe the evolution and origin of cities.** • **Classify cities functionally into different zones.** • **Describe models in Urban geography with special reference to the work of Christaller and Losch.**		Section – A: Introduction to Urban Geography Meaning and scope of Urban Geography. Approaches to the study of Urban Geography, Development of Urban Geography; Stages of Evolution of Cities; Origin and evolution of towns: Origin, and growth of Ancient, Medieval and Modern towns (one example from each); Urbanization: Trends of Urbanization in World and India. Section – B: Urban Morphology Urban Morphology: Meaning, affecting factors and stages of Development of Urban Morphology; Theories of Urban growth: Concentric zone theory of Burgess, Sector theory of Homer Hoyt and Multiple Nuclei theory of Harris& Ullman, Morphology of Indian Cities (one example.); Urban land use and functional zones of a city; **Central Business District** (CBD); Functional Classification of Cities according to C.D. Harris. Section – C: Models of Urban Geography Concept of Urban Hierarchy: Methods of determination (on the basis of numbers and level of work); Rank size rule and the law of the Primate City; Central place theory of Walter Christaller and August losch; Rural urban fringe: Conceptual explanation, internal structure, characteristic features, Introduction of Conurbation and umland, methods of delimitation of umland (breaking point theory). Stencils are to be permitted during the examination. Recommended Books : **12. Bansal, S. C. (2015). *Urban Geography* (2nd ed.).**	**Reviewed Learning outcomes, recommended books &** **e-learning materials and rearranged & redefined the content and Shifted from elective III to pool of discipline electives**

				Meerut, India: Meenakshi. 13. Daniel, P. (2002). *Geography of Settlement.* Jaipur, India: Rawat. 14. Ghosh, S. (1999). *Geography of Settlements*. Kolkata, India: Orient Longman. 15. Hussain, M. (2003). *Urban Geography*. New Delhi, India: Anmol. 16. Mandal, R. B. (2000). *Urban Geography* (2nd ed.). New Delhi, India: Concept. 17. Singh, R.Y. (2014). *Geography of Settlements* (2nd ed.). Jaipur, India: Rawat. 18. तिवारी, आर. सी. (2016). *अधिवास भूगोल* (अष्ट सं.). इलाहबाद, भारतः प्रयाग पुस्तक भवन. 19. बंसल, एस. सी. (2009). *नगरीय भूगोल.* मेरठ, भारतः मीनाक्षी. 20. मौर्य, एस. डी., एवं सिंह, आर.एन. (2013). *नगरीय भूगोल* (द्वितीय सं.). इलाहबाद, भारतः शारदा पुस्तक भवन. 21. सिंह, आई. (2008). *अधिवास भूगोल.* नई दिल्ली, भारतः यूनिवर्सिटी. 22. सिंह, आर. (2005). *अधिवास भूगोल.* जयपुर, भारतः रावत. **Suggested e-learning materials:** 3. Origin and evolution of towns http://www4.brandonu.ca/ebertsd/281/281f17unit02.pdf 4. Functional Zones of a city http://egyankosh.ac.in/bitstream/123456789/27649/1/Unit-11.pdf	

List of Reading Electives

S. No.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	ENVS___R Agroforestry	After going through this course students will be able to: • Describe agroforestry and agroforestry interventions. • Assess the role of Agroforestry as a sustainable land-use activity. • Describe Nutrient cycling and role of agroforestry in soil and water conservation • Describe various energy plantation methods.		Agroforestry - definition and scope. Tropical deforestation, rising demands of fuel wood, fodder and timber, social, ecological and economic reasons for agroforestry. Traditional agroforestry systems: shifting cultivation, taungya, homegardens. Recent trends in Silvicultureand Energy plantations. Trees in agricultural fields and farm boundaries. Commercial crops under shade of planted trees as well as natural forests. Agroforestry for wasteland development and temperate agroforestry practices. Nutrient cycling and role of agroforestry in soil and water conservation, Nitrogen fixation, improvement in soil physico-chemical properties. Soil organic matter status and soil organic matter, Soil fertility considerations in agroforestry nutrient needs of trees and crops. Recommended Books : 1. Chundawat, B. S., & Gautam, S. K. (2016). *Textbook of Agroforestry*. New Delhi, India: Oxford &Ibh. 2. Jose, S. (2009). *Agroforestry for Ecosystem Services and Environmental Benefits (Advances in Agroforestry)*. Dordrecht, Netherlands: Springer. 3. Mukherjee, A. (2016). *Agroforestry and Watershed Management: An Interlocked System.* New Delhi, India: Random. 4. Raj, A. J. (2017). *Agroforestry Theory and Practices*. Jodhpur, India: Scientific. Suggested e-learning materials: 1. Introductory Agroforestry http://ecoursesonline.iasri.res.in/course/view.php?id=157 2. Forestry Technologies http://agritech.tnau.ac.in/forestry/agroforestry_index.html	Introduction of New Course

S. No.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	ENVS___R Energy Resources and Conservation	After completion of this course students will be able to: • Describe the non-conventional sources of energy. • Explain concepts on energy utilization and conservation. • Emphasize energy conservation strategies in residential, industrial and transportation sector. • Describe National Energy Policy.		Introduction: Energy, work and power. Classification of energy resources, An overview of the current global and National Energy Scenario. Fossil Fuels: Sources, exploration of oil, coal, natural gas, shale; Exploitation of Fossil fuels and their Environmental consequences. Nuclear Energy: Nuclear fission and Fusion; Nuclear fuel cycle, Nuclear reactor and nuclear power, Renewable and Alternative Energy Sources, Solar energy, Solar power, Photovoltaic cells; Wind power; Geothermal energy; Ocean energy. Environmental consequences of biomass resource harnessing, Energy Conservation: National Energy Policy, Energy efficient appliances, BEE Label, Modes of Energy Conservation in residential, industrial and transportation sector. Recommended Books : 1. Agarwal, S. K. (2003). *Nuclear Energy: Principles Practice and Prospects.* New Delhi, India: APH. 2. Chaturvedi, P. (1995). *Bio-Energy Resources.* New Delhi, India: Concept. 3. Dayal, M. (1997). *Renewable Energy: Environment and Development*. New Delhi, India: Konark. 4. Mahajan, V. S. (1991). *National Energy: policy, crisis and growth*. New Delhi, India: Ashish. 5. Markuszewski, R., & Blaustein, B. D. (1986). *Fossil fuels utilization. Environmental concerns*. Washington, DC: American Chemical Society. 6. Vandana, S. (2002). *Alternative Energy.* New Delhi, India: APH. Suggested e-learning materials: 1. Biodiesel production https://nptel.ac.in/courses/102105058/52 2. Sustainability through Green Manufacturing Systems: An Applied Approach https://nptel.ac.in/courses/112104225/22	Introduction of New Course

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	ENVS___R Man and Environment	After the completion of this course, students will be able to: • Describe the complex interactions of humans and ecological systems in the natural world. • Synthesize, and apply a wide range of scientific literature in the ecological and environmental science. • Interpret a wide range of scientific literature in ecology and environmental science. • Apply the information in the realms of environmental sciences and sustainability.		Human Population, its Growth and Distribution, Environmental Deterioration associated with population growth, Man Induced Environmental Changes, Types of Human Activities, Impact of Human Activities such as Deforestation, Mining and Industrialization. Environmental Awareness- Need and Role in Betterment of Environment Concept and Significance of Environmental Movements, Environmental Movements in India with special reference to The Bishnoi Movement, Chipko Movement, Appiko Movement, Narmada BachaoAndolan, Silent Valley Movement. Components of natural and built environment: Resources and human settlements, modifications in natural environment, causes and consequences. Recommended Books : 1. BalAnand, S. (2005). *An Introductiion to Environmental Management*. Mumbai, India : Himalaya. 2. Chandana, R. (2008). *A Geography of population*. New Delhi, India: Kalyani. 3. Chopra, G. (2006). *Population Geography*. New Delhi, India: Commonwealth. 4. Chorley, R. J., Schumm, S. A., & Sugden, D. E. (1984). *Geomorphology*. London, UK: Methuen and Company. 5. Dayal, P. (1994). *A Text Book of Geomorphology*. New Delhi, India:Kalyani. 6. Rapoport, A. (2016). *Human aspects of urban form: towards a man—environment approach to urban form and design*. Oxford, UK: Elsevier Pergamon Press. Suggested e-learning materials: 1. Environment and Ecology https://nptel.ac.in/courses/122102006/ 2. Ecological Degradation and Environmental Protection https://nptel.ac.in/courses/109104045/35#	Introduction of New Course

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	ENVS___R Water and Sustainable Development	After the completion of this course, students will be able to: • Classify major causes of exploitation of water resources, particularly in the Indian and Asian context. • Summarize rainwater harvesting and water conservation measures. • Describe methods of Irrigation management. • Describe importance of Wetlands and its conservation		Water and sustainable development. Water and human health – Access to safe drinking water and sanitation; public health issues. Water and food production – Role of irrigation in food security. Shifts in cropping patterns, Rain-fed agriculture, increasing use of groundwater. Environmental, economic and social implications of exploitation of ground water resources. Water and human amenities – Urban water supplies; exploitation, conservation and rainwater harvesting. Wetland, its use and abuse with Ramsar Convention. Urban floods, storm water drainage and integrated urban water management (IUWM). Irrigation management – canals and micro-irrigation. Recommended Books : 1. Asawa, G. L. (2005). *Irrigation and Water Resources Engineering*, New Delhi, India: New Age. 2. Biswas, A. K., Jellau, M., & Stout, G. (1993). *Water for sustainable development in 21st century – A Global perspective*. New Delhi, Inida: Oxford University Press. 3. David, L. F. (2007). *Water Policy for Sustainable Development*. Baltimore, Maryland: Johns Hopkins University Press. 4. Jain, S. K., & Singh, V. P. (2003). *Water Resources Systems Planning and Management*. Amsterdam, Netherlands: Elsevier. Suggested e-learning materials: 1. Water, Society and Sustainability https://onlinecourses.nptel.ac.in/noc18_hs36/preview 2. Irrigation Efficiencies - II and Irrigation Methods and their Suitability https://nptel.ac.in/courses/105102159/15	Introduction of New Course

S. No.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
5.	GEOG ___ R Environmental Challenges and Disaster Management	After the completion of this course, students should be able to: • Explain approaches to study environmental development and crisis. • Describe world energy crisis with its causes and suggested measures for improvement. • Describe several environmental problems their causes, consequences and mitigation. • Depict the major disasters and their management with the help of case studies.		Environment:- Definition and types of Environment; Environmental Development Crisis:-Introduction and its causes; Energy Crisis:- Concept, Causes and Remedies; Environmental issues associated with Green Revolution; Impact of Urbanization on Environment. Deforestation:- Concept, Causes, Effects and Conservation; Desertification:- Concept, Causes, Impacts and Preventions; Water Scarcity:- Causes ; Methods of Rain Water Harvesting (special reference to Traditional Methods); Acid Rain:- Causes, Consequences and Mitigation Measures; Solid Waste:- Introduction, Types and Management. Disaster:- Definition and Classification; Natural Disaster:- Nature and Types; Flood:- Causes, Impacts and Methods of Management; Earthquake:- Introduction, Types, Causes, Effects and Mitigation; Case Studies:- Bhuj Earthquake-2001,Tsunami (Southern India)-2004 and Kedarnath Disaster-2013. * Note – Stencils are to be permitted during the examination. Recommended Books : 1. Gautam, A. (2010). *Environmental Geography*. Allahabad, India:ShardaPustakBhawan. 2. Ghosh,G.K. (2015). *Disaster Management*.New Delhi, India:A.P.H. 3. Singh, S. (2002). *Physical Geography*.Gorakhpur, India: Vasundhara. Suggested e-learning materials: 1. Deforestation:- Concept, Causes, Effects https://www.livescience.com/27692-deforestation.html 2. Acid Rain:- Causes, Consequences and mitigation measures https://www.conserve-energy-future.com/causes-and-effects-of-acid-rain.php 3. Solid Waste:- Introduction, Types and Management https://www.indiawaterportal.org/topics/solid-waste	Introduction of New Course

S. N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
6.	GEOG ___R India: Socio-Political and Environmental Scenario	After the completion of this course, students will be able to: • Understand the current issues related with boundaries, water sharing, agricultural disparities, food security in India. • Describe problems in Agricultural Development. • Discuss Gender Issues and women Safety. • Find the role of non – conventional energy resources for solving energy crisis.		Relation of India with neighbouring countries and border disputes with China and Pakistan. Drought problems, Interlinking of rivers as a solution of water crises and disputes of river water sharing with reference to Narmada, Krishna, Cauvery and Sutlej Yamuna Link (SYL). Problems and disparities in agricultural development, food security and farmer suicides in India. Energy crisis in India and its solution with the help of nuclear, solar, hydro and wind power. Gender issues and women safety, poverty and unemployment. Recommended Books : 1. Deshpande, C.D. (1992).*India,A Regional Interpretation*. New Delhi, India:ICSSR& Northern Book Centre. 2. Gallaher, C. et al. (2012). *Key Concepts in Political Geography* (Reprint). New Delhi, India: Sage. 3. Hussain, A. (2007). *Political Geography*. New Delhi, India: Vishvabharti. 4. Singh, R. L. (Ed.).(1971). *India - A Regional Geography*. Varanasi, India: National Geographical Society. 5. Tirtha, R.,&Gopal, K.(1996).*Emerging India.* Jaipur. India: Rawat. 6. बंसल, एस. सी. (2011). *भारत का भूगोल.* मेरठ, भारत: मीनाक्षी. Suggested e-learning materials: 1. Interlinking of rivers, https://www.geoecomar.ro/website/publicatii/Nr.192013/12_mehta_web_2013.pdf 2. Farmer suicides, http://www.ipcinfo.org/fileadmin/user_upload/fsn/docs/Agriculture%20and%20rural%20development%20in%20India.pdf 3. Food Security, https://dfpd.nic.in/LwB3AHIAaQB0AGUAcgBlAGEAZABkAGEAdABhAC8AUABvAHIAdABhAGwALwBNAGEAZwBhAHoAaQBuAGUALwBEAG8AYwB1AG0AZQBuAHQALwA=1_93_1_Original.pdf 4. Gender Issues in India, https://www.indiacelebrating.com/social-issues/gender-inequality-in-india/	Introduction of New Course

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
7.	GEOG __ R Rajasthan: Challenges and Prospects	After the completion of this course, students will be able to: • Describe the major environmental, socio economic problems of Rajasthan. • Explain desertification, Aravalli development, agriculture and tourism of Rajasthan. • Analyze existing state and national policies in terms of socio economic conditions. • Aware society regarding existing policies related to child marriage, Female feticide and other Social problems.		Major Canal Irrigation Project and Its impact; Desertification and Desert Development programmes; Identification of drought prone areas and mitigation, problem of mining and Aravalli Development Programme, Problems and measures of Agricultural development; Programmes for forest conservation; Poultry farming, Planning for livestock development; Role of Tourism in the economy. Socio- economic issues and Government policies and programmes: child marriage, female feticide, female education, gender discrimination and caste; unemployment and poverty . Recommended Books : 1. Singh, G. (2010). *Geography of India*(9th ed.). Delhi, India: Atma Ram. 2. शर्मा, आर. (2010). *राजस्थानकाभूगोल.* उदयपुर, भारत: हिमाशुं. 3. शर्मा एच. एस.,एवंशर्मा, एम. एल. (2015). *राजस्थानकाभूगोल.*जयपुर, भारत:पचंशील. 4. सक्सैना, एच. (2014). *राजस्थानकाभूगोल.*जयपुर, भारत:राजस्थानहिन्दीग्रंथअकादमी. Suggested e-learning materials: 1. Indira Gandhi Canal https://www.rajras.in/index.php/indira-gandhi-canal/ 2. tourist spots in Rajasthan http://www.transindiatravels.com/rajasthan/tourist-places-to-visit-in-rajasthan/ 3. Problem of Desertification http://www.cazri.res.in/annals/1993/1993JA-1.pdf.	Introduction of New Course

S. No.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
8.	GEOG___R Transforming India	After the completion of this course, students will be able to: • Assess the ongoing governmental policies applicable to socio-economic and health sectors. • Aware society about the injustice caused to women in terms of Triple Talaq. • Explain current livelihood struggle in the society and the role of skill development in enhancing quality of life. • Suggest the measures of improvement in the policies.		Transforming India into a digitally empowered society and development through digitalization, its effects and problems. Demonetization- a step to less cash to cash less economy. Indian youth as a change agent and quality of education for empowering Indian youth, Skill development and empowering youth, Population pressure in job sector and creating livelihood opportunities. SwachhBharatMission and Sanitation revolution for clean and healthy society, Ayushman Bharat Yojana- a step towards Health for all. BetiBachao BetiPadhao- a step for girl's development and Triple Talaq in India- an injustice for women or religious issue. Recommended Books : 1. Ghosh, J., Chandrashekra, C.P.,&Patnaik, P.(2017).*Demonetisation Decoded*. NewYork, NY:Routledge. 2. Panigrahi, R.L.(2005). *Population problems in India*. New Delhi, India: DPH. 3. Sinha,M., &Sinha, R.K.(Ed). (2008). *Swachh Bharat, A clean India*. New Delhi, India:Prabhat. Suggested e-learning materials: 1.Transforming India http://transformingindia.in/ 2.Digital India https://www.indianeconomy.net/splclassroom/what-is-digital-india/ 3.Demonetization http://www.mbauniverse.com/group-discussion/topic/business-economy/demonetisation 4.Skill Development in India https://www.indiainfoline.com/article/article-latest/skill development-in-india-gaps-and-opportunities 118092700366_1.html 5.Swachh Bharat Mission https://www.mapsofindia.com/my-india/society/swachh-bharat-abhiyan-making-india-clean-more 6.Beti Bachao and BetiPadhao http://www.mbauniverse.com/group-discussion/topic/social-issues/beti-bachao-beti-padhao	Introduction of New Course

S. N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
9.	GEOL___ R Geo Tourism	After the completion of this course, students will be able to: • Elucidate the criterion require for designating geotour sites. • Explore the geological and geographical attributes of the geosites. • Develop a geo-conservation plan for geotour sites. • Evaluate the potential of geosites for revenue generation.		Definition and scope of Geotourism. Principles of Geotourism. Geoconservation Plans. Introduction to geodiversity and Geopark. UNESCO's Global Geopark development program. Overview of GSI monuments and geotour sites-Sendra Granite of Pali District Rajasthan, Lonar Lake of Buldana District Maharastra, Peninsular Gneiss at LalbaghBangalore Karnataka, Natural Arch in Tirumala hills Chitoor District, Barr Conglomerate, Pali District Rajasthan, Marine Gondwana Fossil Park, Fossil Wood Parks, Siwalik Fossil Park, Stromatolite Parks, Columnar Basalt, Pillow Lava, Pyroclastic Rocks, NephelineSyenite, Welded Tuff, Charnockite, Great Boundary Fault, Eparchaean Unconformity, Tirumala hills. World's major geotour sites. Recommended Books : 1. Chen, A. (2015). *The Principles of Geotourism*. Beijing, China: Springer-Verlag. 2. Dowling, R.,& Newsome, D. (Eds.). (2018). *Handbook of Geotourism*. Gloucestershire, UK:Edward Elgar. 3. Dowling, R., & Newsome, D. (Eds.). (2005). *Geotourism*. Oxford, UK: Elsevier. 4. Newsome, D.,& Dowling, R. (Eds.). (2010). *Geotourism: The Tourism of Geology and Landscape*. Oxford, UK: Goodfellow. Suggested e-learning materials 1. UNESCO geological heritage and geo-tourism in Peruhttp://www.unesco.org/new/en/media-services/single view/news/unesco_geoparks_geological_heritage_and_geo_tourism_in_peru/ 2. Geotourism https://link.springer.com/referenceworkentry/10.1007%2F978-3-319-01669-6_93-1 3. Geotourism in India https://www.gsi.gov.in	Introduction of New Course

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
10.	GEOL___R Indian Mineral Deposits, Economics and Mining Ethics	After the completion of this course, students will be able to: • Explain the distribution of mineral resources in India. • Evaluate the mineral resources and reserves in Indian and global perspective. • Familiarize with the concept of mineral legislation and policies. • Delineate the different environmental issues associated with mining activities.		Introduction to types and distribution of various mineral deposits in India. Occurrences of important metallic, non-metallic/industrial and fuel mineral deposits of India. Mineral economics and its major concept. Introduction for Global mineral resources. Conservation and substitution of minerals; changing pattern of mineral consumption, Growth of mineral industry and economy, Mineral industry and its adverse effect to the environment. Environmental baseline data needed for mine planning-Its acquisition and documentation during different stages of exploration. Nature and extent of environmental problems due to surface and underground mining. Legislation and control measures for mining. Mineral legislation in Indian context (The Mines and Minerals Regulation and Development Act, 1957). Reclamation and restoration of mined land. Recommended Books : 1. Arogyaswamy, R.N.P. (1995). *Courses in Mining Geology*(4th ed.). New Delhi, India: Oxford and IBH. 2. Banerjee, D. K. (1998). *Mineral Resources of India*(2nd ed.). Kolkata, India: The World Press. 3. Chatterjee, K.K. (1993). *An Introduction to Mineral Economics* (2nd ed.).Bangalore, India: New Age International. 4. Sharma, N.L.,& Ram, K.S.V. (1964). *Introduction to India's economic minerals*. Dhanbad, India: Dhanbad.. 5. Sinha, R.K.,& Sharma, N.L. (1988). *Mineral Economics* (4th ed.).New Delhi, India: Oxford & IBH. Suggested e-learning materials: 1. Mineral and energy resources http://ncert.nic.in/ncerts/l/legy207.pdf 2. Economic Minerals of India: https://www.researchgate.net/publication/315831629_Economic_Minerals_of_India.	Introduction of New Course

S. No.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
11.	GEOL____R Innovation and Entrepreneurship in Earth sciences	After the completion of this course, students will be able to: • Understand necessary steps to open a new venture. • Gain an understanding of creating products or services, launching innovative projects and making R&D investments in a start-up context. • Develop marketing strategies for tools and technical products used in earth sciences. • Familiarize with the legal concepts and financial planning for a successful new venture.		An overview of Entrepreneurs and Entrepreneurship. Evolution and Growth of Earth Science. Entrepreneurship in India, Starting small business. Planning-Organization and Management. Basic layout of Proposal for seeking loan from financial institution, Legal requirements, Basic Financial Planning and problems. Case study of successful Earth Science Entrepreneurs in India. Earth Science component in Government of India. PSU (MECL, NHPC Mini Ratna, ONGC, NTPC, CIL Maharatna) and in MNC (Larsen and Toubro, Tata, Reliance, Vedanta, Dalmiya groups, Aditya Birla). Entrepreneurs Skills and Competencies. Earth Science technology for harnessing Innovation. Challenges of new startups, Marketing Strategies development, Tools and techniques for market Assessments, Methods and sources for market survey and Market Information. Presentation of Market Survey Report. Recommended Books : 1. Clarysse, B. (2011). *The Smart Entrepreneur: How to Build for a Successful Business*. London, UK: Elliott & Thompson. 2. Sethi, A. (2016). *From Science to Startup: The Inside Track of Technology. Entrepreneurship*.Göttingen, Germany: Copernicus & Springer. 3. Westhead, P.,& Wright, M.(2013). *Entrepreneurship. A very short introduction*. Oxford, UK: Oxford University Press. Suggested e-learning materials: 1. Sustainability, Innovation and Entrepreneurship https://nptel.ac.in/courses/110107094/26 2. New Enterprises https://ocw.mit.edu/courses/sloan-school-of-management/15-390-new-enterprises-spring	Introduction of New Course

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark

12.	**GEOL____R** **Natural Hazards and Disasters**	**After the completion of this course, students will be able to:** • **Explain the key concepts, definitions, perspectives of all hazards and management.** • **Describe prevention and mitigation of natural hazards.** • **Depict the preparedness response and recovery management of natural disasters.** • **Elucidate the sustainable development methods in disaster mitigation.**		**Introduction to Disasters and Hazards, Processes (Internal and External), Types of Hazards: causes and consequences, Prediction and Indicators of Natural Disasters, Socio-economic and Health impacts of Natural Disasters.** **Natural Disasters – Earthquake: Processes, Magnitude, Intensity and Impact. Volcanism: Types, Risks and Impact. Tsunami and Cyclone: Types, Causes, processes and Impact. Floods: Introduction, Magnitude, Frequency, Zonation and Impact. Mass Wasting: Classification, causes and Impact. Disaster Management: Prevention, Preparedness and Mitigation, Planning and control of Natural Disaster. Case Studies: Nepal Earthquake, Kedarnath Disaster, Bhuj Earthquake 2001.** **Recommended Books :** 1. **Bolt, B.A. (1988). *Earthquakes.* New York, NY: WH Freeman & Company.** 2. **Decker, R. W. & Decker, B. B. (2005). *Volcanoes* (4th ed.). New York, NY: WH Freeman & Company.** 3. **Dowrick, D. (2003). *Earthquake Risk Reduction Zone.* England, UK: John Wiley & Sons.** 4. **Gere, J.M.,& Shah, H.C. (1984). *Terra Non Firme Understanding and Preparing for Earthquakes.* New York, NY: WH Freeman & Company.** 5. **IGNOU (2005). *Understanding Natural Disasters*. eGyanKosh, Noida, India: Shagun Offset Press.** 6. **Keller, E.A.,& Devecchio, E.D. (2015). Natural Hazards (4th ed.). New York, NY: Pearson.** 7. **Keller, E.A. (1978). *Environmental Geology*(9th ed.). North Carolina, NC: Bell & Howell.** 8. **Montgomery, C.W. (2013). *Environmental Geology* (10th ed.). New York, NY: Mc-Graw-Hill.** 9. **Prakash, I. (1994). *Disaster Management.* Ghaziabad,India:RastriyaPrahari.** 10. **Sharma, V.K. (1995). *Disaster Management.* New Delhi, India: Indian Institute of Public Administration (*IIPA*).** 11. **Singh, S. (2015). *Environmental Geography*. Allahabad, India: Pravalika.** **Suggested e-learning materials:** 1. **Introduction to Natural hazards** **https://epgp.inflibnet.ac.in/ahl.php?csrno=17** **https://onlinecourses.nptel.ac.in/noc19_ce14/preview** 2. **Disasters and Hazards**	**Introduction of New Course**

				https://ndma.gov.in/en/	

Note: Yellow highlighted and bold content illustrate the modification in the syllabus.

BANASTHALI VIDYAPITH
SCHOOL OF EARTH SCIENCES

Name of the Programme: M.Sc. (Geology)

Programme Educational Objectives:

Banasthali Vidyapith is an epitome of tradition and modernity. Vidyapith aims to preserve and inculcate the essential values and ideals of Indian culture. It believes in simple living and high thinking. Our educational ideology is based on the concept of fivefold education focusing on physical, practical, aesthetic, moral and intellectual aspects in order to develop a balanced personality.

Geology is one of the disciplines of Earth Sciences that incorporates the scientific aspects of origin, evolution, nature, composition and structure of the Earth. It includes physical chemical and biologically active processes that shape the surface and interior of the Earth.

Geologists are involved in identification of minerals, rock and fossils. They provide systematic approach in understanding of minerals composition and structure. They also emphasizes on occurrence and genesis of rocks, deformational history, geotectonic events within the geological time scale, landforms, fossils and available economic Earth resources.

This Postgraduate curriculum is designed to provide an advanced knowledge in geology, and incorporates the ideas transferred from other sciences to geological problems. The Course provides hands on experience in practical knowledge from laboratory works and fieldwork as required for industry and academia. The curriculum promotes research projects from specialized area of geosciences and provides essential competencies to analyze and synthesize geosciences related problems.

The main objectives of the Master of Sciences in Geology program are:

- **To promote advanced study and original research in one or more areas of geology, Geophysics, Hydrogeology and Engineering geology.**
- **To produce technically qualified, well-rounded geologist trainee for mining, engineering, ground water and petroleum, with the potential to become leaders of industry, enterprises, and state institutions.**
- **To become licensed Professional Geologists for new start ups with in India and abroad.**
- **To recognize public issues related to geological hazard and be ready and able to contribute to their resolution for society.**
- **To develop a basic understanding of energy resources and their formation, availability and exploration techniques.**
- **To acquire information about modern analytical and exploration techniques.**
- **To inculcate effective skills for presentation of data, models, hypothesis, communication and management skills; required for professional development in the sphere of academic, research and job perspective.**

Programme Outcomes:

PO1: Geology Knowledge: Possess knowledge and comprehension of the core and basic knowledge associated with the Earth Sciences' profession, including public sector and private sector, viz. mining industries; civil engineering department, petroleum Industries, and groundwater departments.

PO2: Planning Abilities: Demonstrate effective planning abilities including time management, resource management, during field training based studies, which is an integral part of the program designed to consolidate the students understanding by applying classroom-taught concepts in the field.

PO3: Problem Analysis: Utilize the principles of scientific inquiry, thinking analytically, clearly and critically, while solving problems and making a decision during real-time geo-research problems.

PO4: Modern Tool Usage: Learn, select, and apply appropriate methods and procedures, resources, and modern geo-research-related analytical and computing tools.

PO5: Leadership Skills: Understand and consider the human reaction to change, motivation issues, leadership and team building when planning changes required for fulfillment of geological practice (including civil engineering mega-structure construction, mining activity related to geo-recourse exploitation), professional and societal responsibilities.

PO6: Professional Identity: Understand, analyze and communicate the value of their professional roles in society as Geoscientists in public sector as well as in private sectors to search new reserves, evaluate its economic viability and find out judicious techniques to extract it.

PO7: Geological Ethics: Honor personal values and apply ethical principles in professional and social contexts. Demonstrate the highest standards of integrity, morality, professional conscience, and moral responsibility while making decisions.

PO8: Communication: Acquire necessary competence in both oral written communication required to convey the results, advice, and recommendations from geological investigations to a variety of end users (e.g., policymakers, the stake holders, the public, and the media).

PO9: The Geologists and Society: Understand the role of Geology in service of the society of an instrumental view of nature contributing to its exploitation, and helping providing the raw materials needed for economic development, frequently with high ecological impacts.

PO10: Environment and Sustainability: Understand and apply information related to environmental geology and geo recourse conservation in issues of environmental contexts and sustainable development.

PO11: The Geology and Economics: Geology plays an essential role in many areas of the economy. Economic growth and sustainability, as well as societal well-being, requires reliable supplies of energy and mineral resources, the supply of clean water and the secure and sustainable production of food. All this will be contingent on sustained investment in technology, infrastructure, education, and skills development.

PO12: Life- long Learning: Acquire lifelong learning with the aim of improving knowledge, skills, and competencies within a personal, civic, social and/or employment-related perspective.

Programme Scheme:

Semester I

Existing Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
GEOL ~~401~~	~~Fuel Geology~~	~~5~~	0	0	~~5~~
GEOL ~~405~~	Geotectonics and Structural Geology	~~5~~	0	0	~~5~~
GEOL ~~408~~	Mineralogy and Analytical Techniques	~~5~~	0	0	~~5~~
GEOL ~~409~~	~~Ore Genesis and Economic Geology~~	~~5~~	0	0	~~5~~
GEOL ~~402~~L	~~Geology Lab I~~	0	0	12	6
	Total	**20**	**0**	**12**	**26**

Proposed Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
GEOL ____	**Geochemistry and Isotope Geology**	**4**	**0**	**0**	**4**
GEOL ____	**Geomorphology**	**4**	**0**	**0**	**4**
GEOL ____	**Geotectonics and Structural Geology**	**4**	**0**	**0**	**4**
GEOL ____	**Mineralogy and Analytical Techniques**	**4**	**0**	**0**	**4**
GEOL ____	**Sedimentary Petrology**	**4**	**0**	**0**	**4**
GEOL ____L	**Geology Lab-I with Field Work**	**0**	**0**	**12**	**6**
	Total	**20**	**0**	**12**	**26**

SEMESTER II

Existing Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
GEOL ~~404~~	Geophysics and Exploration Method	~~5~~	0	0	~~5~~
GEOL ~~406~~	Igneous Petrology	~~5~~	0	0	~~5~~
GEOL ~~407~~	Metamorphic Petrology	~~5~~	0	0	~~5~~
GEOL ~~410~~	~~Sedimentary Petrology~~	~~5~~	0	0	~~5~~
GEOL ~~403L~~	~~Geology Lab-II with Field Work~~	0	0	12	6
	Total	**20**	**0**	**12**	**26**

Proposed Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
GEOL ____	**Geophysics and Exploration Method**	**4**	**0**	**0**	**4**
GEOL ____	**Igneous Petrology**	**4**	**0**	**0**	**4**
GEOL ____	**Metamorphic Petrology**	**4**	**0**	**0**	**4**
GEOL ____	**Ore Genesis and Economic Geology**	**4**	**0**	**0**	**4**
GEOL ____	**Stratigraphy**	**4**	**0**	**0**	**4**
GEOL ____L	**Geology Lab-II**	**0**	**0**	**12**	**6**
	Total	**20**	**0**	**12**	**26**

SEMESTER III

Existing Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
GEOL ~~504~~	~~Geochemistry and Isotope Geology~~	~~5~~	0	0	~~5~~
GEOL ~~508~~	~~Mining and Engineering Geology~~	~~5~~	0	0	~~5~~
GEOL ~~509~~	Palaeontology	~~5~~	0	0	~~5~~
GEOL ~~510~~	~~Stratigraphy~~	~~5~~	0	0	~~5~~
GEOL ~~505L~~	Geology Lab-III with Field work	0	0	12	6
	Total	**20**	**0**	**12**	**~~26~~**

Proposed Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
GEOL ____	**Hydrogeology**	**4**	**0**	**0**	**4**
GEOL ____	**Palaeontology**	**4**	**0**	**0**	**4**
GEOL ____	**Remote Sensing and GIS in Geology**	**4**	**0**	**0**	**4**
GEOL ____L	**Geology Lab-III with Field Work**	**0**	**0**	**12**	**6**
GEOL ____	**Discipline Elective**	**4**	**0**	**0**	**4**
	Open Elective	**4**	**0**	**0**	**4**
	Reading Elective I	**0**	**0**	**0**	**2**
	Total	**20**	**0**	**12**	**28**

Existing Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
GEOL ~~501~~	~~Concepts of Remote sensing and GIS~~	~~5~~	0	0	~~5~~
GEOL ~~503~~	~~Environmental Geology and Hydrogeology~~	~~5~~	0	0	~~5~~
GEOL ~~506~~L	~~Geology Lab IV~~	0	0	~~12~~	~~6~~
GEOL ~~507~~	~~Geomorphology~~	~~5~~	0	0	~~5~~
GEOL ~~502~~D	Dissertation	0	0	~~10~~	~~5~~
	Total	**~~15~~**	**0**	**~~22~~**	**~~26~~**

Proposed Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
	Reading Elective II	**0**	**0**	**0**	**2**
GEOL___D	Dissertation **	**0**	**0**	**48**	**24**
	Total	**0**	**0**	**48**	**26**

List of Discipline Electives					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
GEOL ____	**Environmental Geology**	4	0	0	4
GEOL ____	**Fuel Geology**	4	0	0	4
GEOL ____	**Marine Geology**	4	0	0	4
GEOL ____	**Mining and Engineering Geology**	4	0	0	4

List of Reading Electives					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ENVS_R	**Agroforestry**	**0**	**0**	**0**	**2**
ENVS_R	**Energy Resources and Conservation**	**0**	**0**	**0**	**2**
ENVS_R	**Man and Environment**	**0**	**0**	**0**	**2**
ENVS _R	**Water and Sustainable Development**	**0**	**0**	**0**	**2**
GEOG_R	**Environmental Challenges and Disaster Management**	**0**	**0**	**0**	**2**
GEOG_R	**India: Socio-Political and Environmental Scenario**	**0**	**0**	**0**	**2**
GEOG_R	**Rajasthan: Challenges and Prospects**	**0**	**0**	**0**	**2**
GEOG_R	**Transforming India**	**0**	**0**	**0**	**2**
GEOL_R	**Geo Tourism**	**0**	**0**	**0**	**2**
GEOL_R	**Indian Mineral Deposits, Economics and Mining Ethics**	**0**	**0**	**0**	**2**
GEOL_R	**Innovation and Entrepreneurship in Earth Sciences**	**0**	**0**	**0**	**2**
GEOL_R	**Natural Hazards and Disasters**	**0**	**0**	**0**	**2**

List of Online Reading Electives

S. No.	Course Name	Proposed Alternative On-line Course	Credit point(s)	URL link
1	ENVS__R Energy Resource and Conservation	Non-Conventional Energy Resources	2	https://onlinecourses.nptel.ac.in/noc18_ge09/preview
2	GEOL__R Indian Mineral Deposits, Economics and Mining Ethics	Mineral Resources: Geology, Exploration, Economics and Environment	2	https://onlinecourses.nptel.ac.in/noc18_ce13/preview
3	GEOL__R Natural Hazards and Disasters	Natural Hazards Part 1	2	https://onlinecourses.nptel.ac.in/noc19_ce14/preview

***Lecture hrs/week; T-Tutorials hrs/week; P-Project/Practical/Lab/All other non-classroom academic activities, etc. hrs/week; C-Credit Points of the Course**
****Students shall carry out their dissertation at any Company/Laboratory /Industry/Research Institute/University/Banasthali Vidyapith.**

Note: Brief of changes done in the present BOS.

- **The course scheme has been changed as earlier there were five credits for lectures and now they are four.**

- **Semester I**

  The course **GEOL 401 Fuel Geology** have been shifted to pool of discipline electives and is replaced by modified course **Geochemistry and Isotope Geology from semester III**.

  Geomorphology is introduced as a modified course in place of **GEOL 409 Ore Genesis and Economic Geology**. Earlier it was present in semester IV as GEOL 507 under previous scheme.

  The courses **GEOL 405 Geotectonics and Structural Geology** & **GEOL 408 Mineralogy and Analytical Techniques** are retained with modification in the same semester as **Geotectonics and Structural Geology** & **Mineralogy and Analytical Techniques,** respectively under revised scheme.

  The course **GEOL 409 Ore Genesis and Economic Geology** is shifted to semester II.

  The course **Sedimentary Petrology i**s introduced as a modified course under revised scheme. Earlier it was in Semester II **as GEOL 410 Sedimentary Petrology.**

  The course **GEOL 402L Geology Lab-I** has been modified updated to **Geology Lab-I with Field Work**.

- **Semester II**

  The courses **GEOL 404 Geophysics and Exploration Method, GEOL 406 Igneous Petrology** & **GEOL 407 Metamorphic Petrology** are retained in the same semester with minor modification under revised scheme.

  GEOL 410 Sedimentary Petrology has been replaced by Ore Genesis and Economic Geology, earlier was in semester I.

  GEOL 510 Stratigraphy is shifted from semester III with minor modifications under revised scheme.

  The course **GEOL 403L Geology Lab-II with Field work** has been replaced by new course **Geology Lab-II.**

- **Semester III**

  GEOL 504 Geochemistry and Isotope Geology have been shifted to semester I and replaced by new course **Hydrogeology.**

  GEOL 509 Palaeontology is retained in the same semester under revised scheme with minor modifications.

  GEOL 510 Stratigraphy is replaced by new course **Remote Sensing and GIS in Geology.**

  GEOL 505L Geology Lab-III with Field work is replaced by modified course **Geology Lab-III with Field Work** in the same semester with significant modification.

  Pool of **Discipline Electives** has been introduced in semester III.

  Open Elective has been introduced in semester III

- **Semester IV**

  The courses **GEOL 501 Concepts of Remote sensing and GIS & GEOL 503 Environmental Geology and Hydrogeology** have been removed and **GEOL 507 Geomorphology** is shifted to Semester I under revised scheme with modifications.

  GEOL 506 L Geology Lab IV has been removed from the semester**.**

  GEOL 502 D Dissertation have been retained and introduced for entire semester under revised scheme.

Common pool of **Reading Electives** has been introduced in semester III and IV.

Note: Yellow highlighted and bold content illustrate the modification in the syllabus.

Name of the Programme : M.Sc. (Geology)

Course Details :

FIRST SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
1.	**GEOL ~~401~~** **Fuel Geology**	~~After the completion of this course, students will be able to:~~ • ~~Explore coal deposits, their mode of occurrences, structures in coal seams and application of coal petrography.~~ • ~~Describe the geology of petroleum reservoirs, prospective and their exploration techniques.~~ • ~~Describe the source of radioactive minerals, chemistry, prospects and exploration techniques.~~ • ~~Provide feasible solutions for radioactive waste management.~~	**Section A** Definition, origin and types of coal. Mode of occurrences and structures in coal seam. Coal petrography. ~~Stratigraphy of coal measures.~~ Indian coal deposits. ~~Industrial application of coal petrology~~. Coal bed methane-~~a new energy resource.~~ **Section B** Origin, composition, migration and entrapment of natural hydrocarbons. Properties of source and reservoir rocks. Porosity and permeability. Reservoir traps: structural, stratigraphic and combination traps. Geographical and geological distributions of onshore and offshore petroliferous basins of India. **Section C** Mineralogy and geochemistry of radioactive minerals. Distribution of radioactive minerals in India. Radioactive waste management. Geological and geophysical methods of petroleum exploration. **Recommended Books:** ~~1. Acharyya, S.K. (2000) Coal and Lignite Resources of India: An overview, Geological Society of India, Bangalore.~~ ~~2. Francis, W. (1961) Coal, Edward Arnold Ltd., London.~~ ~~**3.** Aswathanarayana, U. (1985) Principles of Nuclear Geology, Oxford Press., New Delhi~~		**Replaced by new course** **The course has been shifted to semester-III to pool of discipline electives.**

			4. Boyle, R.W. (1982) Geochemical prospecting for Thorium and uranium deposits, Elsevier.Amsterdam& New York, 5. Chandra, D., Singh, R.M, Singh, M.P. (2000) Textbook of coal (Indian context), Tara book agency, Varanasi 6. Dahlkamp, F.J. (1993) Uranium Ore Deposits, Springer Verlag. Berlin Heidelberg 7. Durance, E.M. (1986) Radioactivity in Geology-principles and application, Ellis Hoorwool, Chichester, England. 8. Holson, G.D. and Tiratso E.N., (1985) Introduction to Petroleum Geology, Gulf Publishing, Houston, Texas. 9. Krishnaswamy, S. (1979) India's Mineral Resources, Oxford IBH Publications, New Delhi. 10. Levorsen, A.I. (1967) Geology of Petroleum, 2nd ed. Freeman, San Francisco. 11. Petroliferous basins of India: Publisher: KDMIPE, ONGC, 1986 12. Selley, R.C. (1998) Elements of Petroleum Geology, Academic Press, San Diego 13. Singh, M.P. (1998) Coal and Organic Petrology, Hindustan Publ. Corp., New Delhi. 14. Tissot, B.P. and Welte D.H. (1984) Petroleum formation and occurrence, Springer-Veralg. Berlin Heidelberg.		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
2.	**GEOL _____ Geochemistry and Isotope Geology**	**After the completion of this course, students will be able to:** • **Describe the composition of the Earth and processes by which the chemical elements have been synthesized over the history of the cosmos.** • **Explain the origin and geochemical evolution of atmosphere, biosphere, hydrosphere and major global geochemical cycles.** • **Describe the major principles and methods involved in geochemical prospecting.** • **Explain the structure of atomic nuclei its effects on nuclear stability, fractionation of stable isotopes, radiogenic isotopes geochemistry and their application in**		**Section A** Introduction to Geochemistry: Origin of elements. Cosmic abundance of elements.Pregeological history of the Earth. Structure and composition of Earth. Geochemical classification of elements. Principles of ionic substitutions in minerals. **Section B** Geochemistry of hydrosphere, biosphere and atmosphere. Geochemical cycles: Carbon, Oxygen, Nitrogen, Phosphate. Geochemical prospecting. Geochemical anomalies. Meteorites: classification, mineralogy, origin, and significance of meteorites. **Section C** Isotope Geochemistry: Introduction and physics of the nucleus. Radioactive decay and Law. Radioactive decay scheme of Rb-Sr method, Sm-Nd method, K-Ar method, Ar-Ar method, U-Th-Pb method, Fission tracking dating.Stable isotope geochemistry of oxygen, nitrogen, carbon and sulphur. **Recommended Books:** 1. **Albarede, F. (2003). *An introduction to geochemistry* (2nd ed.). New York, NY: Cambridge University Press.** 2. **Faure, G. & Mensing, T.M. (2005). *Isotope, principles and applications* (3rd ed.). New York, NY: John Wiley & Sons.** 3. **Hoefs, J. (1986). *Stable isotope geochemistry* (3rd ed.). Berlin, Germany: Spriger- Verlag,** 4. **Krauskopf K. B. (1979). *Introduction to Geochemistry*. New York, NY: McGraw Hill.** 5. **Mason, B., & Moore, C.B. (1982). *Introduction to Geochemistry* (2nd ed.). New York, NY:Wiley Eastern.** 6. **Mason, B. (1982). *Principles of Geochemistry* (3rd ed.). New York, NY: John Wiley & Sons.** **Suggested e-learning materials:** 1. **Geochemical Prospecting https://pubs.usgs.gov/bul/1000f/report.pdf** 2. **Origin of Elements https://www2.lbl.gov/abc/wallchart/chapters/10/0.html**	**Reviewed learning outcomes and suggested e-learning materials** **As the scheme has been changed and considered as a new course** **Few modifications have been done** **Earlier it was present in**

		dating and palaeoclimate reconstruction.			**semester-III**

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
3.	**GEOL ____ Geomorphology**	**After the completion of this course, students will be able to:** • **Explain erosion and deposition features formed due to various geomorphic process** • **Delineate various climatic conditions that helps to modify the landforms.** • **Describe the application of geomorphology in multidiscipline such as civil engineering, hydrology.** • **Explain the interaction between climate, tectonics and sea level interaction in fluvial environment.**		Section A Introduction to Geomorphology, fundamental concepts, geomorphic agents and processes. Geomorphic models of landscape evolution. Weathering: types and weathering products. Mass wasting. Section B Erosional and depositional landforms: fluvial, glacial, aeolian, coastal and karst landscape. Geomorphology of India-Peninsular, extra peninsular and Indo-Gangetic Plain. Section C Geomorphic response to tectonics, sea level/base level change, anthropogenic affects. Climate change and geomorphic response of fluvial systems of arid and humid regions. Introduction to Anthropocene. **Recommended Books:** 1. **Allision, R.J. (2002). *Applied Geomorphology*. New York, NY: Wiley and Sons.** 2. **Leopold, L.B. (1976). *Fluvial processes in geomorphology*. New Delhi, India: E.P.H.** 3. **Mc Duff, L.D. (Ed.). (1992). *Principles of Physical Geology*. London, UK: Chapman and Hall.** 4. **Pitty, A.F. (1971). *Introduction to geomorphology*. London,UK: Methuen.** 5. **Sharma, H.S. (1990). *Indian Geomorphology*. New Delhi, India: Concept.** 6. **Thornbury, W.D. (1980). *Principles of Geomorphology* (2nd ed.). New York, NY: Wiley Eastern.**	**Reviewed learning outcomes and suggested e-learning materials** **Few modifications have been done Added relevant topics** **As the scheme has been changed and considered as a new course**

				Suggested e-learning materials: 1. **Anthropocene https://www.cambridge.org/core/books/geomorphology-in-the-anthropocene** 2. **Geological Agents http://www.ncert.nic.in/ncerts/l/kegy207.pdf** 3. **Glossary of landforms https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=41992.wba**	**Earlier it was present in semester-IV**

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
4.	**GEOL _____ Geotectonics and Structural Geology**	**After the completion of this course, students will be able to:** • **Recognize and interpret the geological structure of deformed continental regimes, from mildly deformed upper crustal regimes to complexly deformed deeper crustal regimes.** • **Interpret the relative timing of formation of structures, the kinematics of deformation, and the progressive deformation histories in these regimes.** • **Interpret stress regimes strain rate and fluid**	**~~Section A~~** Introduction and tectonic framework of Earth crust. Convection currents and Wilson Cycle. Introduction to plate tectonics and types of plate boundaries. Tectonic features of extensional, compressional and strike-slip terrain. Continental drift ~~theories.~~ ~~Concept of~~ Sea floor spreading. Palaeomagnetism. Hotspots and mantle plumes. ~~Tectonic activity within Indian Plates~~. Himalayan Orogeny. **Section B** Mechanical properties of rocks. Concept of stress and strain. Behavior of material under stress. Theory of rock failure. ~~Elastic and Plastic behavior of rock.~~ Brittle and Ductile deformation. ~~Dynamics of Folding.~~ Classification and Mechanism of Folding and Faulting. Recognition criteria of faulting. ~~Beta and pi diagrams.~~ **Section C** Unconformities: types, formation and significance in stratigraphic correlation. Joints: classification, criteria for recognition and tectonic significance. Concept and types of Lineation, Foliations, Cleavages and their significance. Boudinage structures. **Recommended Books:** ~~1. Condie, K.C. (1984) Plate Tectonics & crustal Evolution, Pergamon Press, London~~ ~~2. Cox, A. (1973) Plate Tectonics and Magnetic Reversal, WM Frauman& Co. San Fransisco~~ ~~3. George H. Davis, Stephen J. Reynolds, Charles F. Kluth (2013) Structural Geology of Rocks and region, 3rd Ed. John Wiley and Sons, U.S.~~	**Section A** Introduction and tectonic framework of Earth crust. Continental drift hypothesis, Supporting evidences and criticism. Convection currents, Sea floor spreading and Palaeomagnetism. Introduction to plate tectonics: types of plate boundaries and plate boundary processes. Tectonic features of extensional, compressional and strike-slip terrain.Hotspots and mantle plumes.Tectono-structural subdivisions of Himalaya and Himalayan Orogeny. **Section B** Mechanical properties of rocks. Concept of stress and strain. Behavior of material under stress. Theory of rock failure. Brittle and Ductile deformation. Classification and Mechanism of Folding and Faulting. Recognition criteria of faulting. Boudinage structures. **Section C** Unconformities: types, formation and significance in stratigraphic correlation. Joints: Genetic classification, criteria for recognition and tectonic significance. Concept and types of Lineation, Foliations, Cleavages and their significance. Shear Zones: Characteristics, Geometry and types. Brittle and ductile shear sense indicators. **Recommended Books:** **1. Billings, M.P. (1972). *Structural Geology* (3rd ed.). New York, NY: Prentice Hall.** **2. Condie, K.C. (2016). Earth as An Evolving Planetary System (3rd ed.). Amsterdam, Neitherland: Elsevier Academic Press.** **3. Dennis, G.J. (1987). Structural Geology An Introduction.**	**Reviewed learning outcomes and suggested e-learning materials** **Few modifications have been done Added relevant topics** **As the scheme has been changed so it is considered as a**

		pressure histories during continental deformation. • **Apply the information of structural geology in the mining and resource exploration environment.**	~~4. Hobbs, B.E., Means, W.D. and Williams, P.F. (1976) An outline of structural geology, John Wiley and Sons, U.S.~~ ~~5. MP Billings (1972) Structural Geology, Prentice Hall, U.K.~~ ~~6. Park, R.G. (1989) Foundations of Structural Geology, 2nd ed. Chapman & Hall, New York~~ ~~7. Patwardhan, A.M. (1999) Dynamic earth System, Prentice hall, New Delhi~~ ~~8. Ramsay, J.G. (1967) Folding and fracturing of rocks, McGraw Hill, New York~~ ~~9. Turotte, D.L. and Schubret, G. (2002) Geodynamics (2nd ed.), Cambridge University Press, UK.~~ ~~10. Valdiya, K. S. (2010) The making of India-Geodynamic Evolution, Macmillan Publishers, India Ltd.~~	**Iowa, IA: Wm. C. Brown.** **4. Fossen, H. (2010). *Structural Geology* (2nd ed.). Cambridge, UK: Cambridge University Press.** **5. George, H. D., Stephen J. R., & Charles F. K. (2013). Structural Geology of Rocks and Region (3rd ed.). New York, NY: John Wiley and Sons.** **6. Ghosh, S. K. (1993), Structural Geology Fundamentals and Modern Developments. London, UK: Pergamon Press.** **7. Hobbs, B.E., Means, W.D., & Williams, P. F. (1976). An Outline of Structural Geology. New York, NY: John Wiley and Sons.** **8. Kerey, P., Kleperis, & K. A., Vine, J. F. (2009). Global Tectonics (3rd ed.). New Jersey, NJ: Wiley Blackwell.** **9. Park, R.G. (1989). Foundations of Structural Geology, (3rd ed.). New York, NY: Chapman & Hall.** **10. Passchier, C. W., & Trouw, R. A. J. (2005). Microtectonics (2nd ed.). New York, NY: Springer Berlin Heidelberg.** **11. Pluijm B. A., & Marshak, S. (2004). *Earth Structure An Introduction to Structural Geology and Tectonics* (2nd ed.). New York, NY: W. W. Norton & Company.** **12. Ramsay, J.G., & Huber, M. I. (1987). *The Techniques of Modern Structural Geology*: *Strain Analysis* (Vol. 1). New York, NY: McGraw Hill.** **13. Ramsay, J.G., & Huber, M. I. (1987). *The Techniques of Modern Structural Geology: Folds and Fractures* (Vol. 2). New York, NY: McGraw Hill.** **14. Ramsay, J.G., & Lisle, R. J. (2000). *The Techniques of Modern Structural Geology*: *Application of Continuum Mechanics in Structural Geology* (Vol. 3). London, UK: Elsevier Academic Press.** **15. Twiss, R. J., & Moores, E. M.. (2007). Structural Geology. (2nd ed.). New York, NY: WH Freeman.** **Suggested e-learning materials:**	**new course**

				1. Geological Map Interpretation https://ocw.tudelft.nl/courses/structural-geology-map-interpretation/ **2. Geologic Structures https://nptel.ac.in/courses/105105106/2 https://nptel.ac.in/courses/105104152/18** **3. Continuum mechanics, Fault and Ductile Deformation Notes https://ocw.mit.edu/courses/earth-atmospheric-and-planetary-sciences/12-113-structural-geology-fall-2005/lecture-notes/** **4. Structural Geology and Tectonics http://www.uh.edu/~jbutler/anon/anoncoursestructure.html**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
5.	**GEOL ____ Mineralogy and Analytical Techniques**	**After the completion of this course, students will be able to:** • **Explain the crystal structure, physical and optical properties of minerals.** • **Demonstrate the relationship between the internal structure of minerals with their external form and effect on physical properties.**	**Section A** ~~Mineral:definition and chemical principles of minerals~~. Isomorphism and Polymorphism, Exsolution and Solid solution. Physical properties of mineral. ~~Light: interaction of light and matter and~~ polarization of light. Behaviour of isotropic and anisotropic minerals in polarized light. ~~Refractive Index.~~ Double refraction and birefringence. Sign of elongation. Interference figures. Extinction and its types. Relief and Pleochroism. Twinning. Accessory Plates. **Section B** Silicates: structure and classification. A detailed study of the following important minerals with reference to structural formulae, crystal structure, chemistry, physical and optical properties and mode of occurence. Silicates: Olivine, Garnet, Melilite, Kyanite, Andalusite, Sillimanite, Beryl, Pyroxene, Amphibole, Serpentine,	**Section A** Introduction and scope. Isomorphism and Polymorphism, Exsolution and Solid solution. Physical properties of minerals. Polarization of light. Behaviour of isotropic and anisotropic minerals in polarized light. Double refraction and birefringence. Sign of elongation. Interference figures. Extinction and its types. Relief and Pleochroism. Twinning: Cause, types and laws. Accessory Plates. **Section B** Silicates: structure and classification. A detailed study of the following important minerals with reference to structural formulae, crystal structure, chemistry, physical and optical properties and mode of occurrence. Silicates: Olivine, Garnet, Melilite, Kyanite, Andalusite, Sillimanite, Beryl, Pyroxene, Amphibole, Serpentine, Mica, Kaolinite, Chlorite, Talc, Feldspar. Non-silicates: Calcite, Aragonite, Dolomite, Apatite, Gypsum,	**Reviewed learning outcomes and suggested e-learning materials** **Few modifications have been done**

		• **Explain the mineralogical concepts of polymorphism, solid solution, exsolution and twinning.** • **Discuss the various analytical technique used for identification and detection of minerals and rocks.**	Mica, Kaolinite, Chlorite, Talc, Feldspar, ~~Cordierite~~ Non-silicates: Calcite, Aragonite, Dolomite, Apatite, ~~Monazite,~~ Gypsum, ~~Anhydrite~~, Barite, Spinel, ~~Hematite~~, Rutile, ~~Bauxite~~,~~Periclase.~~ **Section C** Definition of Crystal. Classification of crystal into crystal systems. ~~Twinning.Thin section and polished section making. Sample etching, staining and model count techniques~~. Introduction to analytical techniques like XRD (X-ray diffraction), Scanning Electron Microscope (SEM), Electron Probe Micro Analyser (EPMA), Thermogravimetric Analysis (TGA), Transmission Electron Microscope (TEM), Mass spectrometry, ~~Inductively Coupled Plasma- Mass Spectroscopy (ICPMS), Inductively coupled plasma – Atomic emission spectrometry,~~ Atomic absorption spectrometry and their application in mineral characterization. **Recommended Books:** ~~1. Berry, L.G, Mason, B. and Dietrich, R. V. (1982) Mineralogy, CBS Publication, New Delhi, India~~ ~~2. Cornelis Klein & Barbara Dutrow (2007) Mineral science, John Wiley & Sons, US~~ ~~3. Dexter Perkins (2010) Mineralogy, Pearson Education, US.~~ ~~4. Gill, R (1977) Modern analytical geochemistry, Longman, Singapore~~ ~~5. Paul F. Kerr (1959) Optical Mineralogy, McGraw Hill Book Company, Inc., US~~ ~~6. Perry, D.L. (1990) Instrumental Surface Analysis of Geologic Materials, VCH Pub. Inc., New York.~~ ~~7. Phillips, Wm, R. and Griffen, D.T. (1986) Optical Mineralogy, CBS Edition, New Delhi.~~ ~~8. Read, H.H. (1968) Rutley's Element of Mineralogy, Thomas Murby and Co., London~~	Barite, Spinel, Rutile. **Section C** Definition of Crystal. Classification of crystal into crystal systems. Introduction to analytical techniques like XRD (X-ray diffraction), Scanning Electron Microscope (SEM), Electron Probe Micro Analyser (EPMA), Thermogravimetric Analysis (TGA), Transmission Electron Microscope (TEM), Mass spectrometry (MS), Atomic absorption spectrometry (AAS) and their application in mineral characterization. **Recommended Books:** **1. Berry, L.G, Mason, B., & Dietrich, R. V. (1982). *Mineralogy*. New Delhi, India: CBS.** **2. Gill, R. (1977). *Modern analytical geochemistry.* London, UK: Rouledge.** **3. Gribble, C.D. (1991). *Rutley's Element of Mineralogy* (27th ed.). Delhi, India: CBS.** **4. Kerr, P.F. (1959). *Optical Mineralogy* (4th ed.). New Delhi, India: McGraw Hill.** **5. Klein, C., & Dutrow, B. (2007). *Mineral science* (23rd ed.). New York, NY: John Wiley & Sons.** **6. Perkins, D. (2010). *Mineralogy* (3rd ed.). USA, Pearson.** **7. Perry, D.L. (1990). *Instrumental Surface Analysis of Geologic Materials*. New York, NY:VCH.** **8. Phillips, Wm, R., & Griffen, D.T. (1986). *Optical Mineralogy* (5th ed.). New Delhi, India: CBS.** **9. Read, H.H. (Ed.). (1968). *Rutley's Element of Mineralogy* (24th ed.). London, UK: Thomas Murby and Co.** **10. Rollinson, H. (1993). *Using Geochemical Data-Evaluation, Presentation, Interpretation*. New York, NY: Longman Scientific & Technical.** **11. Skoorg, D.A., West, D. M., Holler, F.J., & Crouch, S.R. (2004). *Fundamentals of analytical chemistry.* (8th ed.). California, CA: Thomson Brooks Cole.**	**As the scheme has been changed so it is considered as a new course**

			9. Rollinson, H. (1993) Using Geochemical Data Evaluation, Presentation, Interpretation, Longman, Harlow, Essex, England : New York : Longman Scientific & Technical 10. Skoorg, D.A. et al (2004) Fundamentals of analytical chemistry, 8th Ed. Thomson Brooks Cole, US	**Suggested e-learning materials:** **1. Mineral forms http://www.galleries.com/minerals** **2. Gemstones and gemology resources http://www.galleries.com/gemstones http://farlang.com/gems** **3. Mineral properties https://naturalhistory.si.edu/research/mineral-sciences**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
6.	**GEOL 409 Ore Genesis and Economic Geology**	After the completion of this course, students should be able to: • Describe the minerals that can be used for economic and/or industrial purposes. • Identify and describe the precious and base metals, nonmetallic minerals and building stone. • Explain the ore formation processes and its geological setting. • Estimate the resource and reserves availability.	**Section A** Ore deposits and ore minerals. Magmatic processes of mineralization. Prophyry, skarn and hydrothermal mineralization. Fluid inclusion studies. Mineralization associated with (a) ultramafic, mafic and acidic rocks (b) greenstone belts (c) submarine volcanism (d) komatites, anorthosites and kimberlites. Stratiform and stratabound ores. **Section B** Occurrence and distribution of metalliferous deposits of India: iron, manganese, aluminium, chromium, gold, silver, nickel, molybdenum, lead, zinc, copper, tungsten. Indian deposits of non-metals: mica, asbestos, barytes, gypsum, graphite. Minerals used in different industries: fertilizer, paint, ceramic and cement industries. **Section C** Resources, Reserve and their classification: strategic, critical and essential minerals. Mineral legislation of India. National Mineral Policy. Mineral Concession Rules. Marine Mineral Resources and Law of Sea. **Recommended Books:** 1. Evans, A.M. (1993) Ore Geology and Industrial		**Replaced by new course** **This course has been shifted to semester-II under new course scheme**

			Minerals, Blackwell Publication, London 2. Gokhale, K.Y.G.K. and Rao, T.C. (1978) Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi. 3. Guilbert, J.M. and Park Jr., C.F. (1986) The Geology of Ore deposits. Freeman & Co., New York 4. Jensen, M.L. and Bateman, A.M. (1981) Economic Mineral Deposits, 3rd ed., John Wiley, New York 5. Krishnaswamy, S. (1979) India's Mineral resources, Oxford & IBH Publ. Co., New Delhi 6. Mookherjee, A. (2000) Ore Genesis-A holistic approach, Allied Publisher, New Delhi.		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
7.	**GEOL ____ Sedimentary Petrology**	**After the completion of this course, students will be able to:** • **Describe the principles of sedimentary petrology, the characteristics and the origin of the sedimentary rocks.** • **Explain formation of sediments, transportation, deposition and formation of sedimentary rocks.** • **Depict the**		**Section A** Sedimentary rocks: Textures, structure and classification. Grain size analysis. Palaeocurrent analysis. Trace fossils and stromatolites: classification and environment of deposition. Provenance and diagenesis of sediments. Heavy mineral analysis. **Section B** Field and laboratory techniques in sedimentology. Genesis and classification of sedimentary rocks: Clastic rocks- conglomerate, breccia, sandstone and shale. Non-clastic rocks- limestone, dolomite, evaporite, phosphorite, chert. **Section C** Definition and classification of sedimentary basins. Sedimentary basins of India. Principles and applications of C-14 and OSL dating. Sedimentary environment and facies modeling for marine, non-marine and mixed sediments.	**Reviewed learning outcomes and suggested e-learning materials** **The course has been shifted**

		classification of sedimentary basins with reference to plate tectonics and sedimentation. • **Identify the provenance for the sediments.**		**Recommended Books:** 1. **Blatt, H., Middleton, G.V., & Murray, R.C. (1980). *Origin of Sedimentary Rocks*. New Jersey, NJ: Prentice Hall.** 2. **Blatt, H., Tracy, R.J., & Owens, B.E. (2006). *Petrology: Igneous, Sedimentary and Metamorphic* (3rd ed.). New York, NY: W.H. Freeman and Company.** 3. **Collins, J.D., & Thompson, D.B. (1982). *Sedimentary Structures*. London, UK: George Allen & Unwin.** 4. **Pettijohn, F.J. (1975). *Sedimentary Rocks* (3rd ed.). New Delhi, India: Harper and Row.** 5. **Reineck, H.E., & Singh, I.B. (1973). *Depositional Sedimentary Environments.* Berlin, Germany: Springer-Verlag,** 6. **Folk, R.L. (1981). *Petrology of Sedimentary Rocks* (2nd ed.). Austin, TX: Hemphill.** 7. **Selley, R.C. (2000). *Applied Sedimentology*. San Diego, CA: Academic Press.** 8. **Tucker, M.E. (1981). *Sedimentary Petrology: An Introduction* (3rd ed.). New York, NY: Wiley & Sons.** **Suggested e-learning materials:** 1. **Sedimentary Texture and Structures https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000448GO/P000594/M022660/ET/1505973116E-TextSedimentaryStructures.pdf** 2. **Basin depositional environment https://link.springer.com/chapter/10.1007/978-3-662-04029-4_1**	**from semester II under revised scheme and considered as a new course** **Few modifications have been done**

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
8.	~~**GEOL 402 L**~~ ~~**Geology Lab-I**~~	~~After the completion of this course, students should be able to:~~ ~~• Interpret the toposheets for civil engineering purposes.~~ ~~• Interpret the geological history of the given area supplemented with structural data in geological maps.~~ ~~• Make systematic descriptions of minerals in hand specimen & thin section and elaborate the laboratory methods for preparation of mineral or rock sections.~~ ~~• Develop a systematic procedure for megascopic identification and description of economic fuel minerals their origin, mode of occurrence and utilization.~~ ~~• Prepare map showing distribution of metallic, non-metallic, fuel and Industrial mineral in India.~~	**Geotectonics and Structural Geology** a) Study of symbols used in Structural maps b) Preparation of geological map cross profile and their interpretation ~~c) Structural problems based on Stereographic projections using stereo nets~~ d) Preparation of map showing tectonic and seismic zones of India **Mineralogy and Analytical Techniques** a) Identification of rock forming minerals in hand specimens and under polarizing microscope b) Goniometer and its use in measuring interfacial angle of crystals and calculation of axial ratio c) Preparation of thin sections of rocks and minerals **Ore Genesis and Economic Geology** a) Megascopic study of metallic ore minerals in hand specimen b) Preparation of maps showing distribution of metallic, non metallic and industrial minerals in India ~~**Fuel Geology**~~ ~~a) Megascopic study of different types of coal~~ ~~b) Study of geological maps and sections of important oilfields of India~~ ~~c) Preparation of maps showing petroliferous basins, coal seams and radioactive minerals (U and Th) in India~~ **Recommended Books:** ~~1. Aswathanarayana, U. (1985) Principles of Nuclear Geology, Oxford Press., New Delhi~~ ~~2. Billings, M.P. (1972) Structural Geology, Prentice Hall, New York~~ ~~3. Chandra, D., Singh, R.M, Singh, M.P. (2000) Textbook of coal (Indian context), Tara book~~		**The course has been replaced with the updated course under new scheme**

			~~agency, Varanasi~~ ~~4. Cornelis, K. and Barbara, D. (2007) Mineral science, John Wiley & Sons, US~~		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
9.	**GEOL___L Geology Lab-I with Field work**	**After the completion of this course, students will be able to:** • **Interpret the toposheets for civil engineering purposes.** • **Interpret the geological history of the given area supplemented with structural data in geological maps.** • **Make systematic descriptions of minerals in hand-specimen & thin-section and elaborate the laboratory methods for preparation of mineral or rock sections.** • **Determine the average slope**		**Geotectonics and Structural Geology** 1. Toposheet Indexing 2. Study of symbols used in Structural maps 3. Preparation of geological map, cross profile and their interpretation 4. β & π diagrams a) Plotting of Planes and Line b) Plunging and non-plunging folds c) Determination of angle between planes d) Determination of pitch and plunge e) Determination of positions of σ_1 σ_2 σ_3 in conjugate fracture planes 5. Preparation of map showing tectonic and seismic zones of India 6. Elementary Idea of stereo plot software **Mineralogy and Analytical Techniques** 1. Identification of rock forming minerals in hand specimens and under polarizing microscope 2. Goniometer and its use in measuring interfacial angle of crystals and calculation of axial ratio 3. Preparation of thin sections of rocks and minerals **Geomorphology** 1. Drainage morphometry and determination of average slope angle **Sedimentary Petrology**	**Reviewed learning outcomes and suggested e-learning materials** **Few modifications have been done**

		angle and river morphometry. • **Describe the petrography of common sedimentary rocks both at macroscopic and microscopic level.** • **Analyze and interpret geochemistry of common sedimentary rocks using various plots and graphs.**		1. Megascopic and microscopic study of clastic and non-clastic rocks 2. Grain size analysis by sieving method: Plotting of size distribution data as frequency and cumulative curves, computation of statistical parameters and interpretation **Geological Field Work** *** Note: Scientific calculators are permitted during examination.** **Recommended Books:** **1. Billings, M. P. (1972). *Structural Geology* (3rd ed.). New York, NY: Prentice Hall.** **2. Blatt, H., Middleton, G.V., & Murray, R.C. (1980). *Origin of Sedimentary Rocks*. New Jersey, NJ: Prentice Hall Inc.** **3. Cornelis, K., & Barbara, D. (2007). *Mineral science.* New York, NY: John Wiley & Sons.** **4. Folk, R.L. (1981). *Petrology of Sedimentary Rocks* (2nd ed.). Austin, TX: Hemphill.** **5. Gribble, C.D. (1991). *Rutley's Element of Mineralogy* (27th ed.). Delhi, India: CBS.** **6. Kerr, P.F. (1959). *Optical Mineralogy* (4th ed.). New Jersey, NJ: McGraw Hill.** **7. Lisle, R. J., Brabham, P.J., & Barnes J. W. (2011). *Basic Geological Mapping* (5th ed.). London, UK: Wiley Blackwell.** **8. Perry, D.L. (1990). *Instrumental Surface Analysis of Geologic Materials*. New York, NY: VCH.** **9. Pettijohn, F.J. (1975). *Sedimentary Rocks* (3rd ed.). New Delhi, India: Harper and Row.** **10. Phillips, W. R., & Griffen, D.T. (1986). *Optical Mineralogy* (5th ed.). New Delhi, India: CBS.** **11. Ragan, M. D. (2009). *Structural Geology an Introduction to Geometrical Techniques* (3rd ed.). New York, NY: Cambridge University Press.** **12. Rowland, S.M., Duebendorfer, E. M., & Ilsa, M. S.**	

				(2007). *Structural Analysis and Synthesis A Laboratory Course in Structural Geology* (3rd ed.). Victoria, Australia: Blackwell. **13. Survey of India Toposheets** **14. Thornbury, W.D. (1980). *Principles of Geomorphology* (2nd ed.). New York, NY: Wiley Eastern.** **15. Tucker, M.E. (1981). *Sedimentary Petrology: An Introduction* (3rd ed.). New York, NY: Wiley & Sons.** **Suggested e-learning materials:** **1. Stereonet Software https://app.visiblegeology.com/stereonetApp.html** **2. Mineral forms http://www.webmineral.com/** **3. Map interpretation: https://ocw.tudelft.nl/courses/structural-geology-map-interpretation/** **4. Field Mapping http://www.geosci.usyd.edu.au/users/prey/FieldTrips/BrokenHillOlary/Mapping.html** **5. Geologic maps and stratigraphic Sections, Mineralogy and Sedimentary petrology https://nptel.ac.in/courses/105105106/3**	

SECOND SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
1.	**GEOL ____ Geophysics and Exploration Method**	**After the completion of this course, students will be able to:** • **Develop integrated overview of exploration methods and the physics of waves, focusing on seismic reflection and refraction.** • **Explain the principal theories and specialized techniques used in land and marine survey.** • **Detect economically viable deposits such as ore minerals, fossil fuels and reservoirs.** • **Work in academic, research and industries related with geophysical exploration.**	**Section A** Introduction to Geophysics. Shape and size of Earth. Gravitational field of the Earth. Variation of gravity on the Earth. Principles of gravity methods and instruments used. Gravity field surveys. Corrections applied to gravity data: Bouguer anomaly, Regional and residual anomalies, Gravity anomaly, anomaly maps and their interpretation. **Section B** Geomagnetic field of the Earth. Magnetic properties of rocks. Principles of magnetic methods. Instruments of magnetic surveying. Fluxgate magnetometer. Proton-precision magnetometer. Alkali vapour magnetometer. Aeromagnetic surveys. **Section C** Electrical methods: basic principles and various types of electrode configuration. Electrical and resistivity surveying. Field procedures: profiling and sounding. Seismic methods: principles and instruments used. Seismic velocity and interpretation of seismic data. Seismic refraction and reflection method. Well logging ~~applications in petroleum, groundwater and mineral exploration~~. **Recommended Books:** ~~1. Dobrin, M.B. (1976) Introduction to Geophysical Prospecting, McGraw Hill, London~~ ~~2. Lowrie, W. (1997) Fundamentals of Geophysics, Cambridge University press, London~~ ~~3. Parasnis, D.S. (1975) Principles to applied Geophysics, Chapman and Hall, New Delhi~~ ~~4. Sharma, P.V. (1986) Geophysical Methods in Geology, Elsevier, London~~ ~~5. Telford, W.M., Geldart L.P., and Sheriff, R.E. (1990) Applied Geophysics, Cambridge University Press, Cambridge.~~	**Section A** Introduction to Geophysics. Shape and size of Earth. Gravitational field of the Earth.Variation of gravity on the Earth. Principles of gravity methods and instruments used. Gravity field surveys. Corrections applied to gravity data: Bouguer anomaly, Regional and residual anomalies, Gravity anomaly, anomaly maps and their interpretation. **Section B** Geomagnetic field of the Earth. Magnetic properties of rocks.Principles of magnetic methods. Instruments of magnetic surveying. Fluxgate magnetometer.Proton-precision magnetometer. Alkali vapour magnetometer. Aeromagnetic surveys. **Section C** Electrical methods: Basic principles and various types of electrode configuration. Electrical and resistivity surveying. Field procedures: profiling and sounding. Seismic methods: principles and instruments used. Seismic velocity and interpretation of seismic data.Seismic refraction and reflection method. Well logging: Types. **Recommended Books:** 1. **Dobrin, M. B. (1976). *Introduction to Geophysical Prospecting* (4th ed.). London, UK: McGraw Hill.** 2. **Haldar, S. K. (2013). *Mineral Exploration: Principles and Applications*. Amsterdam, Netherland: Elsevier.** 3. **Lilly, R. J. (1998). *Whole Earth Geophysics*. London, UK: Pearson.** 4. **Lowrie, W. (1997). *Fundamentals of Geophysics* (2nd ed.). London, UK:Cambridge University press.**	**Reviewed learning outcomes and suggested e-learning materials** **Few modifications have been done** **As the scheme has been changed so it is considered as a new course**

			6.~~TS Ramakrishna (2006) Geophysical Practice in mineral exploration and mapping (Geological Society of India, Memoir 62).~~	5. **Mishra. D. C. (2011). *Gravity and Magnetic Methods for Geological Studies: Principles, Integrated Exploration and Plate Tectonics*, Hyderabad, India: CRC.** 6. **Parasnis, D.S. (1975). *Principles to applied Geophysics* (5th ed.). New Delhi, India: Chapman and Hall.** 7. **Ramakrishna T.S. (2006). *Geophysical Practice in mineral exploration and mapping.* Banglore, India: Geological Society of India, Memoir 62.** 8. **Sharma, P.V. (1986). *Geophysical Methods in Geology*. London, UK: Elsevier.** 9. **Telford, W.M., Geldart L.P., & Sheriff, R.E. (1990). *Applied Geophysics* (2nd ed.). Cambridge, UK: Cambridge University Press.** **Suggested e-learning materials:** **1. International Geomagnetic Reference Field http://wdc.kugi.kyoto-u.ac.jp/igrf/index.html** **2. World Magnetic Model Calculator http://www.geomag.bgs.ac.uk/data_service/models_compass/wmm_calc.html**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
2.	**GEOL ___ Igneous Petrology**	**After the completion of this course, students will be able to:** • **Explain the various physical and chemical processes forming igneous rocks.**	**Section A** Magma- its nature and composition. Generation of magma. Factors controlling evolution of magma. Influence of volatiles and role of oxygen fugacity in magmatic crystallizations. Phase equilibrium studies of binary and ternary systems and their relations to magma genesis and crystallization. ~~Magmatism in different tectonic settings.~~ **Section B** Major and minor elements ~~in the crust~~. Normative minerals. Variation diagrams and discrimination diagrams. Forms, textures and structures of igneous rocks. IUGS	**Section A** Magma- its nature and composition. Generation of magma. Factors controlling evolution of magma. Influence of volatiles and role of oxygen fugacity in magmatic crystallizations. Phase equilibrium studies of binary and ternary systems (Di-Ab-An and An-Di-Fo). **Section B** Major and minor elements. Trace and Rare Earth elements. Trace element partitioning. Normative minerals. Variation diagrams and discrimination diagrams.Forms, textures and structures of igneous	**Reviewed learning outcomes and suggested e-**

		• **Describe and apply phase equilibria principles to common igneous rock.** • **Describe the various geochemical indices for mineralogical and petrological evolution of igneous rocks.** • **Describe the petrography and petrogenesis of important igneous rocks of Indian occurrence.**	classification of Igneous rocks: Plutonic, Volcanic and ~~Hypabyssal.~~ **Section C** Petrology and petrogenesis of major igneous rock types giving Indian examples of ultramafic, basaltic, granitic, ophiolite, carbonatite, lamprophyres and layered mafic intrusions. **Recommended Books:** ~~1. Best Myron G. (2002) Igneous and Metamorphic Petrology, Blackwell Science, Oxford, UK~~ ~~2. Blatt, H., Tracy, R.J. and Owens, B.E. (2006) Petrology: Igneous, Sedimentary and Metamorphic, 3rd Ed. W.H. Freeman and Company, New York~~ ~~3. Bose, M.K. (1997) Igneous Petrology, World Press, Kolkata~~ ~~4. Hall, A. (1997). Igneous Petrology, Longman, Harlow.~~ ~~5. LeMaitre, R.W. (2002) Igneous Rocks: A classification and glossary of Terms, Cambridge University Press, New York~~ ~~6. Phillpotts, A.R. (1994) Principles of Igneous and Metamorphic Petrology, Prentice Hall of India~~ ~~7. Wilson, M. (1989) Igneous Petrogenesis, Unwin Hyman, London~~ ~~8. Winter, J.D. (2001) An introduction to Igneous and Metamorphic Petrology, Prentice hall, New Jersey.~~	rocks. IUGS classification of Igneous rocks. Plutonic, Volcanic and Ultramafic and Mafic. **Section C** Petrology and petrogenesis of major igneous rock types giving Indian examples of ultramafic, basaltic, granitic, ophiolite, carbonatite, lamprophyres and layered mafic intrusions. **Recommended Books:** **1. Best M. G. (2002). *Igneous and Metamorphic Petrology* (2nd ed.). Oxford, UK: Wiley-Blackwell.** **2. Blatt, H., Tracy, R.J., & Owens, B.E. (2006). P*etrology: Igneous, Sedimentary and Metamorphic* (3rd ed.). New York, NY: W.H. Freeman and Company.** **3. Bose, M.K. (1997). *Igneous Petrology*. Kolkata, India: World Press.** **4. Hall, A. (1997). *Igneous Petrology*. Harlow, UK: Longman.** **5. LeMaitre, R.W. (2002). *Igneous Rocks: A classification and glossary of Terms* (2nd ed.). New York, NY: Cambridge University Press.** **6. Phillpotts, A.R. (1994). *Principles of Igneous and Metamorphic Petrology* (2nd ed.). Cambridge, UK: Cambridge University Press.** **7. Wilson, M. (1989). *Igneous Petrogenesis*. London, Unwin Hyman.** **8. Winter, J.D. (2001). *An Introduction to Igneous and Metamorphic Petrology* (2nd ed.). New Jersey, NJ: Prentice hall.** **Suggested e-learning materials:** **1. Igneous- textures https://swayam.gov.in/course/3948-petrology** **2. Igneous rock-slides http://funnel.sfsu.edu/courses/geol426/ http://www.geolab.ie/**	**learning materials** **Few modifications have been done** **As the scheme has been changed so it is considered as a new course**

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
3.	**GEOL ___ Metamorphic Petrology**	**After the completion of this course, students will be able to:** • **Identify metamorphic mineral assemblages, texture, structures to decipher the order of crystallization of minerals.** • **Describe the metamorphic reaction responsible for metamorphism of rock.** • **Recognize pressure-temperature-time (P-T-t) path associated with tectonic setting of metamorphosed rocks.** • **Describe composition of the fluid phase in the rock during metamorphism.**	**Section A** Metamorphism and metamorphic processes. Mineralogical phase rule of closed and open system and its application. Metamorphic Reactions. Reaction mechanisms and types. Evolution of facies concept, metamorphic facies series and concept of paired metamorphic belts. Metamorphic zones and Isograds. **Section B** Metamorphic structures and textures. Replacement textures and reaction rims. Diagrammatic representation of mineral reactions and paragenesis: ACF, AKF, AFM diagrams. Progressive, regional and thermal metamorphism of pelitic, calcareous and basic igneous rocks. Charnockites. **Section C** Experimental Petrology: ~~methods and techniques,~~ application of experimental petrology to anatexis and formation of granitic magmas. Geothermometer and Geobarometer. Pressure-Temperature-Time path models for metamorphism. Regional metamorphism in relation to the theory of Plate Tectonics. Ocean floor metamorphism. **Recommended Books:** ~~1. Best Myron G. (2002) Igneous and Metamorphic Petrology, Blackwell Science, Oxford, UK.~~ ~~2. Bhaskar Rao, B. (1986) Metamorphic Petrology. Oxford &IBH, New Delhi.~~ ~~3. Blatt, H., Tracy, R.J. and Owens, B.E. (2006) Petrology: Igneous, Sedimentary and Metamorphic, 3rd Ed. W.H. Freeman and Company, New York~~ ~~4. Bucher, K. and Frey, M. (1994) Petrogenesis of Metamorphic Rocks, 6th Ed. Of Winkler's book, Springer Verlag, New York~~ ~~5. Edger, A.D. (1973) Experimental Petrology, Clarendon Press, Oxford~~	**Section A** Metamorphism and metamorphic processes. Mineralogical phase rule of closed and open system and its application. Metamorphic Reactions. Reaction mechanisms and types. Evolution of facies concept, metamorphic facies series and concept of paired metamorphic belts. Metamorphic zones and Isograds. **Section B** Metamorphic structures and textures. Replacement textures and reaction rims. Diagrammatic representation of mineral reactions and paragenesis: ACF, AKF, AFM diagrams. Progressive, regional and thermal metamorphism of pelitic, calcareous and basic igneous rocks. Charnockites. **Section C** Experimental petrology and its application to anatexis and formation of granitic magmas. Geothermometer and Geobarometer. Pressure-Temperature-Time-Depth path models for metamorphism. Regional metamorphism in relation to the theory of Plate Tectonics. Ocean floor metamorphism. Metamorphic Processes associated with Orogenic Belts of India. **Recommended Books:** **1. Best, M. G. (2002). *Igneous and Metamorphic Petrology* (2nd ed.). Oxford, UK, Blackwell Science.** **2. Bhaskar Rao, B. (1986). *Metamorphic Petrology*. New Delhi, India:Oxford & IBH.** **3. Blatt, H., Tracy, R. J., & Owens, B. E. (2006). *Petrology: Igneous, Sedimentary and Metamorphic* (3rd ed.). New York, NY: W.H. Freeman and Company.** **4. Bucher, K., & Frey, M. (1994). *Petrogenesis of Metamorphic Rocks. (*6th ed.). New York, NY: Springer-Verlag.** **5. Edger, A.D. (1973). *Experimental Petrology*. Oxford, UK: Clarendon Press.** **6. Phillpotts, A.R. (1994). *Principles of Igneous***	**Reviewed learning outcomes and suggested e-learning materials** **Few modifications have been done** **As the scheme has been changed so it is considered as a new course**

			~~6. Phillpotts, A.R. (1994) Principles of Igneous &Metamorphic Petrology, Prentice Hall, India~~ ~~7. Spry, A. (1969) Metamorphic Textures, Pergamon Press, UK~~ ~~8. Turner, F.J. (1998) Metamorphic Petrology, McGraw Hill, New York~~ ~~9. Winkler, H.G.E. (1979) Petrogenesis of metamorphic rocks. Springer Verlag, New York~~ ~~10. Winter, J.D. (2001) An introduction to Igneous and Metamorphic Petrology, Prentice hall, New Jersey~~ 11. ~~Yardley, B.W.D. (1990) An Introduction to Metamorphic Petrology, ELBS, Longman, London~~	***&Metamorphic Petrology*** **(2nd ed.). Cambridge, UK: Cambridge University Press.** **7. Spry, A. (1969).** ***Metamorphic Textures*****. London, UK: Pergamon Press.** **8. Turner, F. J. (1968).** ***Metamorphic Petrology*****:** ***Minerological and Field Aspects.*** **New York, NY: McGraw Hill.** **9. Winkler, H.G.E. (1979).** ***Petrogenesis of metamorphic rocks*****. New York, NY: Springer Verlag.** **10. Winter, J.D. (2001).** ***An introduction to Igneous and Metamorphic Petrology*** **(2nd ed.). New Jersey, NJ: Prentice hall.** **11. Yardley, B.W.D. (1990).** ***An Introduction to Metamorphic Petrology*****. London, UK: ELBS, Longman.** **Suggested e-learning materials:** **1. Introduction to Metamorphism http://www.geol.ucsb.edu/faculty/hacker/geo102C/lectures/part2.html** **2. Entropy, Gibb's Free Energy and Clausius-Clapeyron equation https://epgp.inflibnet.ac.in/ahl.php?csrno=448** **3. Graphical Representation of Minerals Assemblages ACF https://swayam.gov.in/courses/5105-metamorphic-petrology** **4. Metamorphism of Mafic Rocks, Metamorphism https://ocw.mit.edu/courses/earth-atmospheric-and-planetary-sciences/12-109-petrology-fall-2005/lecture-notes/Dec1notes.pdf** **http://vidyamitra.inflibnet.ac.in/index.php/content/index/5a3a2aeb8007bef10465cb33**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
4.	**GEOL ~~410~~ Sedimentary Petrology**	~~After the completion of this course, students should be able to:~~ • ~~Describe the principles of sedimentary petrology, the characteristics and the origin of the sedimentary rocks.~~ • ~~Explain formation of sediments, transportation, deposition and formation of sedimentary rocks.~~ • ~~Depict the classification of sedimentary basins with reference to plate tectonics and sedimentation.~~ • ~~Identify the provenance for the sediments.~~	**Section A** Provenance and diagenesis of sediments. Sedimentary textures: ~~definition, measurement and interpretation of grain size.~~ Sedimentary structures. Palaeocurrent analysis. Trace fossils and stromatolites: classification and environment of deposition. Heavy mineral analysis. **Section B** Field and laboratory techniques in sedimentology. Genesis and classification of sedimentary rocks: ~~Siliciclastic rocks~~ - conglomerate, breccia, sandstone, ~~siltstone, clay ston~~e and shale. Carbonate rock - limestone, dolomite, ~~marl,~~ evaporite, phosphorite, chert. **Section C** Definition and classification of sedimentary basins. Sedimentary basins of India. ~~Purpose and scope of basin analysis. Plate Tectonics and sedimentation.~~ Sedimentary environment and facies modelling for marine, non-marine and mixed sediments. **Recommended Books:** ~~1. Blatt, H., Middleton, G.V. and Murray, R.C. (1980) Origin of Sedimentary Rocks, Prentice Hall Inc., NJ~~ ~~2. Blatt, H., Tracy, R.J. and Owens, B.E. (2006) Petrology: Igneous, Sedimentary and Metamorphic, 3rd Ed. W.H. Freeman and Company, New York~~ ~~3. Collins, J.D. and Thompson, D.B. (1982) Sedimentary Structures, George Allen & Unwin, London~~ ~~4. Pettijohn, F.J. (1975) Sedimentary Rocks, 3rd Ed. Harper and Row Publication, New Delhi~~ ~~5. Reineck, H.E. and Singh, I.B. (1973) Depositional Sedimentary Environments, Springer-Verlag, Berlin~~ ~~6. Robert L. Folk (1981) Petrology of Sedimentary Rocks Hemphill Pub Co; 2 edition, Austin, Texas, U.S.A~~ ~~7. Selley, R.C. (2000) Applied Sedimentology, Academic Press, San Diego~~		**Replaced by new course** **The course has been shifted to semester-I under new course scheme**

			~~8. Tucker, M.E. (1981) Sedimentary Petrology: An Introduction, Wiley & Sons, New York~~		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
5.	**GEOL ___ Ore Genesis and Economic Geology**	**After the completion of this course, students will be able to:** • **Describe the minerals that can be used for economic and/or industrial purposes.** • **Identify and describe the precious and base metals, nonmetallic minerals and building stone.** • **Explain the ore formation processes and its geological setting.** • **Estimate the resource and reserves availability.**		**Section A** Introduction to Ore forming processes, Magmatic processes of mineralization, hydrothermal mineralization, oxidation and supergene enrichment. Prophyry, skarn. Fluid inclusion studies. Stratiform and stratabound ores. **Section B** Occurrence and distribution of metalliferous deposits of India: iron, manganese, aluminium, chromium, gold, nickel, lead, zinc, copper, tungsten. Indian deposits of non-metals: mica, asbestos, barytes, gypsum, graphite. Minerals used in different industries: fertilizer, paint, ceramic and cement industries. **Section C** Resources, Reserve and Classification of Ore Reserve (Russian, UNFC System and USGS/USBM Classification), Parameters for Reserve Estimation, Stages of Exploration, Ore Reserve Calculation Methods, National Mineral Policy. Mineral Concession Rules. Marine Mineral Resources and Law of Sea. **Recommended Books:** **1. Evans, A.M. (1993). *Ore Geology and Industrial Minerals* (3rd ed.). London, UK: Blackwell.** **2. Gokhale, K.Y.G.K., & Rao, T.C. (1978). *Ore deposits of India their distribution and processing.* New Delhi, India: Tata-McGraw Hill.** **3. Guilbert, J.M., & Park Jr., C.F. (1986). *The Geology of Ore deposits*. New York, NY: Freeman & Co.** **4. Jensen, M.L. & Bateman, A.M. (1981). *Economic Mineral Deposits* (3rd ed.). New York, NY: John Wiley.** **5. Krishnaswamy, S. (1979). *India's Mineral resources*. New**	**Reviewed learning outcomes and suggested e-learning materials** **As the scheme has been changed so it is considered as a new course** **The course has been shifted from semester-I**

				Delhi, India: Oxford & IBH. **6. Mookherjee, A. (2000). *Ore Genesis-A holistic approach*. New Delhi, India:Allied.** **7. Prasad, U. (2015). *Economic Geology: Economic Mineral Deposits* (2nd ed.). New Delhi, India:CBS.** **8. Sen, A.K., & Guha P.K. (1981). *A Handbook of Economic Geology*. Calcutta, India:Modern Book Agency.** **9. Tiwari, S. K. (2010). *Ore Geology, Economic Minerals and Mineral Economics* (Vol. 1). New Delhi, India: Atlantic.** **10. Tiwari, S. K. (2010). *Ore Geology, Economic Minerals and Mineral Economics* (Vol. 2). New Delhi, India: Atlantic.** **Suggested e-learning materials:** **1. Economic Minerals https://epgp.inflibnet.ac.in/ahl.php?csrno=448** **2 Indian mineral occurrence https://nptel.ac.in/courses/105105170/**	**Some topic has been replaced with relevant topics**

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
6.	**GEOL ____ Stratigraphy**	**After the completion of this course, students will be able to:** • **Explain rock successions and their interpretation in terms of geological time scale.** • **Elaborate its application in**		**Section A** Stratigraphic classification (Lithostratigraphy, Biostratigraphy and Chronostratigraphy). Sequence stratigraphy, magneto-stratigraphy, Earth's climatic history. **Section B** Nature and evolution of early crust. Cratons: Dharwar, Bastar, Singhbhum, Aravalli and fold belts: Eastern Ghat Mobile Belt (EGMB), Pandayan Mobile Belt and Satpura Mobile Belt of India with special reference to tectonics and stratigraphy. **Section C** Stratigraphy of the Palaeozoic, Mesozoic and Cenozoic formations of India. Stratigraphy boundary problems in India: demarcation of Precambrian-Cambrian, Permian-Triassic, Cretaceous-Tertiary and Neogene-Quaternary boundaries in	**Reviewed learning outcomes and suggested e-learning materials** **Few modific**

		petroleum geology and archaeology. • **Identify various sedimentary basins of India.** • **Explain the straigraphic boundary problems in India.**		relation to mechanisms of extinction and evolution. **Recommended Books:** **1. Boggs, S. (2014). *Principles of Sedimentology and Stratigraphy* (5th ed.). New York. NY: Merrill.** **2. Catuneanu, O. (2006). *Principles of Sequence Stratigraphy*. Oxfor, UK: Elsevier.** **3. Danbar, C.O., & Rodgers, J. (1957). *Principles of Stratigraphy*. New York, NY: John Wiley & Sons.** **4. Krishnan, M. S. (2012). *Geology of India and Burma* (6th ed.).. Delhi, India: CBS.** **5. Kumar R. (1978). *Historical Geology and Stratigraphy of India*. New Delhi. India: New Age International.** **6. Lemon, R.R. (1990). *Principles of Stratigraphy*. New York, NY: Merrill.** **7. Naqvi, S.M., & Rogers, J.J.W. (1987). *Precambrian Geology of India*. New York, NY: Oxford University Press.** **8. Ramakrishnan, M., & Vaidyanathan, R. (2010). *Geology of India* (Vol. 1). Bangalore, India:Geological Society of India.** **9. Ramakrishnan, M., & Vaidyanathan, R. (2010). *Geology of India* (Vol. 2). Bangalore, India: Geological Society of India.** **10. Rogers, J.J.W. (1993). *A history of Earth*. Cambridge, UK: Cambridge University Press.** **11. Roy, A.B., & Jakhar, S.R. (2012). *Geology of Rajasthan* (Northwest India) *Precambrian to Recent*. Jodhpur, India: Scientific.** **Suggested e-learning materials:** 1. **Boundary Problems https://books.google.co.in/books/about/Stratigraphic_Boundary_Problem_in_India.html**	**ations have been done** **Shifted the course from semester -III** **As the scheme has been changed so it is considered as a new course**

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
7.	**~~GEOL 403 Geology Lab-II with Field Work~~**	~~After the completion of this course, students should be able to:~~ • ~~Describe the petrography of common igneous, metamorphic and sedimentary rocks both at macroscopic and microscopic level.~~ • ~~Interpret the gravity, bore hole and seismic data used in exploration geophysics.~~ • ~~Prepare map showing distribution of metallic, non-metallic, fuel and Industrial mineral in India.~~	**Igneous Petrology** a) Megascopic and microscopic study of different igneous rocks b) Calculation of CIPW Norms **Sedimentary Petrology** a) Megascopic and microscopic study of clastic and non-clastic rocks b) Grain size analysis by sieving method: Plotting of size distribution data as frequency and cumulative curves, computation of statistical parameters and interpretation **Metamorphic Petrology** a) Megascopic and microscopic study of different metamorphic rocks b) Graphic construction of ACF, AKF and AFM diagrams **Geophysics and Exploration Methods** a) Interpretation of Seismic and resistivity data b) Study of gravity data maps and their interpretation **Recommended Books:** 1. ~~Blatt, H., Middleton, G.V. and Murray, R.C. (1980) Origin of Sedimentary Rocks, Prentice Hall Inc., New Jersey~~ 2. ~~Bose, M.K. (1997) Igneous Petrology, World Press, Kolkata~~ 3. ~~Bucher, K. and Frey, M. (1994) Petrogenesis of Metamorphic Rocks, 6th Ed. Of Winkler's book, Springer-Verlag, New York~~ 4. ~~Hall, A. (1997) Igneous Petrology, Longman~~		**The course has been replaced with new nomenclature**

			5. LeMaitre, R.W. (2002) Igneous Rocks: A classification and glossary of Terms, Cambridge University Press, New York 6. Lowrie, W. (1997) Fundamentals of Geophysics, Cambridge University press, London 7. Pettijohn, F.J. (1975) Sedimentary Rocks, 3rd Ed. Harper and Row Publication, New Delhi 8. Robert L. Folk (1981)Petrology of Sedimentary Rocks Hemphill Pub Co; 2 edition 9. Spry, A. (1969) Metamorphic Textures, Pergamon Press, UK 10. Tucker, M.E. (1981) Sedimentary Petrology: An Introduction, Wiley & Sons, New York 11. Turner, F.J. (1998). Metamorphic Petrology, McGraw Hill, New York 12. Wilson, M. (1989) Igneous Petrogenesis, Unwin Hyman, London 13. Yardley, B.W.D. (1990) An Introduction to Metamorphic Petrology, ELBS, Longman, London		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
8.	**GEOL_____ Geology Lab-II**	**After the completion of this course, students will be able to:** • **Describe the petrography of common igneous and metamorphic rocks both at macroscopic and microscopic level.**		**Geophysics and Exploration Method** 1. Interpretation of Seismic and resistivity data 2. Study of gravity data maps and their interpretation **Igneous Petrology** 1. Megascopic and microscopic study of different igneous rocks 2. Calculation of CIPW Norms **Metamorphic Petrology** 1. Megascopic and microscopic study of different metamorphic rocks 2. Graphic construction of ACF, AKF and AFM diagrams	**Reviewed learning outcomes and suggested e-learning materials**

		• **Interpret the gravity, bore-hole and seismic data used in exploration geophysics.** • **Analyze and interpret geochemistry of common igneous and metamorphic rocks using various plots and graphs.** • **Identify different rock types in various stratigraphic horizons of India.** • **Develop a systematic procedure for megascopic identification and description of economic fuel minerals their origin, mode of occurrence and utilization.** • **Prepare map showing distribution of**		**Stratigraphy** 1. Study of rocks in hand specimens from known Indian Stratigraphic horizons and type localities 2. Map Preparation of important lithotectonic units of India **Ore Genesis and Economic Geology** 1. Megascopic study of metallic ore minerals in hand specimen 2. Preparation of maps showing distribution of metallic, non metallic and industrial minerals in India 3. Numericals based on reserve estimation 4. Megascopic study of different types of coal 5. Study of geological maps and sections of important oilfields of India, petroliferous basins, coal seams and radioactive minerals (U and Th) in India *** Note: Scientific calculators are permitted during examination.** **Recommended Books:** **1. Bose, M. K. (1997). *Igneous Petrology*. Kolkata, India: World Press.** **2. Bucher, K., & Frey, M. (1994). *Petrogenesis of Metamorphic Rocks* (6th ed.). New York, NY: Springer-Verlag.** **3. Chandra, D., Singh, R.M., & Singh, M.P. (2000). *Textbook of coal* (Indian context), Varanasi, India:Tara.** **4. Krishnaswamy, S., (1979). *India's Mineral Resources.* New Delhi, India: Oxford IBH.** **5. Kumar, R. (1978). *Historical Geology and Stratigraphy of India*. New Delhi, India:New Age International.** **6. LeMaitre, R.W. (2002) *Igneous Rocks: A classification and glossary of Terms* (2nd ed.). New York, NY: Cambridge University Press.** **7. Lowrie, W. (1997). *Fundamentals of Geophysics* (2nd ed.). London, UK: Cambridge University press.**	**Few modifications have been done** **As the nomenclature has been changed it is considered as a new course**

		metallic, non-metallic, fuel and Industrial mineral in India.		**8. Singh, M.P. (1998). Coal and Organic Petrology. New Delhi, India:Hindustan.** **9. Spry, A. (1969). Metamorphic Textures. UK, Pergamon Press. Turner, F.J. (1998). Metamorphic Petrology, New York, NY: McGraw Hill.** **10. Wilson, M. (1989). *Igneous Petrogenesis*, London, UK: Unwin Hyman.** **11. Yardley, B.W.D. (1990). *An Introduction to Metamorphic Petrology*. London, UK: ELBS, Longman.** **Suggested e-learning materials:** **1. Magnetic North, Geomagnetic and Magnetic Poles http://wdc.kugi.kyoto-u.ac.jp/igrf/index.html** **2. World Magnetic Model Calculator http://www.geomag.bgs.ac.uk/data_service/models_compass/igrf.html** **3. Introduction to metamorphism http://www.geol.ucsb.edu/faculty/hacker/geo102C/lectures/part2.html** **4. Phase Equilibrium https://serc.carleton.edu/research_education/equilibria/index.html** **5. International Commission on stratigraphy http://www.stratigraphy.org/** **6. International Chronostratigraphic Chart http://www.stratigraphy.org/index.php/ics-chart-timescale** **7. Textures of rocks and economic minerals https://epgp.inflibnet.ac.in/ahl.php?csrno=448** **8. Textures of igneous rocks https://swayam.gov.in/course/3948-petrology**	

THIRD SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
1.	**GEOL ~~5~~04 Geochemistry and Isotope Geology**	~~After the completion of this course, students should be able to:~~ • ~~Describe the composition of the Earth and processes by which the chemical elements have been synthesized over the history of the cosmos.~~ • ~~Explain the origin and geochemical evolution of atmosphere, biosphere, hydrosphere and major global geochemical cycles.~~ • ~~Describe the major principles and methods involved in geochemical prospecting.~~ • ~~Explain the structure of atomic nuclei its effects on nuclear stability, fractionation of stable isotopes, radiogenic isotopes geochemistry and their application in dating and palaeoclimate reconstruction.~~	**Section A** Introduction to Geochemistry: ~~scope and history of Geochemistry.~~ Origin of elements. Cosmic abundance of elements. Earth in relation to solar system and universe. Composition of Earth. Geochemical classification of elements. Principles of ionic substitutions in minerals. ~~Definition and examples of transition elements, platinum group of elements, rare earth elements, compatible elements, incompatible elements, high-field strength elements (HFSE), large ion lithophile elements (LILE).~~ **Section B** ~~Trace elements: definition and trace element partitioning, factors governing values of partition coefficients (P,T, ionic size and charge, composition, crystal field effects). Application of trace elements in igneous rocks.~~ Geochemistry of hydrosphere, biosphere and atmosphere. Geochemical cycles: Carbon, Oxygen, Nitrogen, Phosphate and principles of geochemical prospecting. Meteorites: classification, mineralogy, chemical composition, origin, age and significance of meteorites. **Section C** Introduction and physics of the nucleus. Radioactive decay. Law of radioactive decay.Principles of mass spectrometry. Radioactive decay scheme of Rb-Sr method, Sm-Nd method, K-Ar method, Ar-Ar method, U-Th-Pb method. Stable isotope geochemistry of oxygen, nitrogen, carbon and sulphur. **Recommended Books:** 1. ~~Albarede, F, (2003) An introduction to geochemistry. Cambridge University Press, New York.~~ 2. ~~Brian Mason: (1982) Principles of Geochemistry. John Wiley & Sons, New York.~~		**Replaced by new course** **The course has been shifted in semester -I under new course scheme**

			3. ~~Faure, G. and Mensing, T.M. (2005) Isotope, principles and applications. 3rd ed. John Wiley & Sons, New York.~~ 4. ~~Hoefs, J (1986) Stable isotope geochemistry 3rd edition. Spriger- Verlag, Berlin.~~ 5. ~~K. B. Krauskopf: (1979) Introduction to Geochemistry. McGraw Hill, New York.~~ 6. ~~Mason, B. and Moore, C.B. (1982) Introduction to Geochemistry, Wiley Eastern, New York~~		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
2.	**GEOL_____ Hydrogeology**	**After the completion of this course, students will be able to:** • **Explain the distribution and movement of groundwater in the soil and rocks of the Earth's crust.** • **Describe hydrological cycle and related parameters.** • **Determine the physical and chemical**		**Section A** **Introduction and scope of hydrogeology. Groundwater: origin and age of groundwater. Hydrological cycle, Vertical distribution of groundwater. Water table, Porosity, Permeability, Zone of saturation: specific yield and retention.** **Section B** **Aquifers: Characteristics and types. Darcy's law, hydraulic conductivity. Well hydraulics: Confined and Unconfined. Groundwater modeling: Types and steps in development of groundwater model.** **Section C** **Water Sampling. Groundwater quality. Saline water intrusion: Groundwater regimes in India. Groundwater exploration (Geological and Geophysical methods). Artificial recharge of groundwater. Rain water harvesting.** **Recommended Books:** **1. Arul, P. (2000). *A textbook of groundwater*. Virudachalam, India: Dhanam.** **2. Karanth, K.R. (1989). *Hydrogeology*. New Delhi, India:**	**New course introduced**

		parameters to assess groundwater quality. • Evaluate the major geological factors controlling groundwater exploration.		Tata McGraw Hill. 3. Nagabhushaniah, H. S. (2001). *Groundwater in Hydrosphere*. New Delhi, India: CBS. 4. Raghunath, H. M. (2014). *Groundwater* (3rd ed.). New Delhi, India: New Age International. 5. Todd, D. K., & Mays, L. W. (2004) *Groundwater Hydrology* (3rd ed.). New Delhi, India: Wiley India. **Suggested e-learning materials:** 1. Introduction to hydrogeology https://epgp.inflibnet.ac.in/ahl.php?csrno=448 2. Ground water hydrology https://nptel.ac.in/courses/105105106/	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
3.	GEOL ~~508~~ Mining and Engineering Geology	~~After the completion of this course, students will be able to:~~ • ~~Recognize geochemical, geological, geophysical sampling method to locate ore bodies.~~ • ~~Describe the suitable mining methods and time plan to carry out mining activity on different sites.~~ • ~~Explain the~~	~~**Section A**~~ ~~Introduction: Definition, basic concepts terminology and broad classification of mining methods. Geological factors considered for the selection of mining method viz. Alluvial/Surface mining, Quarrying, Open-cast mining and Underground mining methods.~~ ~~**Section B**~~ ~~Ore dressing and its importance, low grade ores and their beneficiation. Basic ore dressing operations viz. crushing, grinding, sizing, screening and classification. Concentration process, Magnetic and electrostatic separation, Gravity concentration, Froth Floatation, Amalgamation and Agglomeration.~~ ~~**Section C**~~ ~~Engineering properties of rocks and physical characteristics of building stones, concretes and other aggregates. Geological and geotechnical investigations, types and problems of major civil engineering structures: dams and reservoirs, bridges, highways and tunnels. Mass~~		**The course has been shifted to pool of discipline electives.**

		methods of ore processing and beneficiation. • **Consider the geological factors controlling the site selection for civil engineering projects.**	movement with special emphasis on landslides and causes of hillslope instability. Seismic design of buildings. **Recommended Books:** 1. Arogyaswamy, R.N.P. (1995) Courses in Mining Geology, Oxford and IBH Publishing Co., New Delhi. 2. Clark, G.B. (1967) Elements of Mining, Asia Publishing House, New Delhi. 3. Bell, F.G. (2009) Fundamentals of engineering Geology, BS Publications, Hyderabad 4. Gaudin, A.M. (1939). Principles of Mineral Dressing. McGraw Hill Pub. Co. Ltd. Bombay 5. Krynin, D.P. and Judd W.R. (1957) Principles of Engineering Geology and Geotechnique, McGrawHill, New York. 6. Luis Gonzalez de Vallejo and Mercedes Ferrer (2011) Geological Engineering, CRC Press, Netherland 7. McKinstry, H.E. (1972) Mining Geology, Prentice-Hall Inc, New York. 8. MT Maruthesha Reddy (2008) A Text Book of Applied Engineering Geology, New Age International Publishers, New Delhi 9. N ChennaKesavulu (2014) Text Book of Engineering Geology, Trinity Press, New Delhi 10. Prabin Singh (2008) Engineering and General Geology, SK Kataria& Sons, New Delhi 11. SubinoyGangopadhyay (2013) Engineering Geology, Oxford University Press, New Delhi 12. Thomas, L.J. (1978) An Introduction to Mining, Methuen of Australia, Sydney.		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
4.	**GEOL ____ Palaeontology**	**After the completion of this course, students will be able to:** • **Describe the characteristics and preservation of fossils.** • **Explain the evolution of life and their environment forms from fossil records.** • **Explain the morphology of microfossils and their application in determining palaeoclimate, sea level change.** • **Elucidate the geology of oil and gas reservoirs and their location.**	**Section A** Introduction and scope of Palaeontology. Concepts of taphonomy and biostratinomy. Principles of palaeoecology. Theories on origin of life. Principles of biogeography. Patterns and causes of Extinction. Concept and mechanism of speciation. **Section B** Modes of preservation of fossils. Collection, preservation and preparation of fossils. Fossil record and geological time scale. Evolution of Man, Horse and Elephant. Siwalik vertebrate fauna and Gondwana flora. Trace fossils. **Section C** Definition and scope of micro-palaeontology. Techniques in micro-palaeontology. Morphotaxonomy of Foraminifera, Ostracodes, Conodonts and Radiolaria. Importance of microfossils in stratigraphy, determination of palaeoclimatic environments and sea level changes in the geological past and the role of micro-palaeontology in oil exploration. **Recommended Books:** ~~1. Bignot, B. (1985) Elements of Microplaeontology,Grahm and Trottman, London~~ ~~2. Braiser, M.D. (1980) Microfossils, Geogrge Allen and Unwin, London~~ ~~3. Clarkson, E.N.K. (1998) Invertebrate Palaeontology and Evolution, Wiley-Blackwell, Singapore~~ ~~4. Cushman, J.A. (1940) The Foramanifera, their classification and use, Harvard University Press, Cambridge~~ ~~5. Glaessner, M.F. (1945) Principles of Micropalaeontology, Melbourne University Press, Melbourne~~ ~~6. Jain, P.C and Anantharaman, M.S. (2005) Palaeontology: Evolution and Animal Distribution.~~	**Section A** Introduction and scope of Palaeontology. Concepts of taphonomy and biostratinomy. Principles of palaeoecology. Theories of origin of life.Principles of biogeography. Patterns and causes of Extinction.Concept and mechanism of speciation. **Section B** Modes of preservation of fossils.Collection, preservation and preparation of fossils. Fossil record and geological time scale. Evolution of Man, Horse and Elephant.Siwalik vertebrate fauna and Gondwana flora. Trace fossils. **Section C** Definition and scope of micro-palaeontology.Techniques in micro-palaeontology. Morphotaxonomy of Foraminifera, Ostracodes, Conodonts, Radiolaria and diatoms. Importance of microfossils in stratigraphy, determination of palaeo environments and sea level changes in the geological past and the role of micro-palaeontology in oil exploration. **Recommended Books:** 1. **Armstrong, H. A., & Braiser, M.D. (2005). *Microfossil* (2nd ed.). Oxford, UK: Blackwell.** 2. **Bignot, B. (1985). *Elements of Microplaeontology*. London, UK: Graham and Trotman.** 3. **Clarkson, E.N.K. (1998). *Invertebrate Palaeontology and Evolution* (4th ed.). Singapore:Wiley-Blackwell.** 4. **Cushman, J.A. (1948). *The Foramanifera, their classification and use* (4th ed.). Cambridge, UK: Harvard University Press.** 5. **Glaessner, M.F. (1945). *Principles of Micropalaeontology*. Melbourne, Australia: Melbourne University Press.** 6. **Jain, P.C., & Anantharaman, M.S. (2005). *Palaeontology: Evolution and Animal Distribution* (6th ed.). New Delhi, India: Vishal.** 7. **Moore, R.C, Lalicker, C.G. & Fisher, A.G. (1997).**	**Reviewed learning outcomes and suggested e-learning materials** **As the scheme has been changed so it is considered as a new course** **Few modifications have been done**

			~~(6th edition), Vishal Publishing Co, New Delhi~~ ~~7. Moore,R.C, Lalicker, C.G & Fisher, A.G (1997) Invertebrate fossils. (1st Indian edition), CBS Publishers & Distributors, New Delhi.~~ ~~8. Prothero, D.R. (1998) Bringing Fossil to Life An Introduction to Palaeontology, McGraw Hill, New York~~ ~~9. Raup, D.M., and Stanley, S.M. (1985) Principles of Palaeontology, CBS Publications, New Delhi~~ 10. ~~Shrock,R.R and Twenhofel,W.H. (1987) Principles of Invertebrate Paleontology. McGraw Hill, New York~~	***Invertebrate fossils*. New Delhi, India:CBS.** 8. **Prothero, D.R. (2003). *Bringing Fossil to Life-An Introduction to Palaeontology* (3rd ed.). New York, NY: Columbia University Press.** 9. **Raup, D. M., & Stanley, S. M. (1985). *Principles of Palaeontology* (2nd ed.). New Delhi, India:CBS.** 10. **Shrock, R. R., & Twenhofel, W. H. (2005). *Principles of Invertebrate Paleontology* (2nd ed.). New York, NY: CBS.** **Suggested e-learning materials:** 1. **Fossils morphology https://www.palaeontologyonline.com/** 2. **Origin of life and evolution https://nptel.ac.in/courses/122103039/module2/lec6/4.html** **3. Taphonomy https://www.encyclopedia.com/science-and-technology/biology-and-genetics/biology-general/taphonomy**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
5.	**GEOL ~~510~~** **Stratigraphy**		**Section A** ~~History of stratigraphic nomenclature and the modern stratigraphic code.~~ Stratigraphic classification. Sequence stratigraphy, magneto-stratigraphy and ~~climate stratigraphy.Geochronology. Graphic representation of stratigraphic data.~~ Earth's climatic history. **Section B** ~~Early history of Earth.~~ Nature and evolution of early crust. ~~Evolution of granite, greenstone and grenulite belt.~~ ~~Proterozoic sedimentary basins of India: Cuddapah, Vindhyan and Bikaner Nagaur basin.~~ **Section C**		**Replaced by new course** **The course has been shifted to semester -II under**

			Stratigraphy of the Palaeozoic, Mesozoic and Cenozoic formations of India. Stratigraphy boundary problems in India: demarcation of Precambrian-Cambrian, Permian-Triassic, Cretaceous-Tertiary and Neogene-Quaternary boundaries in relation to mechanisms of extinction and evolution. **Recommended Books:** 1.~~Boggs,S.(1987) Principles of Sedimentology and Stratigraphy, Merrill, NewYork.~~ ~~1. Catuneanu, O. (2006) Principles of Sequence Stratigraphy, Elsevier, Italy~~ ~~2. Danbar, C.O. and Rodgers, J. (1957) Principles of Stratigraphy, John Wiley & Sons, New York~~ ~~3. Krishnan, M.S. (1982) Geology of India and Burma, CBS Publishers & Distributors, Delhi~~ ~~4. Lemon,R.R. (1990) Principles of Stratigraphy, Merrill Publication, New York~~ ~~5. Naqvi, S.M. and Rogers, J.J.W. (1987) Precambrian Geology of India. Oxford University Press, New York.~~ ~~6. Ramakrishnan, M and Vaidyanathan, R. (2010) Geology of India (Vol.1) Geological Society of India, Bangalore, 552pp~~ ~~7. Ravindra Kumar (1978) Historical Geology and Stratigraphy of India, New Age International Publishers Ltd. New Delhi.~~ ~~8. Rogers, J.J.W. (1993) A history of earth, Cambridge University Press, UK~~ ~~10.Vaidyanathan, R. and Ramakrishnan, M. (2010) Geology of India (Vol.2) Geological Society of India, Bangalore, 438pp~~		**new course scheme**

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
6.	**GEOL_____ Remote Sensing and GIS in**	**After the completion of this course, students will be able to:** • **Explain the**		**Section A** **Remote Sensing (RS): Principle and scope. Electromagnetic radiation– types and sources, Black body radiation. Absorption bands and Atmospheric windows. Remote Sensing Sensor: types and their resolution. General Orbital**	**Reviewed learning outcomes**

	Geology	**principles of platforms and sensor characteristics, satellite orbits and data characteristics.** • **Elucidate principles and applications of advance techniques including multispectral, hyperspectral, thermal-infrared, microwave remote sensing.** • **Describe the concepts and components of GIS and GPS.** • **Describe the applications of Geographical information System in various fields of geology.**		**characteristics of satellites. Sensor characteristics of remote sensing satellites: LANDSAT, IRS series (LISS and AWiFS), ASTER, Quickbird. Indian Planetary Missions.** **Section B** **Multispectral, Hyperspectral, Thermal Infrared, Microwave remote sensing: Introduction, Principle and applications in geology. Global Positioning System (GPS): Introduction and application in geology. Fundamentals of Digital Image Processing (DIP): Image rectification, Image enhancement and Image classification.** **Section C** **Principles and application of Geographic Information System (GIS). Components of GIS. Map projections-Types and properties. Raster and vector data models. Digital Elevation Model (DEM) and its applications in Geology.** **Recommended Books:** **1. Bonham-Carter, G. F. (1994). *Geographic Information System for Geoscientists: Modelling with GIS*. London, UK: Oxford Pergamon Press.** **2. Clarbe, C. K. (1997). *Getting started with Geographic Information System*. New York, NY: Prentice Hall.** **3. Demers, M.N. (1997). *Fundamentals of Geographic Information System*. New York, NY: John Wiley & Sons.** **4. Drury, S.A. (1987). *Image Interpretation in Geology*. London, UK: Allen and Unwin.** **5. George, J. (2005). *Fundamentals of Remote Sensing*. Hyderabad, India:Universities Press.** **6. Gupta, R. P. (2003). *Remote Sensing Geology*. Berlin, Germany: Springer–Verlag.** **7. Jain, A.K. (1989). *Fundamentals of digital image processing*. New Delhi, India: Prentice Hall.** **8. Jensen, J.R. (1996). *Introductory Digital Image Processing: A Remote Sensing Perspective*. Berlin, Germany: Springer-Verlag.** **9. Lillesand, T. M., & Kiefer, R.W. (2007). *Remote Sensing***	**and suggested e-learning materials** **As the scheme and nomenclature has been changed so it is considered as a new course**

				***and Image Interpretation*. New York, NY: John Wiley.** **10. Pandey, S.N. (1987). *Principles and Application of Photogeology*. New Delhi, India:Wiley Eastern.** **11. Prost, G.L. (1994). *Remote Sensing for Geologists: A guide to Image Intrepretation*. London, UK: CRC Press.** **12. Reddy, M.A. (2002). *Text book of Remote Sensing and Geographic Information System*. Hyderabad, India: B.S..** **13. Sabbins, F.F. (1985). *Remote Sensing-Principles and applications*. New York, NY: Freeman.** **14. Siegal, B.S., & Gillespie, A.R. (1980). *Remote Sensing in Geology*. New York, NY: John Wiley.** **Suggested e-learning materials:** **1. Introduction to GIS** **http://www.gisresources.com/iirs-e-learning-certificate-programmes-remote-sensing-geoinformation-sciences/** **2. Remote Sensing Basics** **https://www.iirs.gov.in/EDUSAT** **3. Introduction to GIS and hydrogeology** **https://epgp.inflibnet.ac.in/ahl.php?csrno=448**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
7.	**GEOL ___L Geology Lab-III with Field work**	**After the completion of this course, students will be able to:** **•Describe the morphological characters of invertebrates and vertebrate fossils.** **• Identify**	**Stratigraphy** a) Study of rocks in hand specimens from known Indian Stratigraphic horizons and type localities **Palaeontology** a) Study of morphological characters of some important Invertebrates fossils belonging to Brachiopoda, Gastropoda, Ammonoidea, Echinoidea and Corals b) Techniques of separation of Microfossils from matrix	**Remote Sensing and GIS in Geology** **1. Procurement of satellite data.** **2. Creating a standard FCC from satellite imagery.** **3. Creating spectral profiles using satellite imagery and its interpretation.** **4. Identification of landforms on topographic maps and satellite imagery.** **5. Registration of satellite data with a toposheet of the area** **6. Generating contrast stretched images.** **7. Classification of images based on supervised and**	**Reviewed learning outcomes and suggested e-learning materials**

		microfossils and their separation from matrix through microscope. **•Assessment of water quality and determination of aquifer properties.** **•Process and analyze remote sensing data.**	c) Study of larger benthic foraminifera d) Morphological study of microfossils ~~**Geochemistry and Isotope Geology**~~ ~~a) Calculation of atomic weight of elements with reference to isotopes~~ ~~b) Calculation and plotting of binding energy and neutron/proton ratios of various isotopes~~ ~~c) Problems related to radioactive decay of nuclides~~ ~~d) Determination of K-Ar ages~~ ~~e) Ages, initial ratios and plotting of isochrones using Rb-Sr and Sm-Nd isotope data~~ **Books Recommended**: ~~1. Bignot, B., (1985) Elements of Microplaeontology, Grahm and Trottman, London~~ ~~2. Braiser, M.D. (1980) Microfossils, Geogrge Allen and Unwin, London~~ ~~3. Chandra, D., Singh, R.M, Singh, M.P., (2000) Textbook of coal (Indian context), Tara book agency, Varanasi~~ ~~4. Clarkson, E.N.K., (1998) Invertebrate Palaeontology and Evolution, Wiley-Blackwell, Singapore~~ ~~5. Cushman, J.A. (1940) The Foramanifera, their classification and use, Harvard University Press, Cambridge~~ ~~6. Faure, G. and Mensing, T.M. (2005) Isotope, principles and applications. 3rd ed. John Wiley & Sons, New York.~~ ~~7. Glaessner, M.F. (1945) Principles of Micropalaeontology, Melbourne University Press, Melbourne~~ ~~8. Krishnaswamy, S., (1979) India's Mineral Resources, Oxford IBH Publications, New Delhi.~~ ~~9. Ravindra Kumar (1978) Historical Geology and Stratigraphy of India, New Age International Publishers Ltd. New Delhi.~~	**unsupervised and accuracy assessment.** **8. Creation of DEM and draping of satellite imagery.** **9. Generating slope map, aspect map and drainage network map** **Hydrogeology** **1. Delineation of hydrological boundaries on water table contour maps** **2. Determination of porosity of rocks.** **3. Determination of permeability of rocks.** **4. Estimation of specific retention and specific yield.** **5. Calculation of storage coefficient and transmissivity.** **6. Physical analysis of water (pH, EC and TDS)** **7. Chemical analysis of water (Anions and cations)** **8. Determination of relative hardness of water** **Palaeontology** 1. Study of morphological characters of some important Invertebrates fossils belonging to Brachiopoda, Gastropoda, Ammonoidea, Echinoidea and Corals 2. Techniques of separation of Microfossils from matrix 3. Study of larger benthic foraminifera 4. Morphological study of microfossils **Geological Field Work** *** Note: Scientific calculators are permitted during examination.** **Recommended Books:** **1. Bignot, B. (1985). *Elements of Microplaeontology*. London, UK: Grahm and Trottman.** **2. Braiser, M. D. (1980). *Microfossils*. London, UK: Geogrge Allen and Unwin.** **3. Clarkson, E. N. K. (1998). *Invertebrate Palaeontology and Evolution*. Singapore: Wiley-Blackwell** **4. Cushman, J. A. (1940). *The Foramanifera, their classification and use*. Cambridge, UK: Harvard University Press.** **5. Drury, S. A. (1987). *Image Interpretation in Geology*.**	**Systematic arrangement for better understanding of the subjects** **As the scheme has been changed so it is considered as a new course Few modifications have been done**

			~~9. Singh, M.P., (1998) Coal and Organic Petrology, Hindustan Publ. Corp., New Delhi.~~	**London, UK: Allen and Unwin.** **6. Glaessner, M. F. (1945). *Principles of Micropalaeontology*. Melbourne, Australia: Melbourne University Press.** **7. Karanth, K.R. (1989). *Hydrogeology*. New Delhi, India: Tata McGraw Hill.** **8. Nagabhushaniah, H. S. (2001). *Groundwater in Hydrosphere*. New Delhi, India:CBS.** **9. Pandey, S. N. (1987). *Principles and Application of Photogeology*. New Delhi, India: Wiley Eastern.** **10. Raghunath, H. M. (2014). *Groundwater*. New Delhi, India: New Age International.** **11. Ray, R. G. (1969). *Aerial Photographs in Geologic Interpretations*. USGS Prof. Paper 373.** **12. Sabbins, F. F. (1985). *Remote Sensing-Principles and applications*. New York, NY: Freeman.** **13. Siegal, B.S., & Gillespie, A.R. (1980) Remote Sensing in Geology. New York, NY:John Wiley.** **14. Todd, D. K., & Mays, L. W. (2004). *Groundwater Hydrology*. New Delhi, India: Wiley India.** **Suggested e-learning materials:** 1. **Microfossils http://www.ga.gov.au/scientific-topics/disciplines/palaeontology** 2. **Fossils Morphology: https://www.palaeontologyonline.com/** 3. **Introduction to GIS and hydrogeology https://epgp.inflibnet.ac.in/ahl.php?csrno=448**	

FOURTH SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
1.	**GEOL 501 Concepts of Remote sensing and GIS**	After the completion of this course, students should be able to: • Explain the principles of platforms and sensor characteristics, satellite orbits and data characteristics. • Elucidate principles and applications of advance techniques including multispectral, hyperspectral, thermal-infrared, microwave remote sensing. • Describe the concepts and components of GIS and GPS. • Describe the applications of Geographical information	**Section A** Remote Sensing: definition, principle and scope. Electromagnetic radiation- types and sources, Black body radiation. Absorption bands and Atmospheric windows. Interaction of EM radiation with Earth: Reflectance – Absorption Emittance and Transmittance. Remote Sensing Sensor: types and their resolution. Scanners, Platforms. Active and passive systems. Types of Satellites. International Space missions: LANDSAT, SKYLAB, SPOT, SEASAT, IKONOS, OCEANSAT. Space research in India: Bhaskara and IRS series. Indian Planetary Missions. **Section B** TIR remote sensing and its applications. Principles of microwave remote sensing and its applications. Radar interferometry. Multispectral and Hyperspectral remote sensing. Geographic positioning system (GPS): Introduction, definition and scope of GPS, advantages and uses of GPS in different fields. Fundamentals of digital image processing: Image rectification, Image enhancement and Image classification. **Section C** Principles and application of geographic information system (GIS), introduction, definition and scope. Components of GIS (hardware and software requirement for GIS application). Maps: Maps and their different features/themes/layers,Map projections-different types and their properties. Satellite Imageries: Raster and vector data. and their relative merits, digitization, topology and their attributes, overlays and analysis. Database: definition and types of database. Advantages and disadvantages of database approach..		**The nomenclature has been changed and shifted to Semester III**

		System in various fields of geology	**Recommended Books:** 1. Bonham-Carter, G.F. (1994) Geographic Information System for Geoscientists: Modelling with GIS, Oxford Pergamon Press, Pergamon 2. Clarbe, C. Kaith (1997) Getting started with Geographic Information System, Prentice Hall, New York 3. Demers, M.N., (1997) Fundamentals of Geographic Information System, John Wiley & Sons Inc., New York. 4. Drury, S.A. (1987) Image Interpretation in Geology, Allen and Unwin, London 5. George, J. (2005) Fundamentals of Remote Sensing, Universities Press, Hyderabad 6. Gupta, R. P. (2003) Remote Sensing Geology, Springer-Verlag, Berlin. 7. Jain, A.K. (1989) Fundamentals of digital image processing, Prentice Hall, New Delhi. 8. Jensen, J.R. (1996) Introductory Digital Image Processing: A Remote Sensing Perspective,Springer-Verlag, Berlin. 9. Lillesand, T. M. and Kiefer, R.W. (2007) Remote Sensing and Image Interpretation, JohnWiley, New York. 10. Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (1991) GIS – Principles and Applications, LongmanScientific and Technical, London. 11. Pande, S.N. (1987) Principles and Application of Photogeology, Wiley Eastern Ltd, New Delhi 12. Readdy, M.A. (2002) Text book of Remote Sensing and Geographic Information System, B.S. Publication, Hydrabad 13. Sabbins, F.F. (1985) Remote Sensing Principles and applications, Freeman, New York 14. Siegal, B.S and Gillespie, A.R. (1980) Remote Sensing in Geology, John Wiley, New York		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
2.	**GEOL 503 Environmental Geology and Hydrogeology**	After the completion of this course, students should be able to: • Explain the application of geologic information to the entire spectrum of interactions between people and physical environment. • Describe and mitigate the exposure of natural hazards on humans. • Explain the distribution and movement of groundwater in the soil and rocks of the Earth's crust. • Delineate hydrological cycle, related parameters and its parameter,	**Section A** Fundamental concepts of environmental Geology. Natural hazards: landslides, floods, earthquakes, Tsunami, volcanoes, and water logging. Environmental aspects of natural resource development: water resources, mineral resources and fossil fuels. **Section B** Pollution, their sources and types. Pollution of rivers, lakes and groundwater. Problem of Arsenic and fluoride and remedial measures for their treatment. Waste disposal practices and management. Waste water treatment. Watershed management. Artificial recharge of groundwater. Rain water harvesting. **Section C** Groundwater: origin and age of groundwater. Hydrological cycle, Precipitation, Evapotranspiration and Infiltration. Vertical distribution of groundwater. Aquifers: Geologic formation as aquifers and types of aquifers. Saline water intrusion: Occurrence, sea water intrusion in coastal areas and control of saline water intrusion. Groundwater regimes in India. Groundwater exploration. Well hydraulics. **Recommended Books:** 1. Bryant, E. (1985) Natural hazards, Cambridge University Press, London 2. David K. Todd and Larry W. Mays (2004) Groundwater Hydrology, Wiley India (New Delhi) 3. H.M. Raghunath (2014) Groundwater, New Age International Publishers, New Delhi 4. H.S.Nagabhushaniah, (2001) Groundwater in Hydrosphere, CBS Publishers and Distributors, New Delhi 5. Karanth, KR (1989) Hydrogeology, Tata McGraw Hill Publications, New Delhi		**The course has been removed from the curriculum**

		groundwater quality and exploration of groundwater.	6. Keller, E.A. (1978) Environmental Geology, Bell and Howell, USA 7. Smith, K., (1992) Environmental hazards, Routledge, London.		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
3.	**GEOL 506 L Geology Lab IV**	After the completion of this course, students will be able to: • Explain about digital image processing • Analyze and interpret remote sensing data. • Determine the average slope angle and river morphometry. • Assessment of water quality and determination of aquifer properties.	**Remote Sensing and GIS** a) Identification of landform on toposheets and satellite images. b) Analysis of satellite data in different bands and interpret various objects on the base of their spectral signature c) Digital Image Processing exercises including 1. Registration of satellite data with a toposheet of the area 2. Generating contrast stretched images from raw data 3. Creating a FCC from raw data 4. Classification of images based on supervised and unsupervised classification 5. Generation of DEM 6. Generating slope map, aspect map and drainage network map **Geomorphology** a) Drainage morphometry and determination of average slope angle **Environmental Geology and Hydrogeology** 1. Preparation of map showing seismic zones of India 2. Study of important Earthquakes of India 3. Preparation of map showing landslides and flood zones of India 4. Determination of porosity of rocks. 5. Determination of permeability of rocks. 6. Chemical analysis of water **Recommended Books:** 1. Drury, S.A. (1987) Image Interpretation in Geology,		**As per changed scheme the course has been removed.**

			Allen and Unwin, London 2. Pande, S.N. (1987) Principles and Application of Photogeology, Wiley Eastern Ltd, New Delhi 3. Ray, R.G. (1969) Aerial Photographs in Geologic Interpretations, USGS Prof. Paper 373 4. Sabbins, F.F. (1985) Remote Sensing Principles and applications, Freeman, New York 5. Siegal, B.S and Gillespie, A.R. (1980) Remote Sensing in Geology, John Wiley, New York 6. Thornbury, W.D. (1980) Principles of Geomorphology, Wiley Eastern Ltd., New York		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
4.	**GEOL 507 Geomorphology**	After the completion of this course, students should be able to: • Explain erosion and deposition features formed due to various geomorphic process • Delineate various climatic conditions that helps to modify the landforms. • Describe the application of geomorphology in	**Section A** Introduction to Geomorphology, fundamental concepts, geomorphic agents and processes. Fluvial geomorphic cycles. Weathering: types and weathering products. Soil: factors, soil profile and classification. Mass wasting and landslides. **Section B** Earthquakes and Volcanoes. Geomorphic models of landscape evolution.Erosional and depositional landforms: fluvial, glacial, aeolian, coastal and karst landscape. **Section C** Geomorphic mapping, slope analysis, drainage patterns and morphometric analysis: stream ordering, bifurcation ratio, drainage density. Geomorphology of India-Peninsular, extra peninsular and Indo-Gangetic Plain. Application of geomorphology in mineral prospecting, civil engineering, hydrology and oil		**As per changed scheme the course has been changed and shifted to semester I under revised scheme**

		multidiscipline such as civil engineering, hydrology. • Explain the interaction between climate, tectonics and sea level interaction in fluvial environment.	exploration. **Recommended Books:** 1. Pitty, A.F. (1971) Introduction to geomorphology, Methuen, London. 2. Holmes, A. (1992) Principles of Physical Geology edited by P. McL. D. Duff. Chapman and Hall, London 3. Leopold, L.B. (1976) FluviaL processes in geomorphology. E.P.H.Publishing House, New Delhi 4. Allision, R.J. (2002) Applied Geomorphology, Wiley and Sons, New York 5. Sharma, H.S. (1990) Indian Geomorphology, Concept Publishing Co. New Delhi. 6. Thornbury, W.D. (1980) Principles of Geomorphology, Wiley Eastern Ltd., New York		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
1.	**GEOL ___D Dissertation**	**After the completion of this course, students will be able to:** • **Describe the recent development and advanced techniques in geology leading to practical implementation to solve complex research problems.** • **Interact and work in academic, research and industrial environment.** • **Use different interpretation skills and data processing techniques to solve real time research problems.** • **Synthesize the outcomes in form of written manuscripts.**	~~The dissertation will be evaluated by internal and external members.~~ ~~The internal committee three members and external will evaluate the dissertation as report, presentation and via voce.~~ ~~The marks of continous assessment will be sent by internal committee members.~~		**Replaced by new course scheme** **Now introduced for the full semester**

List of Discipline Electives					
S.N	**Course List**	**Learning Outcomes**	**Existing Syllabus**	**Suggested Syllabus**	**Remarks**
1.	**GEOL ____ Environmental Geology**	**After the completion of this course, students will be able to:** • **Explain the application of geologic information to the entire spectrum of interactions between people and physical environment.** • **Describe and mitigate the exposure of natural hazards on humans.** • **Elucidate several types of pollutions and their sources.** • **Explain the vulnerability of natural hazards.**		**Section A** **Fundamental concepts of Environmental Geology. Introduction to Natural hazards: Causes and Impact. Types of Hazards. Earthquakes, Tsunami, volcanoes, Landslides and Floods.** **Section B** **Natural Resources. Environmental aspects of natural resource development and Management: Water resources, Mineral resources and Fossil fuels..** **Section C** **Pollution, their sources and types. Air Pollution, Pollution of rivers, lakes and groundwater.** **Recommended Books:** **1. Bryant, E. (1985). *Natural hazards*. London, UK: Cambridge University Press.** **2. Keller, E.A. (1978). *Environmental Geology*. New Jersey, NJ: Bell and Howell.** **3. Montgomery, C.W. (2011). *Environmental Geology*. New York, NY: McGrawHill.** **4. Reichard, J. S. (2011). *Environmental Geology*. New York, NY: McGrawHill.** **5. Smith, K. (1992). *Environmental hazards*. London,UK: Routledge.** **Suggested e-learning materials:** **1. Environment science** **https://epgp.inflibnet.ac.in/ahl.php?csrno=448** **https://nptel.ac.in/courses/105105106/**	**Introduction of pool of discipline electives**

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
2.	**GEOL ___** **Fuel Geology**	**After the completion of this course, students will be able to:** • **Explore coal deposits, their mode of occurrences, structures in coal seams and application of coal petrography.** • **Describe the geology of petroleum reservoirs, prospective and their exploration techniques.** • **Describe the source of radioactive minerals, chemistry, prospects and exploration techniques.** • **Provide feasible solutions for radioactive waste**		**Section A** Definition, origin, types and rank of coal. Mode of occurrences and structures in coal seam. Coal petrography. Indian coal deposits. Introduction to Coal bed methane. **Section B** Origin, composition, migration and entrapment of natural hydrocarbons. Properties of source and reservoir rocks. Porosity: Types and classification and Permeability: Types. Reservoir traps: structural, stratigraphic and combination traps. Geographical and geological distributions of onshore and offshore petroliferous basins of India. **Section C** Mineralogy and geochemistry of radioactive minerals. Distribution of radioactive minerals in India. Sources and classification of radioactive waste. Radioactive waste management. **Recommended Books:** **1. Acharyya, S.K. (2000). *Coal and Lignite Resources of India: An overview*. Bangalore, India: Geological Society of India.** **2. Aswathanarayana, U. (1985). *Principles of Nuclear Geology*. New Delhi, India: Oxford Press.** **3. Boyle, R.W. (1982). *Geochemical prospecting for Thorium and uranium deposits*. Amsterdam & New York, Elsevier.** **4. Chandra, D., Singh, R.M., & Singh, M.P. (2000). *Textbook of coal (Indian context)*. Varanasi, India: Tara.** **5. Dahlkamp, F.J. (1993). *Uranium Ore Deposits,* Berlin**	**Introduction of pool of discipline electives** **The course has been shifted from semester-I and now introduced as pool of discipline electives** **Reviewed learning outcomes and suggested e-learning**

		management.		Heidelberg, Germany: *Springer-Verlag*. 6. Durance, E. M. (1986). *Radioactivity in Geology-principles and application*. Chichester, UK: Ellis Hoorwool. 7. Francis, W. (1961). *Coal*. London, UK: Edward Arnold. 8. Holson, G. D., & Tiratso E.N. (1985). *Introduction to Petroleum Geology*, Houston, TX: Gulf. 9. Krishnaswamy, S. (1979). *India's Mineral Resources*. New Delhi, India: Oxford IBH. 10. Levorsen, A. L. (1967). *Geology of Petroleum* (2nd ed.). San Francisco, CA: Freeman. 11. KDMIPE ONGC. (1986). *Petroliferous basins of India*: Dehradun, India: India Petroleum. 12. Selley, R.C. (1998). *Elements of Petroleum Geology*. San Diego, CA: Academic Press. 13. Singh, M.P. (1998). *Coal and Organic Petrology*. New Delhi, India: Hindustan. 14. Tissot, B.P., & Welte D.H. (1984). *Petroleum formation and occurrence* (2nd ed.). Berlin Heidelberg, Germany: Springer-Veralg. **Suggested e-learning materials:** 1. Fossil fuels https://opentextbc.ca/geology/chapter/20-3-fossil-fuels/ 2. Petroleum and CBM http://oilandgasgeology.com/	materials Few modifications have been done

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
3.	GEOL ___ Marine Geolgy	After the completion of this course, students will be able to: • To introduce		Section A History of development of Marine Geology, Salinity and Density of Ocean Water, Residence times of elements in sea water. Water Masses, types their formation, Ocean Circulation, Coriolis Effect and Ekman spiral, convergence,	Introduction of pool of discipline elective

		various aspects of marine geology including physical, chemical, biological, geological in particular and concepts of Palaeoceanography. • **Interpret the sedimentary process leading to deposition of sediments found in different water depths and marine settings.** • **Explain the major ocean driving forces and significance of sea-level changes in the geological record.** • **Recognize the**		**divergence and upwelling, Currents of Indian, Pacific and Atlantic Ocean. El Nino, Thermohaline circulation and oceanic conveyor belt. Tides, Opening and closing of ocean gateways during Cenozoic.** **Section B** **Ocean Sediments: Meaning, classification based on size and source, Factors controlling the deposition and distribution of oceanic sediments. Classification of the marine environment and marine organisms, Physio-chemical factors affecting marine life – light, temperature, salinity, pressure, nutrients, dissolved gases, adaptation and biological processes. Marine pollution: causes, effect and measures. Ocean resources: Gas hydrate, Manganese nodule, Phosphorite and Placer deposits.** **Section C** **Morphologic and tectonic domains of the ocean floor: Structure, composition and mechanism of the formation of oceanic crust, Hypsometric curves and Major relief features. Seawater- basalt interactions, Hydrothermal vents. Palaeoceanography – approaches to palaeoceanographic reconstructions; proxy indicators for palaeoceanographic interpretation. Joint Global Ocean Flux Study (JGOFS) and its applications in Palaeoceanography..** **Recommended Books:** **1. Davis, R. J. A. (1986). *Oceanography-An Introduction of the Marine Environment* (2nd ed.). Iowa, IA: Win C. Brown.** **2. Garrison, T. (2009). *Essentials of Oceanography* (5th ed.). California, CA: Brooks/Cole Cengage Learning** **3. Erickson, J. (2003). *Marine Geology- Exploring the New Frontiers of the Ocean* (Revised ed.). New York, NY: Facts on File, Inc.** **4. Lal, D. S. (2015). *Oceanography* (Revised ed.). Allahabad, India: Sharda Pustak Bhawan.**	**Reviewed learning outcomes and suggested e-learning materials**

		role of proxy indicators for paleo oceanographic interpretation.		**5. Pinet, P. R. (2016) *Invitation to Oceanography* (7th ed.). Massachusetts, MA: Jones and Bartlett** **6. Riley, J. P. and Chester, R. (1971). Introduction to Marine Chemistry. New York, NY: Academic Press,** **7. Sidhartha, K. (1999) *Oceanography: Brief Introduction*. New Delhi, India: Kisalya** **8. Trujillo, A. P. and Thurman, H. V. (2014). *Essentials of Oceanography* (12th ed.). Pearson** **Suggested e-learning materials:** **1. Elements of Ocean Engneering https://nptel.ac.in/courses/114105002/** **2. Oceanography https://epgp.inflibnet.ac.in/ahl.php?csrno=10** **3. Basalt — Seawater Interaction https://link.springer.com/chapter/10.1007/978-1-4899-0402-7_11** 4. **Introduction to Observational Physical Oceanography https://ocw.mit.edu/courses/earth-atmospheric-and-planetary-sciences/12-808-introduction-to-observational-physical-oceanography-fall-2004/**	

S.N	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
4.	**GEOL ____ Mining and Engineering Geology**	**After the completion of this course, students will be able to:** • **Explain the Recognize geochemical, geological, geophysical sampling method**		**Section A** Introduction: Definition, basic concepts and classification of mining methods. Detail study of surface mining methods: Open pit, Quarrying, Auger and placer Mining. Underground Mining Methods: Room and Pillar method, Sublevel stopping, cut and fill stopping, Square set stopping and Block Caving Methods. **Section B** Ore dressing and its importance. Basic ore dressing operations viz. crushing, grinding, sizing, screening and classification. Concentration process, Magnetic and electrostatic separation,	**Introduction of pool of discipline electives** **The course has been redefined**

		to locate ore bodies. • **Describe the suitable mining methods and time-plan to carry out mining activity on different sites.** • **Explain the methods of ore processing and beneficiation.** • **Consider the geological factors controlling the site selection for civil engineering projects.**		Gravity concentration, Froth Floatation, Amalgamation and Agglomeration. **Section C** Engineering properties of rocks and physical characteristics of building stones, concretes and other aggregates. Geological and geotechnical investigations, types and problems of major civil engineering structures: dams and reservoirs, bridges, highways and tunnels. Mass movement with special emphasis on landslides and causes of hillslope instability. Seismic design of buildings. **Recommended Books:** **1. Arogyaswamy, R.N.P. (1995). *Courses in Mining Geology* (4th ed.). New Delhi, India: Oxford and IBH.** **2. Bell, F.G. (2009). *Fundamentals of engineering Geology*. Hyderabad, India: BS.** **3. Clark, G.B. (1967). *Elements of Mining* (3rd ed.). New Delhi, India: John Wiley.** **4. Gangopadhyay, S. (2013). *Engineering Geology*. New Delhi, India: Oxford University Press.** **5. Gaudin, A.M. (1939). *Principles of Mineral Dressing*. Bombay, India: McGraw Hill.** **6. Kesavulu, C. N. (2009). *Text Book of Engineering Geology* (2nd ed.). New Delhi, India: Trinity Press.** **7. Krynine, D.P., & Judd W.R. (1957). *Principles of Engineering Geology and Geotechnique*. New York, NY: McGrawHill.** **8. McKinstry, H.E. (1972). *Mining Geology*. New York, NY: Prentice-Hall Inc.** **9. Prabin, S. (2014). *Engineering and General Geology*. New Delhi, India: SK Kataria & Sons.** **10. Reddy, M.M.T. (2007). *A Text Book of Applied Engineering Geology*. New Delhi, India: New Age International.** **11. Thomas, L.J. (1978). *An Introduction to Mining :***	**as discipline electives** **Reviewed learning outcomes and suggested e-learning materials** **Few modifications have been done** **Shifted from semester III**

				***exploration, feasibility, extraction, rock mechanics*. Sydney, Methuen of Australia.** **12. Vallejo, L. G. D., & Ferrer, M. (2011). *Geological Engineering*. Netherland: CRC.** **Suggested e-learning materials:** **1. Prospecting for Economic Minerals-Drilling, Sampling, Assaying. http://vidyamitra.inflibnet.ac.in/content/index/5a6f0e258007bef961f76b4f/SL** **2. Stress and strain behavior of material https://nptel.ac.in/courses/105105106/20#** **3. Dam https://epgp.inflibnet.ac.in/ahl.php?csrno=448**	

List of Reading Electives					
S.N.	**Course List**	**Learning Outcomes**	**Existing Syllabus**	**Suggested Syllabus**	**Remarks**
1.	**ENVS_____R Agroforestry**	**After completion of this course students should be able to:** **• Describe agroforestry and agroforestry interventions.** **• Assess the role of Agroforestry as a sustainable land-use activity.** **• Describe Nutrient cycling and role of**		**Agroforestry - definition and scope. Tropical deforestation, rising demands of fuel wood, fodder and timber, social, ecological and economic reasons for agroforestry. Traditional agroforestry systems: shifting cultivation, taungya, homegardens. Recent trends in Silviculture and Energy plantations. Trees in agricultural fields and farm boundaries. Commercial crops under shade of planted trees as well as natural forests. Agroforestry for wasteland development and temperate agroforestry practices. Nutrient cycling and role of agroforestry in soil and water conservation, Nitrogen fixation, improvement in soil physico-chemical properties. Soil organic matter status and soil organic matter, Soil fertility considerations in agroforestry nutrient needs of trees and crops.** **Recommended Books:**	**Introductio n of pool of reading electives**

		agroforestry in soil and water conservation • Describe various energy plantation methods.		1. Chundawat, B. S., & Gautam, S. K. (2016). Textbook of Agroforestry. New Delhi, India: Oxford & Ibh. 2. Jose, S. (2009). Agroforestry for Ecosystem Services and Environmental Benefits (Advances in Agroforestry). Netherlands, Dordrecht: Springer. 3. Mukherjee, A. (2016). Agroforestry and Watershed Management: An Interlocked System. New Delhi, India: Random. 4. Raj, A. J. (2017). Agroforestry Theory and Practices. Jodhpur, India: Scientific. Suggested e-learning materials: 1. Introductory Agroforestry, e-KrishiShiksha http://ecoursesonline.iasri.res.in/course/view.php?id=157 2. Forestry Technologies http://agritech.tnau.ac.in/forestry/agroforestry_index.html	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
2.	ENVS_____R Energy Resources & Conservation	After completion of this course students should be able to: • Describe the non-conventional sources of energy. • Explain concepts on energy utilization and conservation. • Emphasize energy conservation strategies in		Introduction: Energy, work and power. Classification of energy resources, An overview of the current global and National Energy Scenario. Fossil Fuels: Sources, exploration of oil, coal, natural gas, shale; Exploitation of Fossil fuels and their Environmental consequences. Nuclear Energy: Nuclear fission and Fusion; Nuclear fuel cycle, Nuclear reactor and nuclear power, Renewable and Alternative Energy Sources, Solar energy, Solar power, Photovoltaic cells; Wind power; Geothermal energy; Ocean energy. Environmental consequences of biomass resource harnessing, Energy Conservation: National Energy Policy, Energy efficient appliances, BEE Label, Modes of Energy Conservation in residential, industrial and transportation sector. Recommended Books:	Introduction of pool of reading electives

		residential, industrial and transportation sector. • Describe National Energy Policy.		1. Agarwal, S. K. (2003). *Nuclear Energy: Principles Practice and Prospects.* New Delhi, India: APH. 2. Chaturvedi, P. (1995). *Bio-Energy Resources.* New Delhi, India: Concept. 3. Dayal, M. (1997). *Renewable Energy: Environment and Development.* New Delhi, India: Konark. 4. Mahajan, V. S. (1991). *National Energy: policy, crisis and growth*. New Delhi, India: Ashish. 5. Markuszewski, R., &Blaustein, B. D. (1986). *Fossil fuels utilization. Environmental concerns*. Washington, DC: American Chemical Society. 6. Vandana, S. (2002). *Alternative Energy.* New Delhi, India: APH. Suggested e-learning materials: 1. Biodiesel production https://nptel.ac.in/courses/102105058/52 2. Sustainability through Green Manufacturing Systems: An Applied Approach (Video) https://nptel.ac.in/courses/112104225/22	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
3.	ENVS_____R Man and Environment	After the completion of this course, students should be able to: • Describe the complex interactions of humans and ecological systems in the natural world.		Human Population, its Growth and Distribution, Environmental Deterioration associated with population growth, Man Induced Environmental Changes, Types of Human Activities, Impact of Human Activities such as Deforestation, Mining and Industrialization. Environmental Awareness- Need and Role in Betterment of Environment Concept and Significance of Environmental Movements, Environmental Movements in India with special reference to The Bishnoi Movement, Chipko Movement, Appiko Movement, Narmada Bachao Andolan, Silent Valley Movement. Components of natural and built environment:	Introduction of pool of reading electives

		• Synthesize, and apply a wide range of scientific literature in the ecological and environmental science. • Interpret a wide range of scientific literature in ecology and environmental science. • Apply the information in the realms of environmental sciences and sustainability.		Resources and human settlements, modifications in natural environment, causes and consequences. Recommended Books: 1. Bal Anand, S. (2005). *An Introduction to Environmental Management*. Mumbai, India : Himalaya. 2. Chandana, R. (2008). *A Geography of population*. New Delhi, India: Kalyani. 3. Chopra, G. (2006). *Population Geography*. New Delhi, India: Commonwealth. 4. Chorley, R. J., Schumm, S. A., & Sugden, D. E. (1984). *Geomorphology*. London, UK: Methuen and Company. 5. Dayal, P. (1994). *A Text Book of Geomorphology*. New Delhi, India: Kalyani. 6. Rapoport, A. (2016). *Human aspects of urban form: towards a man—environment approach to urban form and design*. Oxford, UK: Elsevier Pergamon Press. Suggested e-learning materials: 1. Environment and Ecology https://nptel.ac.in/courses/122102006/ 2. Lecture-35_Ecological Degradation and Environmental Protection https://nptel.ac.in/courses/109104045/35#	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
4.	ENVS_____R Water and Sustainable Development	After the completion of this course, students should be able to: • Classify major causes of exploitation of water resources, particularly in		Water and sustainable development. Water and human health – Access to safe drinking water and sanitation; public health issues. Water and food production – Role of irrigation in food security. Shifts in cropping patterns, Rain-fed agriculture, increasing use of groundwater. Environmental, economic and social implications of over exploitation of ground water resources. Water and human amenities – Urban water supplies; exploitation, conservation and rainwater harvesting. Wetland, its use and abuse with	Introduction of pool of reading electives

		the Indian and Asian context. • Summarize rainwater harvesting and water conservation measures. • Describe methods of Irrigation management. • Describe importance of Wetlands and its conservation.		Ramsar Convention. Urban floods, storm water drainage and integrated urban water management (IUWM). Irrigation management – canals and micro-irrigation. Recommended Books: 1. Asawa, G. L. (2005). *Irrigation and Water Resources Engineering*, New Delhi, India: New Age. 2. Biswas, A. K., Jellau, M., & Stout, G. (1993). *Water for sustainable development in 21st century – A Global perspective*. Oxford, UK: Oxford University Press. 3. David, L. F. (2007). *Water Policy for Sustainable Development*. Baltimore, Maryland: Johns Hopkins University Press. 4. Jain, S. K., & Singh, V. P. (2003). *Water Resources Systems Planning and Management*. Amsterdam, Netherlands: Elsevier. Suggested e-learning materials: 1. Water, Society and Sustainability https://onlinecourses.nptel.ac.in/noc18_hs36/preview 2. Irrigation Efficiencies - II and Irrigation Methods and their Suitability https://nptel.ac.in/courses/105102159/15	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
5.	GEOG_____R Environmental Challenges and Disaster Management	After the completion of this course, students should be able to: • Explain approaches to study environmental		Environment:-Definition and types of Environment; Environmental Development Crisis:-Introduction and its causes; Energy Crisis:- Concept, Causes and Remedies; Environmental issues associated with Green Revolution; Impact of Urbanization on Environment. Deforestation:- Concept, Causes, Effects and Conservation; Desertification:- Concept, Causes, Impacts and Preventions; Water Scarcity:- Causes; Methods of Rain Water Harvesting (special	Introduction of pool of reading electives

		development and crisis. • Describe world energy crisis with its causes and suggested measures for improvement. • Describe several environmental problems their causes, consequences and mitigation. • Depict the major disasters and their management with the help of case studies.		reference to Traditional Methods); Acid Rain:- Causes, Consequences and Mitigation Measures; Solid Waste:- Introduction, Types and Management. Disaster:- Definition and Classification; Natural Disaster:- Nature and Types; Flood:- Causes, Impacts and Methods of Management; Earthquake:- Introduction, Types, Causes, Effects and Mitigation; Case Studies:- Bhuj Earthquake-2001,Tsunami (Southern India)-2004 and Kedarnath Disaster-2013. * Note – Stencils are to be permitted during the examination. Recommended Books: 1. Gautam, A. (2010). *Environmental Geography.* Allahabad, India: Sharda Pustak Bhawan. 2. Ghosh, G. K. (2015). *Disaster Management.* New Delhi, India:A.P.H. 3. Singh, S. (2002). *Physical Geography*. Gorakhpur, India: Vasundhara. Suggested e-learning materials: 1. Deforestation:- Concept, Causes, Effects https://www.livescience.com/27692-deforestation.html 2. Acid Rain:- Causes, Consequences and Mitigation Measures https://www.conserve-energy-future.com/causes-and-effects-of-acid-rain.php 3. Solid Waste:- Introduction, Types and Management https://www.indiawaterportal.org/topics/solid-waste	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
6.	GEOG____R India: Socio-Political and Environmental Scenario	After the completion of this course, students should be able to:		Relation of India with neighbouring countries and border disputes with China and Pakistan. Drought problems, Interlinking of rivers as a solution of water crises and disputes of river water sharing with reference to Narmada, Krishna, Cauvery and Sutlej-Yamuna Link (SYL). Problems	Introduction of pool of reading

		• Understand the current issues related with boundaries, water sharing, agricultural disparities, food security in India. • Describe problems in Agricultural Development. • Discuss Gender Issues and women Safety. • Find the role of non – conventional energy resources for solving energy crisis.		and disparities in agricultural development and farmer suicides in India. Energy crisis in India and its solution with the help of nuclear, solar, hydro and wind power. Gender issues and women safety, poverty and unemployment. **Recommended Books:** 1. Deshpande, C. D. (1992). *India, A Regional Interpretation*. New Delhi, India: ICSSR & Northern Book Centre. 2. Gallaher, C. et al. (2012). *Key Concepts in Political Geography* (Reprint). New Delhi, India: Sage. 3. Hussain, A. (2007). *Political Geography*. New Delhi, India: Vishvabharti. 4. Singh, R. L. (Ed.).(1971). *India - A Regional Geography*. Varanasi, India: National Geographical Society. 5. Tirtha, R., & Gopal, K. (1996). *Emerging India*. Jaipur. India: Rawat. 6. बंसल, एस. सी. (2011). *भारत का भूगोल*. मेरठ, भारत: मीनाक्षी. **Suggested e-learning materials:** 1. Interlinking of rivers https://www.geoecomar.ro/website/publicatii/Nr.19 2013/12_mehta_web_2013.pdf 2. Farmer suicides http://www.ipcinfo.org/fileadmin/user_upload/fsn/docs/Ag riculture%20and%20rural%20development%20in%20In dia.pdf 3. Food Security https://dfpd.nic.in/LwB3AHIAaQB0AGUAcgBlAGEAZA BkAGEAdABhAC8AUABvAHIAdABhAGwALwBNAGE AZwBhAHoAaQBuAGUALwBEAG8AYwB1AG0AZQBu AHQALwA=1_93_1_Original.pdf 4. Gender Issues in India https://www.indiacelebrating.com/social-issues/gender-inequality-in-india/	electives

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
7.	GEOG_____R Rajasthan: Challenges and Prospects	After the completion of this course, students should be able to: • Describe the major environmental, socio economic problems of Rajasthan. • Explain desertification, Aravalli development, agriculture and tourism of Rajasthan. • Analyze existing state and national policies in terms of socio economic conditions. • Aware society regarding existing policies related to child marriage, Female feticide and other social problems.		Major Canal Irrigation Project and Its impact; Desertification and Desert Development programmes; Identification of drought prone areas and mitigation, problem of mining and Aravalli Development Programme, Problems and measures of Agricultural development; Programmes for forest conservation; Poultry farming, Planning for livestock development; Role of Tourism in the economy. Socio- economic issues and Government policies and programmes: child marriage, female feticide, female education, gender discrimination and caste; unemployment and poverty . Recommended Books: 1. Singh, G. (2010). *Geography of India* (9th ed.). Delhi, India: Atma Ram. 2. शर्मा, आर. (2010). *राजस्थान का भूगोल.* उदयपुर, भारत: हिमाशुं. 3. शर्मा एच. एस., एवं शर्मा, एम. एल. (2015). *राजस्थान का भूगोल.* जयपुर, भारत: पचंशील. 4. सक्सैना, एच. (2014). *राजस्थान का भूगोल.* जयपुर, भारत: राजस्थान हिन्दी ग्रंथ अकादमी. Suggested e-learning materials: 1. Indira Gandhi Canal https://www.rajras.in/index.php/indira-gandhi-canal/ 2. tourist spots in Rajasthan http://www.transindiatravels.com/rajasthan/tourist-places-to-visit-in-rajasthan/ 3. Problem of Desertification http://www.cazri.res.in/annals/1993/1993JA-1.pdf.	Introduction of pool of reading electives

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
8.	GEOG_____R Transforming India	After the completion of this course, students should be able to: • Assess the ongoing governmental policies applicable to socio-economic and health sectors. • Aware society about the injustice caused to women in terms of Triple Talaq. • Explain current livelihood struggle in the society and the role of skill development in enhancing quality of life. • Suggest the measures of improvement in the policies.		Transforming India into a digitally empowered society and development through digitalization, its effects and problems. Demonetization- a step to less cash to cash less economy. Indian youth as a change agent and quality of education for empowering Indian youth, Skill development and empowering youth, Population pressure in job sector and creating livelihood opportunities. Swachh Bharat Mission and Sanitation revolution for clean and healthy society, Ayushman Bharat Yojana- a step towards Health for all. Beti Bachao Beti Padhao- a step for girls development and Triple Talaq in India- an injustice for women or religious issue. Recommended Books: 1. Ghosh, J., Chandrashekra, C. P., & Patnaik, P. (2017). *Demonetisation Decoded*. NewYork, NY: Routledge. 2. Panigrahi, R. L. (2005). *Population problems in India*. New Delhi, India: DPH. 3. Sinha, M., & Sinha, R. K.(Ed). (2008). *Swach Bharat, A clean India*. New Delhi, India: Prabhat. Suggested e-learning materials: 1.Transforming India http://transformingindia.in/ 2.Digital India https://www.indianeconomy.net/splclassroom/what-is-digital-india/ 3.Demonetization http://www.mbauniverse.com/group-discussion/topic/business-economy/demonetisation 4.Skill Development in India https://www.indiainfoline.com/article/article-latest/skill development-in-india-gaps-and-opportunities 118092700366_1.html 5.Swachh Bharat Misson	Introduction of pool of reading electives

				https://www.mapsofindia.com/my-india/society/swachh-bharat-abhiyan-making-india-clean-more 6. BetiBachao and BetiPadhao http://www.mbauniverse.com/group-discussion/topic/social-issues/beti-bachao-beti-padhao	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
9.	GEOL_____R Geo Tourism	After the completion of this course, students should be able to: • Elucidate the criterion require for designating geotour sites. • Explore the geological and geographical attributes of the geosites. • Develop a geo-conservation plan for geotour sites. • Evaluate the potential of geosites for revenue generation.		Definition and scope of Geotourism. Principles of Geotourism. Geoconservation Plans. Introduction to geodiversity and Geopark. UNESCO's Global Geopark development program. Overview of GSI monuments and geotour sites-Sendra Granite of Pali District Rajasthan, Lonar Lake of Buldana District Maharastra, Peninsular Gneiss at Lalbagh Bangalore Karnataka, Natural Arch in Tirumala hills Chitoor District, Barr Conglomerate Pali District Rajasthan, Marine Gondwana Fossil Park, Fossil Wood Parks, Siwalik Fossil Park, Stromatolite Parks, Columnar Basalt, Pillow Lava, Pyroclastic Rocks, Nepheline Syenite, Welded Tuff, Charnockite, Great Boundary Fault, Eparchaean Unconformity, Tirumala hills. World's major geotour sites. Recommended Books: 1. Chen, A. (2015). *The Principles of Geotourism*. Beijing, China: Springer-Verlag. 2. Dowling, R., & Newsome, D. (Eds.). (2018). *Handbook of Geotourism*. Gloucestershire, UK: Edward Elgar. 3. Dowling, R., & Newsome, D. (Eds.). (2005). *Geotourism*. Oxford, UK: Elsevier. 4. Newsome, D., & Dowling, R. (Eds.). (2010). *GEOTOURISM: The Tourism of Geology and Landscape*. Oxford, UK: Goodfellow. Suggested e-learning materials	Introduction of pool of reading electives

				1. UNESCO geological heritage and geo-tourism in Peru http://www.unesco.org/new/en/media-services/single view/news/unesco_geoparks_geological_heritage_and_geo_ tourism_in_peru/ 2. Geotourism https://link.springer.com/referenceworkentry/10.1007%2F 978-3-319-01669-6_93-1 3. Geotourism in India https://www.gsi.gov.in	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
10.	GEOL_____R Indian Mineral Deposits, Economics and Mining Ethics	After the completion of this course, students should be able to: • Explain the distribution of mineral resources in India. • Evaluate the mineral resources and reserves in Indian and global perspective. • Familiarize with the concept of mineral legislation and policies. • Delineate the		Introduction to types and distribution of various mineral deposits in India. Occurrences of important metallic, non-metallic/industrial and fuel mineral deposits of India. Mineral economics and its major concept. Introduction for Global mineral resources. Conservation and substitution of minerals; changing pattern of mineral consumption, Growth of mineral industry and economy, Mineral industry and its adverse effect to the environment. Environmental baseline data needed for mine planning-Its acquisition and documentation during different stages of exploration. Nature and extent of environmental problems due to surface and underground mining. Legislation and control measures for mining. Mineral legislation in Indian context (The Mines and Minerals Regulation and Development Act, 1957). Reclamation and restoration of mined land. Recommended Books: 1. Arogyaswamy, R. N. P. (1995). *Courses in Mining Geology* (4th ed.). New Delhi, India: Oxford and IBH. 2. Banerjee, D. K. (1998). *Mineral Resources of India* (2nd	Introduction of pool of reading electives

		different environmental issues associated with mining activities.		ed.). Kolkata, India: The World Press. 3. Chatterjee, K. K. (1993). *An Introduction to Mineral Economics* (2nd ed.). Bangalore, India: New Age International. 4. Sharma, N. L., & Ram, K. S. V. (1964). *Introduction to India's economic minerals*. Dhanbad, India: Dhanbad. 5. Sinha, R. K., & Sharma, N. L. (1988). *Mineral Economics* (4th ed.). New Delhi, India: Oxford & IBH. Suggested e-learning materials: 1. Mineral and energy resources http://ncert.nic.in/ncerts/l/legy207.pdf 2. Economic Minerals of India https://www.researchgate.net/publication/315831629_Economic_Minerals_of_India	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
11.	GEOL _____R Innovation and Entrepreneurship in Earth Sciences	After the completion of this course, students should be able to: • Understand necessary steps to open a new venture. • Gain an understanding of creating products or services, launching innovative projects and making R&D investments in a startup context. • Develop marketing		An overview of Entrepreneurs and Entrepreneurship. Evolution and Growth of Earth Science. Entrepreneurship in India, Starting small business. Planning-Organization and Management. Basic layout of Proposal for seeking loan from financial institution, Legal requirements, Basic Financial Planning and problems. Case study of successful Earth Science Entrepreneurs in India. Earth Science component in Government of India PSU (MECL, NHPC Mini Ratna, ONGC, NTPC, CIL Maharatna) and in MNC (Larsen and Tuobro, Tata, Reliance, Vedanta, Dalmiya groups, Aditya Birla). Entrepreneurs Skills and Competencies. Earth Science technology for harnessing Innovation. Challenges of new startups, Marketing Strategies development Tools and techniques for market Assessments, Methods and sources for market survey and Market Information. Presentation of Market Survey Report.	Introduction of pool of reading electives

		strategies for tools and technical products used in earth sciences. • Familarize with the legal concepts and financial planning for a successful new venture.		Recommended Books: 1. Clarysse, B. (2011). *The Smart Entrepreneur: How to Build for a Successful Business*. London, UK: Elliott & Thompson. 2. Sethi, A. (2016). *From Science to Startup: The Inside Track of Technology. Entrepreneurship*. Göttingen, Germany: Copernicus & Springer. 3. Westhead, P., & Wright, M. (2013). *Entrepreneurship. A very short introduction*. Oxford, UK: Oxford University Press. Suggested e-learning materials: 1. Sustainability, Innovation and Entrepreneurship https://nptel.ac.in/courses/110107094/26 2. New Enterprises https://ocw.mit.edu/courses/sloan-school-of-management/15-390-new-enterprises-spring	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
12.	GEOL_____R Natural Hazards and Disasters	After the completion of this course, students should be able to: • Explain the key concepts, definitions, perspectives of all hazards and management. • Describe prevention and mitigation of natural hazards. • Depict the preparedness response and recovery		Introduction to Disasters and Hazards, Processes (Internal and External). Types of Hazards: causes and consequences, Prediction and Indicators of Natural Disasters, Socio-economic and Health impacts of Natural Disasters. Natural Disasters – Earthquake: Processes, Magnitude, Intensity and Impact. Volcanism: Types, Risks and Impact. Tsunami and Cyclone: Types, Causes, processes and Impact. Floods: Introduction, Magnitude, Frequency, Zonation and Impact. Mass Wasting: Classification, causes and Impact. Disaster Management: Prevention, Preparedness and Mitigation, Planning and control of Natural Disaster. Case Studies: Nepal Earthquake, Kedarnath Disaster, Bhuj Earthquake 2001.	Introduction of pool of reading electives

		management of natural disasters. • **Elucidate the sustainable development methods in disaster mitigation.**		**Recommended Books:** 1. **Bolt, B. A. (1988). *Earthquakes.* New York, NY: WH Freeman & Company.** 2. **Decker, R. W. & Decker, B. B. (2005). *Volcanoes* (4th ed.). New York, NY: WH Freeman & Company.** 3. **Dowrick, D. (2003). *Earthquake Risk Reduction Zone.* London, UK: John Wiley & Sons.** 4. **Gere, J. M., & Shah, H. C. (1984). *Terra Non Firme Understanding and Preparing for Earthquakes.* New York, NY: WH Freeman & Company.** 5. **IGNOU (2005). *Understanding Natural Disasters*. eGyanKosh, Noida, India: Shagun Offset Press.** 6. **Keller, E. A., & Devecchio, E. D. (2015). Natural Hazards (4th ed.). New York, NY: Pearson.** 7. **Keller, E.A. (1978). *Environmental Geology* (9th ed.). North Carolina, NC: Bell & Howell.** 8. **Montgomery, C.W. (2013). *Environmental Geology* (10th ed.). New York, NY: Mc-Graw-Hill.** 9. **Prakash, I. (1994). *Disaster Management*. Ghaziabad, India: Rastriya Prahari.** 10. **Sharma, V. K. (1995). *Disaster Management*. New Delhi, India: Indian Institute of Public Administration (*IIPA*).** 11. **Singh, S. (2015). *Environmental Geography*. Allahabad, India: Pravalika.** **Suggested e-learning materials:** 1. **Introduction to Natural hazards** **https://epgp.inflibnet.ac.in/ahl.php?csrno=17** **https://onlinecourses.nptel.ac.in/noc19_ce14/preview** 2. **Disasters and Hazards** **https://ndma.gov.in/en/**	

Note: Yellow highlighted and bold content illustrate the modification in the syllabus.

BANASTHALI VIDYAPITH
SCHOOL OF EARTH SCIENCES

Name of Programme:M.Sc. (Environmental Science)

Programme Educational Objectives:

Banasthali Vidyapith is an epitome of tradition and modernity. Vidyapith aims to preserve and inculcate the essential values and ideals of Indian culture. It believes in simple living and high thinking. Our educational ideology is based on the concept of fivefold education focusing on physical, practical, aesthetic, moral and intellectual aspects in order to develop a balanced personality.

The M.Sc. in Environmental Science is an interdisciplinary programme which emphasizes the current issues of environment and serious environmental challenges of local, regional and international level that the world confronts. Students will be able to comprehend the interaction between man and its environment along with effect of human activities on the environment and its functions through a series of academic courses and co-curricular activities. Additionally, students will acquire critical thinking and problem solving skills in order to enrich the quality of the environment.

This programme values an integrated approach on learning, conservation, resource management together with inculcation of solution centric approach in resolving the environmental problems to achieve sustainable development. The programme also envisions developing practical leaders having academic excellence and passion to work for the betterment of the environment and create a better dwelling place built on the principles of environmental justice and sustainability. The main objectives of the M.Sc. Environmental Science programme are:

- **To prepare competent environmental professionals in India and across the globe.**
- **To prepare individuals who are environmentally conscious, empathetic and aware.**
- **To cultivate an interconnected and interdisciplinary approach towards environmental studies to appreciate the interconnected nature of the world and surroundings in which they live.**
- **To provide environmental education in a stimulating environment integrated with nationally and internationally recognized research to develop solutions for common environmental issues.**
- **To prepare students that will communicate excellently about environmental issues in speech and writing.**
- **To instruct digital literacy to support their professional growth.**
- **To develop ethical reasoning, diverse viewpoints and decision-making aptitude in students so they can confront environmental issues while considering the perspectives of a variety of stakeholders and systems.**
- **To foster a spirit in students which lets them to work towards attaining goals and cultivate entrepreneurial capacities.**

Programme Outcomes:

PO1:Environmental Knowledge: Describe the diverse concepts and methods of environmental sciences and their application in various aspects of environmental issues.

PO2:Planning abilities: Demonstrate effective planning to deal with different problems associated with environmental issues such as solid waste management, Energy auditing and Impact assessment of various developmental activities.

PO3:Problem analysis: Formulate mitigation measures for various environmental issues such as waste management and pollution, food and agriculture, energy, climate change, population, resource management and loss of biodiversity.

PO4: Design/development of solution for problems:The research skills strengthen them to formulate hypothesis, identification of environmental problems and develop solution for the betterment of the environment.

PO5:Modern tool usage: Apply various tools commonly used in field research, particularly in the study of air water and soil quality along with spatial analysis software and tools such as GIS and GPS technology.

PO6:Leadership skills: Use their knowledge of EIA and Environmental laws to critically think about their roles and identities as citizens, consumers and environmental actors in an interconnected world.

PO7:Professional Identity: Demonstrate the ability to interpret the consequences of developing projects and consult various environmental agencies to a focused solution.

PO8:Environmental Ethics: Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.

PO9:Communication: Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, along with written and oral communication needed to conduct high-level work as interdisciplinary scholars.

PO10:The Environment and society: Describe various problems associated with sustainable development of project and its impact on society.

PO11:Environment and sustainability: Formulate an action plan for sustainable alternatives that integrate science, humanist, and social perspectives.

PO12:Life- long learning: Prepare them for meaningful careers and higher education in fields related to environmental science and beyond.

Programme Scheme:

Semester: I

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ENVS 402	Ecology and Environment	4	0	0	4
ENVS 405	Environmental Chemistry	4	0	0	4
ENVS 409	Fundamentals of Remote Sensing and GIS	4	0	0	4
ENVS ~~410~~	~~Geography of Environment~~	4	0	0	4
ENVS 411	Introduction to Computer for Environmental Science	4	0	0	4
ENVS 403L	Environment Lab - I	0	0	12	6
	Total:	**20**	**0**	**12**	**26**

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ENVS___	**Climate change and Environment**	4	0	0	4
ENVS 402	**Ecology and Environment**	4	0	0	4
ENVS 405	**Environmental Chemistry**	4	0	0	4
ENVS 409	Fundamentals of Remote Sensing and GIS	4	0	0	4
ENVS 411	Introduction to Computer for Environmental Science	4	0	0	4
ENVS 403L	**Environment Lab - I**	0	0	12	6
	Total:	**20**	**0**	**12**	**26**

Semester: II

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ENVS 401	Applications of Remote Sensing for Natural Resource Management	4	0	0	4
BIO ~~406~~	~~Biostatistics and Research Methodology~~	4	0	0	4
BIO ~~408~~	~~Environmental Biology and Toxicology~~	4	0	0	4
ENVS 406	Environmental Legislation	4	0	0	4
ENVS ~~407~~	~~Environmental Physics~~	4	0	0	4
ENVS 404L	Environment Lab - II	0	0	12	6
	Total:	**20**	**0**	**12**	**26**

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ENVS 401	Applications of Remote Sensing for Natural Resource Management	4	0	0	4
ENVS___	**Biodiversity and Conservation**	4	0	0	4
ENVS 406	**Environmental Legislation**	4	0	0	4
ENVS___	**Environmental Statistics and Research Methodology**	4	0	0	4
ENVS___	**Environmental Toxicology**	4	0	0	4
ENVS 404L	**Environment Lab - II**	0	0	12	6
	Total:	**20**	**0**	**12**	**26**

Semester: III

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ENVS ~~504~~	~~Disaster Management and Mitigation Strategies~~	4	0	0	4
ENVS ~~505~~	~~Energy Auditing and Conservation~~	4	0	0	4
ENVS ~~508~~	~~Environmental Impact Assessment and Management~~	4	0	0	4
ENVS 510	Solid Waste Management	4	0	0	4
ENVS 506L	Environment Lab - III	0	0	12	6
	~~**Elective**~~	4	0	0	4
	Total:	**20**	**0**	**12**	~~**26**~~

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ENVS___	**Air Pollution Monitoring, Control Technology and Management**	4	0	0	4
ENVS 510	Solid Waste Management	4	0	0	4
ENVS___	**Water Pollution Monitoring, Control Technology and Management**	4	0	0	4
ENVS 506L	**Environment Lab - III**	0	0	12	6
ENVS___	**Discipline Elective**	**4**	**0**	**0**	**4**
	Open Elective	**4**	**0**	**0**	**4**
	Reading Elective I	**0**	**0**	**0**	**2**
	Total:	**20**	**0**	**12**	**28**

Semester: IV

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ENVS ~~509P~~	Project	0	0	~~52~~	~~26~~
	Total:	**0**	**0**	~~**52**~~	**26**

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
	Reading Elective II	**0**	**0**	**0**	**2**
ENVS ____P	Project	**0**	**0**	**48**	**24**
	Total:	**0**	**0**	**48**	**26**

Electives					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ENVS 501	Air Pollution Monitoring, Control Technology and Management	**4**	**0**	**0**	**4**
ENVS 502	Biodiversity and Conservation	**4**	**0**	**0**	**4**
ENVS 503	Biotechnology Application to Environmental Science	**4**	**0**	**0**	**4**
ENVS 507	Environmental Health Management	**4**	**0**	**0**	**4**
ENVS 511	Water Pollution Monitoring, Control Technology and Management	**4**	**0**	**0**	**4**

List of Discipline Electives		L	T	P	C
Course Code	**Course Name**				
ENVS 503	Biotechnology Application to Environmental Science	**4**	**0**	**0**	**4**
ENVS___	**Disaster Management and Mitigation Strategies**	**4**	**0**	**0**	**4**
ENVS___	**Energy Auditing and Conservation**	**4**	**0**	**0**	**4**
ENVS 507	Environmental Health Management	**4**	**0**	**0**	**4**
ENVS___	**Environmental Impact Assessment and Management**	**4**	**0**	**0**	**4**
ENVS___	**Environmental Physics**	**4**	**0**	**0**	**4**

List of Reading Electives					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
ENVS_R	**Agroforestry**	**0**	**0**	**0**	**2**
ENVS_R	**Energy Resources and Conservation**	**0**	**0**	**0**	**2**
ENVS_R	**Man and Environment**	**0**	**0**	**0**	**2**
ENVS _R	**Water and Sustainable Development**	**0**	**0**	**0**	**2**
GEOG_R	**Environmental Challenges and Disaster Management**	**0**	**0**	**0**	**2**
GEOG_R	**India: Socio-Political and Environmental Scenario**	**0**	**0**	**0**	**2**
GEOG_R	**Rajasthan: Challenges and Prospects**	**0**	**0**	**0**	**2**
GEOG_R	**Transforming India**	**0**	**0**	**0**	**2**
GEOL_R	**Geo Tourism**	**0**	**0**	**0**	**2**
GEOL_R	**Indian Mineral Deposits, Economics and Mining Ethics**	**0**	**0**	**0**	**2**
GEOL_R	**Innovation and Entrepreneurship in Earth Sciences**	**0**	**0**	**0**	**2**
GEOL_R	**Natural Hazards and Disasters**	**0**	**0**	**0**	**2**

List of Online Reading Electives				
S. No.	**Course Name**	**Proposed Alternative On-line Course**	**Credit point(s)**	**URL link**
1	**ENVS__R Energy Resource and Conservation**	**Non-Conventional Energy Resources**	**2**	**https://onlinecourses. nptel.ac.in/noc18_ge 09/preview**
2	**GEOL__R Indian Mineral Deposits, Economics and Mining Ethics**	**Mineral Resources: Geology, Exploration, Economics and Environment**	**2**	**https://onlinecourses. nptel.ac.in/noc18_ ce13/preview**
3	**GEOL__R Natural Hazards and Disasters**	**Natural Hazards Part 1**	**2**	**https://onlinecourses. nptel.ac.in/noc19_ ce14/preview**

Note:

Semester I

ENVS 410 Geography of Environment hasbeenreplaced by new course ENVS __Climate change and Environment.

Semester II

BIO 406 Biostatistics and Research Methodology and BIO 408 Environmental Biology and Toxicology have been replaced by two new courses ENVS__Environmental Statistics and Research Methodology and ENVS__Environmental Toxicology respectively. ENVS 407 Environmental Physics has been replaced by ENVS 502 Biodiversity and conservation, although ENVS 502 was an elective course of III semester (which is now core course of II semester)&ENVS 407 was shifted from core of II semester todiscipline elective ofIII semester.

Semester III

ENVS 501Air Pollution Monitoring, Control Technology and Management and ENVS 511 Water Pollution Monitoring, Control Technology and Management both have been shifted fromelective of III semester to core courses of III semester.

ENVS 504 Disaster Management and Mitigation Strategies and ENVS 505 Energy Auditing and Conservation have been shifted to pool of Disciplineelectives in III semester from core courseof III semester.

ENVS 407 Environmental Physics has been shifted to DisciplineElective pool of III semester from core course of II semester.

ENVS 508 Environmental Impact Assessment and Management has been shifted to Discipline Elective pool of semester III.

Pool of Discipline Elective has been introduced in III semester

Common Pool of Reading Elective has been introduced in III and IV semester

Open Elective has been introduced in semester III

Semester IV

Project credit has been changed.

L - Lecture hrs/week; T - Tutorial hrs/week;

P - Project/Practical/Lab/All other non-classroom academic activities, etc. hrs/week; C - Credit Points of the Course

Note:Yellow highlighted and bold content illustrate the modification in the syllabus.

Name of Programme: M.Sc. (Environmental Science)

COURSE DETAILS:

FIRST SEMESTER

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1	ENVS_____ Climate Change and Environment	After the completion of this course, students will be able to: • Describe the concept of climate change. • Identify the indicators of climate change and explain the various theories. • Explain the impact of El Niño and La Niña. • Describe carbon sequestration policies related to climate change.		**Section A** Concept of Climate change, Indicators and theories. Global Carbon Cycle: Stocks and Fluxes of Carbon in terrestrial and marine ecosystems and anthropogenic impact, Carbon Sequestration Impact of El Niño and La Niña on environment, Insolation and Heat Budget. **Section B** Ozone depletion: Mechanism and consequences Impact of acid rain on environment Photochemical smog: Mechanism and formation, Impact of Deforestation, Mining on environment **Section C** Policy Perspective: UNFCCC, Role and Function of IPCC, Kyoto Protocol and its implication on Developed and developing countries. Clean Development Mechanism (CDM) and its operation Environmental protection efforts in India and abroad. Recommended Books: 1. Bal, A. S. (2009). *An Introduction to Environmental Management*(1st ed.). Mumbai, India: Himalaya. 2. Bayon, R., Hawn, A.,&Hamilton, K. (2009). *Voluntary Carbon Markets*(2nd ed.).Abingdon, United Kingdom: Routledge. 3. Hester, R. E., & Harrison, R. M. (Eds.). (2010). *Carbon capture: sequestration and storage* .Cambridge, United Kingdom: Royal Society of Chemistry. 4. Kumar, S. (2011). *Protecting Environmental Issues- A Quest for NGO's*. New Delhi, India: AVON.	Introduction of New Course

				5. **Rajagopalan, R. (2014). *Environmental Studies*(2nd ed.). New Delhi, India: Oxford University Press.** 6. **Singh, S. (2015). *Environmental Geography*.Allahabad, India:Pravalika.** 7. **Strahler, A.N. (1988). *Earth Science*. New Delhi, India:Harper and Row.** 8. **Wilson, E., &Gerard, D.(2007). *Carbon Capture and Sequestration Integrating Technology, Monitoring, Regulation*. Ames, IA: Blackwell.** **Suggested e-learning materials:** **1. Climate Change** **https://swayam.gov.in/courses/5257-climate-change** **https://nptel.ac.in/courses/119106008/40**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
2	**ENVS 402** **Ecology and Environment**	**After the completion of this course, students will be able to:** **• Describe the interaction of organisms with their environment.** **• Identify the various threats to biodiversity.** **• Explain the concept of biomes.** **• Describe the various biogeochemical cycles.**	**Section A** **Introduction to Environment** a) Concept of Environment b) Factors of the environment: Physiographic, Climatic, Edaphic, Biotic and Anthropogenic. c) Bio Geochemical Cycles: The Carbon cycle, the Oxygen cycle, the Nitrogen cycle. d) The Hydrological cycle. **Section B** **Concept of Ecology, Ecosystem and Biomes** a) Concept of Ecosystem: With special reference to desert, forest and aquatic ecosystem. b) Food chain, Food web & succession. c) Ecological Pyramids and their types. d) Energy flow in ecosystem. e) Concepts of Biomes. Major biomes of the world: Tropical forest, Temperate forest, Grassland and Tundra. **Section C** **Environmental Pollution and its Effect** a) Environmental pollution-Pollutants and sources: 1.Water pollution, 2. Soil pollution, 3. Air pollution and, 4. Noise pollution. b) Global warming ~~c) Global climatic changes: Indicators and~~	**Section A** **Introduction to Environment** Concept of Environment, Factors of the environment: Physiographic, Climatic, Edaphic, Biotic and Anthropogenic. Bio Geochemical Cycles: The Carbon cycle, the Oxygen cycle, the Nitrogen cycle, The Hydrological cycle. **Section B** **Concept of Ecology, Ecosystem and Biomes** Concept of Ecosystem: With special reference to desert, forest and aquatic ecosystem. Food chain, Food web & succession. Ecological Pyramids and their types. Energy flow in ecosystem, Concepts of Biomes. Major biomes of the world: Tropical forest, Temperate forest, Grassland and Tundra. **Section C** **Environmental Pollution and its Effect** Environmental pollution-Pollutants and sources: Water pollution, Soil pollution, Air pollution and, Noise pollution. **Greenhouse Effect,** Global warming Biodiversity: Threats and Conservation. **Recommended Books:** **1. Atkinson, Raw, M. (2007). *Biogeography*. Philip Allan Updates.**	**Reviewed outcomes and suggested e-learning materials** **The repeated content is removed to maintain the level of detailing and an essential component are added.**

			~~Theories~~ d) Biodiversity: Threats and Conservation **Recommended Books:** ~~1. Atkinson & Raw, Michael (2007): Biogeography. Philip Allan Updates.~~ ~~2. Gautam, A (2007): Environmental Geography, ShardaPustakBhawan, Allahabad.~~ ~~3. Gautam, A. (2005): Resource and Environment (in Hindi), ShardaPushtakBhawan, Allahabad.~~ ~~4. Huggett, R. J (1998): Fundamental of Biogeography. Routledge, London.~~ ~~5. Kayastha, S.L. and Kumra V.K. (1986): Environmental Studies. Tara Book Agency, Varanasi.~~ ~~6. Mathur, H.S.(1998) : Essentials of Biogeography, Pointer Publishers, Jaipur.~~ ~~7. Mehtani, S. &Sinha, A. (2010): Biogeography. Commonwealth Publisher.~~ ~~8. New begin : Plant and Animal Geography.~~ ~~9. Odum, E. P. (1975): Ecology. Rowman and Littlefield, Lanham USA.~~ ~~10. Odum, E.P.(1968) : Fundamentals of Ecology, W.B. Sanders. Company, Philadelphia and London.~~ ~~11. Saxena, H. M. (1999): Environmental Geography. Rawat Publications., Jaipur and New Delhi.~~ ~~12. Saxena, H. M. (2000): Environmental~~	**2. Gautam, A. (2007). *Environmental Geography*. Allahabad,India:ShardaPustakBhawan.** **3. Huggett, R. J. (1998). *Fundamental of Biogeography*. London,UK:Routledge.** **4. Kayastha, S.L., &Kumra, V.K. (1986). *Environmental Studies.* Varanasi, India: Tara Book Agency.** **5. Mathur, H.S. (1998). *Essentials of Biogeography*. Jaipur, India: Pointer.** **6. Mehtani, S., &Sinha, A. (2010). *Biogeography*. Commonwealth.** **7. Odum, E. P. (1975). *Ecology*. Lanham, MD:Rowman and Littlefield.** **8. Odum, E.P. (1968).*Fundamentals of Ecology*. London, UK:W.B. Sanders Company** **9. Saxena, H. M. (1999). *Environmental Geography*. Jaipur, India:Rawat.** **10. Saxena, H. M. (2000). *Environmental Management*. Jaipur, India:Rawat.** **Suggested e-learning materials:** **1. Environment and Ecology https://nptel.ac.in/courses/122102006/16** **2. Ecology and Environment https://swayam.gov.in/courses/4905-july-2018-ecology-and-environment**	

			~~Management. Rawat Publications., Jaipur and New Delhi.~~ ~~13. बाकरे, बाकरे, वाधवा (2005 – 2006) : पर्यावरणीय अध्ययन, रस्तोगीपब्लिकेशन्स, गंगोत्री, शिवाजीरोड़ मेरठ।~~ ~~14. भाटिया, डॉ. ए. एल, कोहली, डॉ के. एस : जन्तुपरिस्थितिकी एवंजन्तुवितरण~~ ~~15. डॉ. अरुण रघुवंशी, पर्यावरणतथाप्रदुषण, मध्य प्रदेशहिन्दीग्रन्थअकादमी।~~ ~~16. डॉ. नरेन्द्रमोहनअवस्थी, एवंडॉ. आर के तिवारी, पर्यावरणभूगोल, मध्य प्रदेशहिन्दीग्रन्थअकादमी।~~ ~~17. डॉ. गायत्री प्रसाद एवंमडॉ. नोटियाल, पर्यावरणभूगोल, शांतापब्लिशर्स।~~ ~~18. एच. एम. सक्सेनापर्यावरणभूगोल, राजस्थान, हिन्दीग्रन्थअकादमी।~~		

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
3	**ENVS 405** **Environmental Chemistry**	**After the completion of this course, students will be able to:** **• Describe the various chemical processes occurring in the air, water and soil.** **• Explain the effect of hydrocarbons and synthetic compounds on biological organisms.** **• Explain the degradation of hydrocarbon and synthetic compounds.** **• Illustrate the working principle, merits and demerits of analytical techniques.**	**Section A** a) Concept and Scope of Environmental Chemistry: Definition and explanation for various terms, segments of environment. Principles and cyclic pathways in the environment: Sulphur, Oxygen, Nitrogen, Phosphorous cycle. b) Chemistry of Water: Unusual physical properties, unusual solvent properties, changes in water properties by addition of solute. c) Soil Chemistry: Formation, constituents and properties of soils, adsorption of contaminants in soil, soil fertility, surface exchange reaction, soil redox potential and adsorption-desorption. **Section B** Chemistry of various organic, inorganic, carcinogenic compounds and their effects. a) Hydrocarbons: Chemistry of hydrocarbon decay, environmental effects, effects on macro and micro organisms. Surfactants: Cationic, anionic and nonionic detergents, modified detergents. b) Pesticides: Classification, degradation, analysis, pollution due to pesticides and DDT problems. c) Synthetic Polymers: Microbial decomposition, polymer decay, ecological and consideration, Photosensitize additives. ~~d) Lead and its compounds: Physical and chemical properties, behavior, human exposure, absorption, influence.~~Aflatoxin occurrence, chemical composition and properties metabolism, ~~acute toxicity, carcinogenicity.~~ ~~e) Destruction of some hazardous substances: Acid halides and anhydrides, alkali metals, cyanides~~	**Section A** Concept and Scope of Environmental Chemistry: Definition and explanation for various terms, segments of environment. Principles and cyclic pathways in the environment: Sulphur, Oxygen, Nitrogen, Phosphorous cycle. Chemistry of Water: Unusual physical properties, unusual solvent properties, changes in water properties by addition of solute. Soil Chemistry: Formation, constituents and properties of soils, adsorption of contaminants in soil, soil fertility, surface exchange reaction, soil redox potential and adsorption-desorption. **Section B** Chemistry of various organic, inorganic, carcinogenic compounds and their effects. Hydrocarbons: Chemistry of hydrocarbon decay, environmental effects, effects on macro and micro organisms. Surfactants: Cationic, anionic and nonionic detergents, modified detergents. Pesticides: Classification, degradation, analysis, pollution due to pesticides and DDT problems. Synthetic Polymers: Microbial decomposition, polymer decay, ecological and consideration, Photosensitize additives. Aflatoxin occurrence, chemical	**Reviewed outcomes and suggested e-learning materials** **Some topicof this course was introduced in Environmental Toxicology course of II semester**

			~~and cyanogens bromides, chromium, aflotoxins, halogenated compounds.~~ **Section C** a) Physico–Chemical methods for analysis of environmental samples:Physico-chemicalparameters; Definition and determination of conductivity, pH, COD, BOD. ~~b) Estimation of various elements at major, minor trace, ultra traces level concentrations; Choice of a technique.~~ c) Principle, merits and demerits of the techniques: colorimetry, atomic absorption spectroscopy, gas chromatography, HPLC, ion exchange chromatography. **Recommended Books:** ~~1. Bhatia S. C, Environmental Chemistry, Cbs Publisher.~~ ~~2. De, A. K. & De, A. K., Environmental Chemistry, New Age International Publishers.~~ ~~3. Gary W.V, Stephen J. D., Environmental Chemistry, A global perspective (Third Edition), Oxford University Press.~~ ~~4. Rao P. Venugopala, Principles Of Environmental Science And Engineering, PHI Learning Pvt. Ltd.~~ ~~5. Séamus P. J. H.,2003, Analytical Chemistry, Oxford University Press, UK.~~ ~~Stanley Manahan & Stanley E. Manahan, Environmental Chemistry, Ninth Edition, CRC Press.~~	composition and properties metabolism. **Section C** Physico–Chemical methods for analysis of environmental samples: Definition and determination of conductivity, pH, COD, BOD. **Principle, merits and demerits of Centrifuge, and Ultra centrifuge.** Principle, merits and demerits of the techniques:colorimetry, atomic absorption spectroscopy, Atomicemission Spectroscopy, gas chromatography, HPLC,ion exchange chromatography. **Recommended Books:** **1. Bhatia, S. C. (2006). *Environmental Chemistry*. New Delhi, India: CBS.** **2. De, A. K., & De, A. K. (2007). *Environmental Chemistry*. New Delhi, India:New Age International.** **3. Gary, W.V., &Stephen, J. D. (2010). *Environmental Chemistry*. *A global perspective*(3rd ed.). London, UK:Oxford University Press.** **4. Rao, P. V. (2006). *Principles of Environmental Science and Engineering*. New Delhi, India:PHI.** **5. Séamus, P. J. H. (2003). *Analytical Chemistry*. London, UK:Oxford University Press.** **6. Manahan, S., &Manahan, S. E. (2009). *Environmental Chemistry (Ninth Edition)*. Florida, FL: CRC Press.** ***7.* Wilson, K., &Walker, J. (2010). *Principals and Techiniques of***	**The repeated content is removed to maintain the level of detailing and an essential component are added.**

				Biochemistry and Molecular Biology. **New York, NY:Cambridge University Press.** **Suggested e-learning materials:** **1. Environmental Chemistry and Analysis https://nptel.ac.in/courses/122106030/** **2. Environmental Chemistry https://swayam.gov.in/course/251-environmental-chemistry**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
4	**ENVS 409** **Fundamentals of Remote Sensing and GIS**	**After the completion of this course, students will be able to:** **• Explain about Remote Sensing, Geographical Information System and Global Positioning System.** **• Outline and interpret the elements of aerial photographs.** **• Describe principles and applications of thermal and microwave remote sensing.** **• Differentiate GIS and science of map making, non spatial versus spatial data**	____	____ **Recommended Books:** **1. Abbasi, S. A. (2005). *Application of G I S & Remote Sensing in Environment Managements*. New Delhi, India:Discovery.** **2. Avery, T. E., &Berlin, G. L. (1985). *Interpretation of Aerial photographs*(4th ed.). Minneapolis, Minnesota:Burgess.** **3. Bhatta, B. (2011). *Remote Sensing and GIS*(2nd ed). New Delhi, India: Oxford University Press.**	**Reviewed outcomes and suggested e-learning materials** **No Change in content**

				4. **Burrough, P.A., &Rachael A. M. (2015). *Principles of Geographic Information Systems*(3rd ed.).Oxford, UK: Oxford University Press.** 5. **Ciciarelli, J. A. (1991). *A Practical Guide to Aerial Photography with an Introduction to Surveying.*US:Springer.** 6. **Curran, P. J. (1985). *Principles of Remote Sensing*. London, UK:Longman.** 7. **Fazal, S. (2008). *GIS Basics.*New Delhi, India:New Age International.** 8. **Ganesh, A., &Narayanakumat, R. (2006). *GPS Principles and Applications*. Satish Serial.** 9. **George, J. (2008). *Fundamentals of Remote Sensing*. Hyderabad, India:Universities Press.** 10. **Heywood, I., Cornelius, S., &Carver, S. (2000). *Introduction to GIS*. New York, NY:Addison Wesley Longman.** 11. **Lillesand, T.M., Kiefer, &R.W., Chipman, J.W. (2011). *Remote Sensing and Image interpretation*. Hoboken, NJ:Wiley and Sons.** 12. **Lo, C.P., &Yeung, A.K.W. (2004). *Concepts and Techniques of GIS*. New Delhi, India:Prentice-Hall of India.** 13. **Paine, D. P., &Kiser, J. D. (2012). *Aerial Photograph and Image interpretation*. New Jersey, NJ: John Wiley and Sons.** 14. **Palet, A.N, (1992). *Remote Sensing-Principles & Application*. Jodhpur, India: Scientific.**	

				Suggested e-learning materials: **1.Introduction to Remote Sensing https://swayam.gov.in/course/3612** **2. Introduction to Geographic Information Systems https://onlinecourses.nptel.ac.in/noc16_ce12/preview**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
5	**~~ENVS 410~~** **~~Geography of Environment~~**	**~~After the completion of this course, students will be able to:~~** **~~• Describe the Physical Dimensions of environment.~~** **~~• Identify the Impact of human activities on environment.~~** **~~• Explain the concept and Significance of Environmental Movements.~~** **~~• Describe the role of Environmental Awareness and polices.~~**	**~~Section A~~** **~~Physical Dimensions~~** ~~a) Endogenetic Process: Concept of Plate Tectonics, Earthquakes and Volcanoes~~ ~~b) Exogenetic process: Weathering and Mass wasting~~ ~~c) Geomorphic processes and resulting landforms :Fluvial, Arid and Coastal~~ ~~d) Composition and Stratification of Atmosphere, Insolation and Heat Budget, Temperature~~ ~~e) Bottom Relief of Ocean, Oceanic Temperature and Salinity~~ **~~Section B~~** **~~Human Dimensions~~** ~~a) Human Population: Growth and Distribution~~ ~~b) Population Growth and Environmental Deterioration~~ ~~c) Man Induced Environmental Changes~~ ~~d) Types of Human Activities~~ ~~e) Impact of Human Activities: Deforestation, Mining and Industrialization~~ **~~Section C~~** **~~Environmental Awareness and Policies~~** ~~a) Environmental Awareness- Need and Role in Amelioration of Environment~~ ~~b) Concept and Significance of Environmental Movements, Environmental Movements in India with special reference to The ChipkoMovement, Narmada BachaoAndolan~~ ~~c) Environmental Protection Efforts in India~~ ~~d) International Environmental Policy with special~~		**Course deleted and replaced with a new course of Climate Change and Environment in the same semester.**

			reference to THE AGENDA 21 EARTH SUMMIT National Environmental Policy of India **Recommended Books:** 1. BalAnand S. (2005) An Introductiion to Environmental Mamagement, Himalaya Publishing HouseMumbal 2. Bloom.A. L. (1998/ 2001): Geomorphology. 3rd edition. Prentice Hall of India, New Delhi. 3. Chandana, R. C (2008): A Geography of population, Kalyani Publishers, New Delhi. 4. Chopra, Girish (2006): Population Geography. Commonwealth Publishers 5. Chorley, R.J., Schumm S A and Sugden D E. (1984). Geomorphology. Methuen and Company Ltd., London. 6. Dayal, P. (1994): A Text Book of Geomorphology. Kalyani Publishers, New Delhi. 7. Husain Majid (2002), Fundamentals of Physical Geography, 2nd Ed. Rawat Pub. Jaipur and New Delhi. 8. Jadhav H.V. and Purohit S.H. (2011): Environmental Studies, Himalaya Publishing House, Mumbai 9. Kale, V. and Gupta, A. (2001): Introduction to Geomorphology. Orient Longman, Hyderabad. 10. King, C.A.M. (1966): Techniques in Geomorphology. Edward Arnold, London. 11. Kumar Satish (2011): Protecting Environmental Issues- A Quest for NGO's, AVON Publication, New Delhi 12. Levag&Goh Cherry (1982), Human & Economic Geography, Oxford University, Press Oxford London		

			13. Rajagopalan R. (2014): Environmental Studies 2nd Ed. Oxford University Press, Delhi 14. Singh, S. (2004): Geomorphology. PrayagPustakBhawan, Allahabad. 15. Singh, S. [1993]: Physical Geography. PrayagPustakBhawan, Allahabad. 16. Singh, S. [1993]: Environmental Geography. PrayagPustakBhawan, Allahabad 17. Strahler, A.N. (1988) Earth Science, Harper and Row Publishers, New Delhi (India reprient). 18. Strahler, A.N. and Strahler, A.H.(1996), Introducing Physical Geography. John Willey and Sons, New York. 19. Thornbury, W.D. (2005): Principles of Geomorphology. John Wiley and Sons, New Delhi (India Reprint). 20. उपाध्याय एल. एन. : भौतिकभूगोलसाजस्थानहिन्दीग्रन्थअकादमी, जयपुर। 21. चतुर्वुजमागोरिया एवंजैन (1964) : भौतिकभूगोल एवंजीवमण्डल, साहित्य भवन, आगरा। 22. तिक्खा, रामनाथ : भौतिकभूगोल, केदारनाथरामनाथ, मेरठ। 23. पी. दयाल : भूआकृतिविज्ञान, शुक्लाबुकडिपो। 24. शर्मा एच. एस., शर्मा एम.एल. औरमिश्राआर.एल. : "भौतिकभूगोल"पंचशीलप्रकाशनजयपुर। 25. सविन्द्र सिंह : भूआकृतिविज्ञान, प्रयागपुस्तकभवन, इलाहबाद। 26. सविन्द्र सिंह (1971) : भौतिकभूगोल, वसुन्धराप्रकाशन, गोरखपुर।		

S. No.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
6	ENVS 411 Introduction to Computer for Environmental Science	After the completion of this course, students will be able to: • Describe the elements of a computer system and functions of its components • Use various computer operating systems. • Create worksheets, charts, documents, inserting tables and pictures and presentation package. • Use photographs and document editing software.	____	____ Recommended Books: 1.Sinha, P.K. (2017). *Computer Fundamentals.* New Delhi, India: BPB. 2. Taxali, R.K. (2000). *PC Software for window - made simple*. New Delhi, India: Tata Mcgraw Hill. Suggested e-learning materials: 1. Computer Fundamentals https://swayam.gov.in/course/4067-computer-fundamentals 2. Introduction to System: Software https://nptel.ac.in/courses/106106092/2	Reviewed outcomes and suggested e-learning materials No Change in the content

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
7	**ENVS 403L Environment Lab-I**	**After the completion of this course, students will be able to:** **• Conduct soil sample analysis.** **• Conduct water sample analysis.** **• Use MS office Package, CorelDraw, Internet services.** **• Create and interpret geospatial data.**	1. Working with Windows. 2. Working with MS office Package (MS-Word, Excel, Power Point). 3. Working with CorelDraw 4. Using Internet services 5. Using subject specific application packages. 6. Determination of conductivity of water/soil samples. 7. Determination of pH for water/soil samples. 8. Determination of TSS and TDS in water samples. 9. Determination of turbidity in water/soil samples. 10. ~~Determination of COD in water samples~~. 11. Determination of BOD in water samples. 12. Determination of Dissolved Oxygen (DO) in water samples. 13. ~~Determination of Alkalinity in water/soil samples~~. 14. Determination of Acidity in water/soil samples. ~~15. Determination of Nitrate in water/soil samples.~~ ~~16. Determination of Nitrogen, Phosphorus and Potassium (N, P, K) in soil samples.~~ ~~17. Determination of water, $CaCO_3$ and Carbon contents in soil samples.~~ 18. Determination of Grain size of soil samples. 19. Determination of micronutrients (Cu, Fe, Mn and Zn) in soil samples. 20. Identify the products of combustion of hydrocarbons. 21. Test the effect of green house on the	1. Working with Windows. 2. Working with MS office Package (MS-Word, Excel, Power Point). 3. Working with CorelDraw 4. Using Internet services 5. Using subject specific application packages. 6. Determination of conductivity of water/soil samples. 7. Determination of pH for water/soil samples. 8. Determination of TSS and TDS in water samples. 9. Determination of turbidity in water/soil samples. 10. Determination of BOD in water samples. 11. Determination of Dissolved Oxygen (DO) in water samples. **12. Determination of Sodium, (Na) in water samples.** **13. Determination of Potassium, (K) in water samples.** 14. Determination of Acidity in water samples 15. Determination of Total Hardness in water samples. 16. Determination of Magnesium Hardness in water samples. 17. Determination of Total Metals (Cr, Fe and Cd) in water samples. 18. Determination of Grain size of soil samples. **19. Determination of leaf area.** 20. Introduction to Satellite Images, TCC, FCC 21. Visual Interpretation 22. Stereoscopic Vision 23. Object Identification with Aerial Photograph 24. Introduction to GIS Software	**Reviewed outcomes and suggested e-learning materials** **Some of the repeated practical's of the forthcoming semester have been removed and replaced by new ones, viz., sodium and Potassium estimation in water samples**

			temperature. 22. Introduction to Satellite Images, TCC, FCC 23. Visual Interpretation 24. Stereoscopic Vision 25. Object Identification with Aerial Photograph 26. Introduction to GIS Software 27. Georeferencing 28. Creation of spatial data 29. Joining Non spatial with spatial data 30. Buffering 31. Map layout	25. Georeferencing 26. Creation of spatial data 27. Joining Non spatial with spatial data 28. Buffering 29. Map layout **Recommended Books:** **1. Narasalah, G. L. (2012).*Environmental Science : A Practical Manual*. Delhi, India: B.S.** **2. Maiti, S.K. (2011). *Handbook of Methods in Environmental Studies. Vol. 2: Soil and Air Analysis.* Jaipur, India: Oxford Book Company.** **3. Rajaraman, V., &Adabala, N. (2014) *Fundamentals of Computers (6th ed.).* New Delhi, India: Prentice Hall.** **Suggested e-learning materials:** **1. Water Quality Monitoring https://nptel.ac.in/courses/103107084/4** **2. Particle Size Distribution https://nptel.ac.in/courses/105103097/10**	

SECOND SEMESTER

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	**ENVS 401 Applications of Remote Sensing for Natural Resource Management**	**After the completion of this course, students will be able to:** • **Use geographical and spatial databases pertaining to land use land cover.** • **Perform interactive geospatial analysis, display and interpret results.** • **Assess the biophysical and social applications of remote sensing.** • **Develop skills to access and plot geospatial data for natural resource management.**	____	____ **Recommended Books:** **1. Jenson, J.R. (2007). *Remote Sensing of the Environment-An Earth Resource Perspective*(2nd ed.). New Jersey, NJ: Prentice Hall.** **2. Joshi, P.K., & Singh, T.P. (2011). *Geoinformatics for Climate Change Studies*. New Delhi, India: TERI Press.** **3. Joshi, P.K., Pani, S., Mohapartra, N., & Singh, T.P. (2010). *Geoinformatics for Natural Resource Management*. Punjab, India: Nova Science.**	**Reviewed outcomes and suggested e-learning materials** **No Change in content**

				4. Kumar, P., Rani, M.,&Pandey, P. (2012). *Conservation areas to beat the heat*. Saarbrücken, Germany: LAP LAMBERT Academic. **5. Lillesand, T., Keifer, R.W., &Chipman, J. (2015). *Remote Sensing and Image Interpretation*(7th ed.).Hoboken, NJ: John Willey and Sons.** **6. Schultz, G.A. &Engman, E.T. (2000). *Remote Sensing in Hydrology and Water Management*. Berlin, Germany:Springer-Verlag.** **Suggested e-learning materials:** **1. Introduction to Remote Sensing https://nptel.ac.in/courses/121107009/** **2. Remote Sensing Applications https://nptel.ac.in/courses/105108077/**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
2	ENVS_ Biodiversity and Conservation	After the completion of this course, students will be able to: • Explain importance of biological diversity. • Describe major threats to biodiversity. • Recognize and implement the various methods of biodiversity conservation with co-existence of various environmental pressures. • Identify different geographical biodiversity hotspots and		Section A Introduction to biodiversity concepts, significance, magnitude and distribution. Biodiversity trends, diversity gradients and related hypotheses methods for monitoring biodiversity trends. Threats to biodiversity, major causes, extinction's, vulnerability of species to extinction, IUCN threat categories, Red data book. Section B Principles of biodiversity conservation Ex situ and In situ methods of conservation, Genetical and evolutionary principles in conservation. Conservation of biological diversity and its significance- source of food, medicine, raw material, aesthetic, cultural and ecosystem services. Concepts, distribution and importance of Hot spots. Strategies for sustainable exploitation of biodiversity.	Reviewed outcomes and suggested e-learning materials ENVS 407 Environmental Physics has been replaced by ENVS 502 Biodiversity & conservation. This course has been shifted from pool of electives of III

		mega-diversity centers.		**Section C** **Conservation – efforts in India, Endangered flora & fauna of India.** **Ethno botany in India & selected medicinal plants.** **Wildlife conservation in India- Project Tiger, Project crocodile, silent valley controversy.** **Conservation of Himalayan, Gangeticecosystems.** **Recommended Books:** 1. **Kumar, U. &Asija, M.J. (2007). *Biodiversity – Principles and conservation* (2nd ed.). Jodhpur, India: Agrobios.** 2. **Mishra, R. (1968). *Ecology Workbook*(2nd ed.). Calcutta, India: Oxford and IBH.** 3. **Odum, E.P. (1983). *Basic Ecology* (2nd ed.). Philadelphia,PA: Holt-Saunders International.** 4. **Odum, E.P. (2004). *Fundamentals of Ecology*. Dehradun, India: Natraj.** 5. **Singh, M.P., Singh, J.K., Mohanka, R., &Sah, R.B. (2007). *Forest environment and biodiversity (*2nd ed.). New Delhi, India: Daya.** 6. **Sinha, B.N. (1990). *Ecosystem Degradation in India*. New Delhi, India: Ashish.** 7. **Tewari, D.N. (1994) *Biodiversity and forest genetic resources*. Dehradun, India: International Book.** **Suggested e-learning materials:** **1. Aquatic Biodiversity and**	**Semester to core of II semester.** **ENVS 407 was shifted from core of II semester to discipline elective pool of III semester**

				Environmental Pollution https://nptel.ac.in/courses/120108002/16 **2. Wildlife Conservation https://nptel.ac.in/noc/individual_course.php?id=noc18-bt26**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
3	~~**BIO 406 Biostatistics and Research Methodology**~~	**After the completion of this course, students will be able to:** • **Apply statistical tools to perform data analysis and data interpretation.** • **Develop problem formulation using multiple statistical relationships and solve them using standard techniques.** • **Draw conclusions from the use of tables, graphs, and charts.** • **Have the versatility to work effectively in a broad range of analytic and scientific positions.**	~~**Section A**~~ ~~a) Scope of Biostatistics, variables in biology,collection, classification, tabulation of data.~~ ~~b) Frequency distribution, Diagrammatic and graphical presentation of statistical data, Sampling techniques.~~ ~~c) Measures of central location and dispersion, Simple measure of skewness and Kurtosis.~~ ~~d) Probability, conditional probability.~~ ~~**Section B**~~ ~~a) Binomial, Poisson and Normal Distribution.~~ ~~b) Correlation and Regression: Least Square method of fitting, Standard error of estimate, Correlation and regression coefficient.~~ ~~c) Basic idea of significance testing, level of significance, students't' test, χ^2 (chi-square) test and F-test, Analysis of variance.~~ ~~**Section C**~~		**This course has been replaced by new course of ENVS Environmental Statistics and Research Methodology in II semester**

			a) Introduction of Research Methodology: Meaning and importance, Nature and areas of research in Biological Sciences. b) Formulation of a research problem (Hypothesis). c) Elements in Research Methodology; Research Designs (CRD, RBD, LSD). d) Ethical, Legal and Social Issues in Biological Research. e) Writing of Research Report/Research Paper : Various components and their organization. **Recommended Books :** 1. Basotia, G.R. & K.K. Sharma, Research Methodology :. 2. Chaudhary, C.H., Research Methodology, RBSA Publication. 3. Daniell, W., Elements of Biostatistical in Health Science – 4. Enhance, D.N., Fundamentals of Statistics . 5. Gupta, S.P., Statistical Methods S. Chand Publications. 6. Khan and Khanam , Fundamentals of Biostatistics , Ukaz Publications. 7. Singh, S., et. al. (1988), Statistical methods for Research Central Publishing, Ludhiana. 8. Zerold Jar, 2008, Biostatistical Analysis (3rd edition) Pearson Dorling Kindersley (India), Pvt ltd.		

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
4	**~~BIO 408 Environmental Biology and Toxicology~~**	**After the completion of this course, students will be able to:** • **Recognize dangerous toxic compounds and what properties make them toxic.** • **Discuss the toxicological concepts of different toxic substances.** • **Predict the transport and fate of toxicants in environment.** • **Assess the effect of toxic substances on the environment health.**	**~~Section A~~** ~~a) Concept of energy, conventional & non-conventional energy sources. Fossil fuels, hydro, wind and nuclear power, geothermal, solar and bioenergy.~~ ~~b) Energy flow in organisms, energy pathways & models, energy efficiencies, conservation of energy.~~ ~~c) Classification & characteristics of resources: water, soil, forest, wild life, land use.~~ ~~d) Conservation of natural resources: water, soil, forest and wild life.~~ **~~Section B~~** ~~a) Origin of pollutants: industrial, agricultural, domestic and vehicular sources.~~ ~~b) Pollutant & their toxicology: Heavy metals and trace elements. agrochemicals (Pesticides, herbicides, rodenticides & fungicides, detergents) & particulate matter.~~ ~~c) Types of radiations including ionizing & non-ionizing radiations & their interaction with matter.~~ ~~d) Radiations as environmental pollutants.~~ ~~e) Effects of radiations at cellular, molecular & genetic level.~~ **~~Section C~~** ~~a) Mutagenecity, carcinogencity.~~ ~~b) Green house effect, acid rains.~~ ~~c) Ozone layer depletion, photochemical smog.~~ ~~d) Types of solid wastes, transport, reuse & recycling.~~ **~~Recommended Books:~~** ~~1. Clark, Bissel&Watham , Environmental Impact~~		**This course has been replaced by new course of ENVS Environmental Toxicology in II semester** **Some essential components regarding toxicology have been added in proposed syllabus**

			Assessment. 2. Encyclopedia of pollution & its control : Vol. I-VI 3. Eugene P. Odum., Fundamentals of Ecology 4. R.L. Smith, Field Biology Timberell J.A, Introduction to Toxicology		

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
5	**ENVS 406 Environmental Legislation**	**After the completion of this course, students will be able to:** **• Explain fundamental concepts in environmental law and policy.** **• Describe the main Environmental Law and Policy regime of the country.** **• Outline various international environmental laws in incorporated into environmental policies of national and state governments.** **• Examine and analyse legal approaches to pollution control, environmental planning and natural resource management.** **• Examine implementation issues associated with environmental regulation and**	**Section A** **Fundamental Principles of Domestic and International Environmental Law** a) State sovereignty, co-operation, Indian Constitutional provision (Fundamental rights, Directive principal of State Policy and Fundamental duties) role of courts b) Key elements of some International Declarations (Stockholm, Rio declaration, Agenda 21, Kyoto protocol on Climate Change) c) Sustainable development: Polluter Pay Principle, Precautionary Principle, Preventive Principle, Intergenerational Equity **Section B** **Domestic Laws on Environment** a) The Environmental Protection Act 1986, Definition of pollution and pollutant b) Power of Central government, The water (Prevention and Control of Pollution) Act 1974 – Definitions, Construction Power and functions of Boards c) The Air (Prevention and control of Pollution) Act, 1981 – Definitions, Constitution Power and functions of Boards, National environmental Tribunal Act1995 ~~d) The national Environmental Appellate Authority Act 1997~~ **Section C** **Environment Related Other Laws and Policies** a) The Forest conservation Act 1980, b) The Wildlife Act 1972, the Cruelty against Animal Act 1960 c) Environmental Impact Assessment Rules 2006,	**Section A** **Fundamental Principles of Domestic and International Environmental Law** a) State sovereignty, co-operation, Indian Constitutional provision (Fundamental rights, Directive principal of State Policy and Fundamental duties) role of courts b) Key elements of some International Declarations (Stockholm, Rio declaration, Agenda 21, Kyoto protocol on Climate Change) c) Sustainable development: Polluter Pay Principle, Precautionary Principle, Preventive Principle, Intergenerational Equity **Section B** **Domestic Laws on Environment** a) The Environmental Protection Act 1986, Definition of pollution and pollutant b) Power of Central government, The water (Prevention and Control of Pollution) Act 1974 – Definitions, Construction Power and functions of Boards c) The Air (Prevention and control of Pollution) Act, 1981 – Definitions, Constitution Power and functions of Boards. **d) National Green Tribunal Act 2010** **Section C** **Environment Related Other Laws and Policies** a) The Forest conservation Act 1980, b) The Wildlife Act 1972, Prevention of Cruelty to Animals Act, 1960 c) Environmental Impact Assessment Rules 2006, d) Bio-Medical waste (management & handling)	**Reviewed outcomes and suggested e-learning materials** **The repeated content is removed to maintain the level of detailing and an essential component are added.**

		environmental regimes	d) Bio-Medical waste (management & handling) rules 1998, e) Hazardous waste (Management and Handling)Rules 1989 and 2000 **Recommended Books:** 1. Diwan,Shyam and Rosencranz, Armin (2002) : Environmental Law and Policy in India, New Delhi, Oxford University Press. 2. Krishna ,Leela. Environmental Law in India, Delhi, Lexis Nexis, Butterworth wadhwa , 3. S.Santakumar's Introduction to Environmental Law, Nagpur, Lexis Nexis, Butterworth wadhwa **4.** Sahasranaman, (2009) :P.B.Handbook of Envuironmental Law in India , New Delhi , Oxford University Press.	rules 1998, Hazardous waste (Management and Handling) Rules 1989 and 2000) **Recommended Books:** **1. Bhatt, S. (2004). *Environment Protection and Sustainable Development*. New Delhi, India: APH.** **2. Diwan, S. &Rosencranz, A. (2002). *Environmental Law and Policy in India* (2nd ed.). New Delhi, India: Oxford University Press.** **3. Leelakrishnan, P. (2010). *Environmental Law in India* (3rd ed.). New York, NY: Lexis Nexis.** **4. Naseem, M., &Naseem, S. (2018). *InterationalEnvironmental Law*. Netherlands: Wolters Kluwer.** **5. Sahasranaman, P.B. (2012). *Handbook of Environmental Law* (2nd ed.). New Delhi, India: Oxford University Press.** **6. Shantha, K. S. (2008). *Introduction to Environmental Law* (2nd ed.). New York, NY: LexisNexis.** **Suggested e-learning materials:** **1. Environmental Legislation in India https://nptel.ac.in/courses/105104099/39** **2. Environmental Law https://swayam.gov.in/courses/5163**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
~~6~~	**ENVS ~~407~~ Environmental Physics**	**After the completion of this course, students will be able to:** • **Apply the concepts and laws of physics that govern the environment.** • **Measure different environmental parameters.** • **Describe applications of laser and detection of environmental pollutants by laser absorption.** • **Describe LIDAR technique and its applications.**	**Section-A** a) The scope of environmental physics b) Laws of thermodynamics, reversible and irreversible thermodynamical process and entropy, Specific heats, Gas Laws for isothermal and adiabatic processes, Lapse rate c) Water and Water Vapour: vapour pressure, dew point, saturation vapour pressure deflect, specific and relative humidity d) Transport laws: General transfer equation, molecular transfer process, diffusion coefficients e) Radiation Laws: black body radiations, Wien's law, Stefan's law, Planck's law, Cosine law for emission and absorption, reflectivity, radiance and irradiance, Wind chill, Hypothermia **Section-B** a) Radiation Environment- Solar Radiation: solar constant, sun-earth geometry, attenuation in the atmosphere, solar radiation at the ground; Terrestrial Radiation; Cloudless skies, Cloudy skies b) Microclimatology of radiations (interception): Direct and diffused solar radiations, Shape factors, canopies of black leaves c) Microclimatology of radiations (absorption and reflection): radiative properties of natural materials **Section-C** a) Laser applications, Laser light transmission through the atmosphere, molecular absorption and particle scattering techniques for detection of molecules of pollutants by absorption of laser,		**Course has been shifted to pool of discipline electives in III semester.**

			b) Remote monitoring capabilities of laser systems, LIDAR technique and its applications ~~c)~~ Microwaves; Environmental aspects of microwaveradiations, Microwave decomposition of toxicvapour stimulants~~.~~ **~~Recommended Books:~~** ~~1. Garg S. C., Bansal R. M., Ghosh C. K, Thermal Physics:; Publisher: McGraw Hill Education (India).~~ ~~2. John, Monteith L. and Unsworth M.H., Principles of Environmental Physics; Publisher: Eastern Book Linkers, London (2nd Edition)~~ ~~3. Orazio S., Principles of Laser, Publisher: Springer.~~ ~~4. Wei G., Schmoldt D., Slusser J.R., UV Radiation in Global Climate Change: Measurements, Modeling and Effects on Ecosystem; Publisher: Springer (2010).~~		

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
7	ENVS ____ Environmental Statistics and Research Methodology	After the completion of this course, students will be able to: • Apply statistical tools to perform data analysis and data interpretation. • Develop problem formulation using multiple statistical relationships and solve them using standard techniques. • Draw conclusions from the use of tables, graphs, and charts. • Have the versatility to work effectively in a broad range of analytic and scientific positions.		**Section A** Basic idea of Environmental Statistics and its applications in Environmental research.Collection, classification, tabulation of data. Frequency distribution Diagrammatic and graphical presentation of statistical data, sampling techniques. Central tendency – concept; arithmetic mean, median, mode for ungrouped and grouped data. Measures of dispersion: range, mean deviation, standard deviation and variance. **Section B** Probability, Binomial, Poisson and Normal Distribution, simple measure of Skewness and Kurtosis. Correlation and Regression: Karl Pearson correlation coefficient and Spearman rank correlation coefficient, Regression. Basic idea of significance testing, level of significance, Student's t-test, $\varkappa^2$ (chi-square) test and F-test and analysis of variance (ANOVA). **Section C** Introduction of Research Methodology: Formulation of a research problem (Hypothesis). Simple experimental designs, Writing of Research Report/Research Paper: Review of literature, The IMRaDformat,Citation and Impact factor, Science citation index (SCI)/ Science citation index Expended (SCI-E), H-index, Citation style (APA, MLA) Academic Ethics and Plagiarism, Intellectual Property Rights and Patent law. Recommended Books : 1. Basotia, G.R. & Sharma, K.K. (1999). *Research Methodology*. Jaipur, India: Mangal Deep. 2. Chaudhary, C.H. (2009). *Research Methodology*. Rajasthan, India: RBSA. 3. Daniel, W. (1987). *Biostatistics: A Foundation for Analysis in the Health Sciences* (4th ed.). New York, NY: John Wiley & Sons Inc.	Introduction of new course.

				4. Elhance, D.N., Elhance, V., &Aggarwal, B.M. (2014). *Fundamentals of Statistic*s. New Delhi, India: KitabMahal. **5. Gupta, S.P. (2014). *Statistical Methods* (43rd ed.). New Delhi, India:S. Chand.** **6. Khan, I.A., &Khanum, A. (2009). *Fundamentals of Biostatistics*. Hyderabad, India: Ukaaz.** **7. Zerold, J. (2008). *Biostatistical Analysis* (3rd ed.). Noida, India: Dorling Kindersley.** **Suggested e-learning materials:** **1. Descriptive Statistics- Measures of Central Tendency and Dispersionhttps://nptel.ac.in/courses/110106064/4** **2. Guidelines for Thesis Preparation http://www.iitk.ac.in/doaaold/thesisguide.pdf** **3. How to Write a Paper www-mech.eng.cam.ac.uk/mmd/ashby-paper-V6.pdf** **4. Introduction to researchhttps://nptel.ac.in/courses/121106007** **5. Methodology for Design Research https://nptel.ac.in/courses/107108011** **6. Research Writinghttps://onlinecourses.nptel.ac.in/noc18_mg13/preview**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
8	ENVS ____ Environmental Toxicology	After the completion of this course, students will be able to: • Recognize dangerous toxic compounds and what properties make them toxic. • Discuss the toxicological concepts of different toxic substances. • Predict the transport and fate of toxicants in environment. • Assess the effect of toxic substances on the environment health.		**Section A** Principles in toxicology; Definition of Xenobiotics. Concepts of LD50; Dose-effect and dose-response relationship. Biological and chemical factors that influence toxicity; Bio-transformation and bio-accumulation. Eco-system influence on the fate and transport of toxicants Abiotic Stress response in living systems. **Section B** Origin of pollutants: industrial, agricultural, domestic and vehicular sources. Pollutant & their toxicology:Heavy metals (Pb and Cr)and trace elements. agrochemicals (Pesticides, herbicides, & fungicides, detergents) & particulate matter. Global dispersion of toxic substance Types of radiations including ionizing & non-ionizing radiations & their interaction with matter. **Section C** Radiations as environmental pollutants. Effects of radiations at cellular, molecular & genetic level, Mutagenesis, Carcinogencity. Recommended Books: 1. Ahmad, P., & Prasad, M. N. V. (2012). *Abiotic Stress Responses in Plants: Metabolism, Productivity and Sustainability*. New York, NY: Springer-Verlag.	Introduction of new course.

				2. **Ahmad, P., Ahanger, M.A., Singh, V.P., Tripathi, D.K., Alam, P., &Alyemeni, M.N. (2018). *Plant Metabolites and Regulation under Environmental Stress*. Massachusetts, MA: Academic Press.** 3. **Cockerham, L.G., & Shane, B.S. (1993). *Basic Environmental Toxicology*. Florida, FL: CRC Press.** 4. **Gaur, R.K., & Sharma, P. (2013). *Molecular Approaches in Plant Abiotic Stress*. Florida, FL: CRC Press.** 5. **Gaur, R.K., & Sharma, P. (2014). *Approaches to Plant Stress and their Management*. New Delhi, India: Springer.** 6. **Newman, M.C. (2014). *Fundamentals of Ecotoxicology: The Science of Pollution* 4th ed.). Florida, FL: CRC Press.** **Suggested e-learning materials:** **1.Environmental Toxicology https://nptel.ac.in/courses/120108002/** **2.Toxicological Chemistry https://nptel.ac.in/courses/122106030/**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
9.	**ENVS 404L Environment Lab-II**	**After the completion of this course, students will be able to:** • **Perform water quality analysis.** • **Perform biochemical analysis of plant samples.** • **Access and plot geospatial data for environmental modeling.** • **Demonstrate applications of remote sensing in natural resource management.**	~~1. Measurement of size of particles by laser technique~~ ~~2. Measurement of thermal conductivity of different materials~~ ~~3. Measurement of speed of electromagnetic radiations of different frequencies~~ ~~4. Measurement of nuclear radiations in environment~~ ~~5. Study of heat transfer by radiations and convections~~ ~~6. To Determine the Hydraulic Conductivity~~ ~~7. To verify Stefan's law~~ ~~8. To verify Planck's law~~ ~~9. Estimation of total hardness.~~ ~~10. Estimation of Calcium content.~~ ~~11. Estimation of Magnesium content.~~ ~~12. Estimation of Chloride content.~~ 13. ~~Estimation of Sulphate content.~~ 14. Estimation of Alkalinity. ~~15. Estimation of dissolved Oxygen.~~ 16. Estimation of Fluoride. 17. Effect of toxicants on insects. 18. Experiment based on food preferences in insects. 19. Land Use/ Land Cover mapping 20. Crop area estimation using remote sensing 21. Forest cover and density mapping 22. Water quality modelling using remote sensing and GIS 23. Flood hazard analysis using multi- temporal imagery 24. Site suitability for solid waste management	1. Estimation of Chloride content. 2. Estimation of Alkalinity. **3. Estimation of organic carbon in soil sample.** 4. Estimation of Fluoride. **5. Estimation of MDA in plant sample.** **6. Estimation of Chlorophyll a in plant samples** **7. Estimation of Chlorophyll b in plant samples** **8. Estimation of Carotenoids in plant sample** **9. To study plant population density by quadrate method** **10. To study plant frequency by quadrate method** 11. Estimation of sodium in soil samples/ sludge sample 12. Estimation of Potassium in soil samples 13. Estimation of Cr and Pb in soil samples/ sludge sample 14. Crop area estimation using remote sensing 15. Forest cover and density mapping 16. Water quality modeling using remote sensing and GIS 17. Flood hazard analysis using multi- temporal imagery 18. Site suitability for solid waste management 19. Effect of toxicants on insects. 20. Experiment based on food preferences in insects. **Recommended Books:** **1. Avery, T.E. & Berlin, G.L. (1985). *Interpretation of Aerial photographs* (4th ed.). Minneapolis: Burgess.** **2. Burrough, P.A. & McDonnell, R.A. (1998). *Principles of Geographic Information Systems (Spatial Information Systems)* (2nd ed.). Oxford, UK: Oxford University Press.** **3. Heywood, I., Cornelius, S., & Carver, S. (2006). *An introduction to geographical information***	**Reviewed outcomes and suggested e-learning materials** **Some new practical's on chlorophyll, carotenoids have been introduced in the second semester to avoid replication and some repeated practical's are deleted**

				systems (3rd ed.). Harlow, England: Pearson Prentice Hall. 4. Lillesand, T.M., Kiefer, R.W. &Chipman J.W. (2011). *Remote Sensing and Image interpretation* (7th ed.).Hoboken, NJ: John Wiley and Sons. 5. Maiti, S.K. (2011). *Handbook of Methods in Environmental Studies. Vol. 1: Water and Wastewater Analysis.* Jaipur, India: Oxford Book Company. 6. Maiti, S.K. (2011). *Handbook of Methods in Environmental Studies. Vol. 2: Soil and Air Analysis.* Jaipur, India: Oxford Book Company. 7. Rajaraman, V., &Adabala, N. (2014) Fundamentals of Computers (6th ed.). New Delhi, India: Prentice Hall. **Suggested e-learning materials:** 1. Analysis of major constituents in water https://nptel.ac.in/courses/122106030/ 2.Water Quality Monitoring: Collection of water samples and estimation of physical parameters https://nptel.ac.in/courses/103107084/4	

THIRD SEMESTER

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1	**ENVS_ Air Pollution Monitoring, Control Technology and Management**	**After the completion of this course, students will be able to:** • **Describe various air pollutants and their sources.** • **Describe the consequences on human health.** • **Predict the control measures of air pollutant depending upon source and type.** • **Illustrate stack sampling and mitigation strategies of SOx and NOx**		**Section A** Air pollution: Definition, sources and effects. Air pollutants; Classification and properties, emission sources, major emissions from global sources and importance of Anthropogenic sources. Effects of air pollution on health, vegetation and materials damages. Photochemical smog. **Section B** Control techniques and equipments for air pollution, particulate emission control: Gravitational settling chambers, cyclone separators, fabric filters, electrostatic precipitator, wet scrubbers. Control of specific gaseous pollutants; control of SOx, control of NOx, control of hydrocarbons, and control of carbon mono-oxide **Section C** Air pollution sampling and measurement: Types of pollutant sampling and measurement, ambient air sampling, collection of gaseous air pollutants, collection of particulate pollutants, stack sampling, analysis of air pollutants **Recommended Books:** **1. Buonicore, A., & Theodore L. (1994). *Air Pollution Control Equipment: Selection, Design, Operation and Maintenance.*NewYork,NY: Springer-Verlag.** **2. Buonicore, A., Wayne, T., & Davis (1992). *Air Pollution Engineering Mannual*. New York,NY: Van Nostrand Reinhold.** **3. Burke, G., Singh, B. R. & Theodore, L. (2000). *Handbook of Environmental Management and Technology*(2nd ed.). New York, NY: John Wiley & Sons.** **4. Cavaseno, V. (1980). *Industrial Air Pollution Engineering*. New York,NY: Mcgraw-Hill.** **5. Cheremisinoff, N. P., (2002). *Handbook of Air pollution prevention and control.* Oxford, UK:Butterworth-heinemannElsevier science.**	**Introduction of New Course** **This course has been shifted to core of III semester from pool of elective of III semester.**

				6. **Cheremisinoff, P. N. (1993).** ***Air Pollution Control and Design for Industry*****. New York,NY: Marcel Dekker.** 7. **De, N. N. (2000).** ***Air Pollution Control Engineering*****(2nd ed.). New York, NY: McGraw-Hill Companies.** 8. **Heinsohn, R.J. &Kabel, R.L. (1999).** ***Sources and Control of Air Pollution*****.NewJersey,NJ:Prentice.** 9. **Kovacs, M. 1995.** ***Pollution Control and Conservation*****. Chichester: Ellis Horwood.** 10. **Kumar, S. & Kumar, R. (2012)*****Air Quality – Monitoring and Modeling*****.Croatia,Rijeka:InTechJanezaTrdine.** 11. **Lodge, J. P. (1988).** ***Methods of Air Sampling and Analysis*****(3rd ed.). Boca Raton, FL: Lewis.** 12. **Metcalf & Eddy, Inc. (1991).** ***Wastewater Engineering-Treatment, Disposal and Reuse*****(3rd ed.).New York,NY: McGraw-Hill.** 13. **Stern, A. C. (1976).** ***AIR POLLUTION Measuring, monitoring and surveillance of air pollution*** **(3rd ed.). Massachusetts, MA:Academic Press.** 14. **Stern, A. C. (1986).** ***AIR POLLUTION. Supplement to measuring, monitoring and surveillance and engineering control of air pollution*****(3rd ed.).Massachusetts, MA:Academic Press.** 15. **William, F., &DeRose, (2004)** ***Principles and Practices of Air Pollution Control,*****United States Air Pollution Training Institute (APTI)** **Suggested e-learning materials:** 1. **Environmental air pollution https://nptel.ac.in/courses/105102089/air%20pollution%20(Civil)/Module-2/1.htm** 2. **Stack Monitoring https://nptel.ac.in/courses/105102089/8** 3. **Guidelines for the Measurement of Ambient Air Pollutantshttp://cpcb.nic.in/openpdffile.php?id=UmVwb3J0RmlsZXMvMjdfMTQ1ODExMDQyNl9OZXdJdGVtXzE5Nl9OQUFRTVNfVm9sdW1lLUkucGRm** 4. **Air pollution control technologies**	

				http://capacitydevelopment.unido.org/wp-content/uploads/2014/11/25.-Air-Pollution-Control-Technologies-Compendium.pdf **5. Kinetics of Air Pollution and Combustion Process https://nptel.ac.in/courses/105104099/**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
2	**ENVS ~~504~~ Disaster Management and Mitigation Strategies**	**After the completion of this course, students will be able to:** • **Explain natural and manmade disaster and associated socio-economic impact .** • **Discuss key concepts, definitions and perspectives of disaster Management** • **Describe the Disaster Management Cycle.** • **Describe planning for hazard mitigation.**	**Section A** **Introduction to Disaster and Hazards** a) Hazards and Disaster: Definition and Difference; Types of Hazards and Disaster; causes and consequences b) Prediction and Indicators of Natural Disasters c) Natural Disasters – Earthquakes, Cyclones, Floods, Drought and Landslides d) Man Made Disaster – Nuclear and Chemical **Section B** **Impact of Disaster and Case Studies** a) Social, Economic and Health impacts of Disaster b) Floods - one case study with special reference to Brahmaputra Basin c) Drought – one case study with special reference to Vidarbha and Telangana region d) Earthquake – one case study with special reference to Himalayan region e) Nuclear – Hiroshima and Nagashakhi **Section C** **Natural Disaster Management and Preparedness** a) Disaster Management: Prevention, Preparedness and Mitigation b) Planning and control of Natural Disaster c) National and State level planning for Hazard Mitigation d) Role of Natural Disaster Management Authority **Recommended Books:** ~~1. BMTPC & CDMM (2003) : Landslide Hazard Zonation of India, New Delhi.~~ ~~2. Bolt, B.A. (1988) : Earthquakes WH Freeman~~	**Discipline Elective**	**The course has been shifted to pool of discipline electives in III semester.**

			& Company, New York. 3. Decker, R.W. & BB Decker (1998): Volcanoes, 3rd Edition WH Freeman & Company, New York. 4. Dowrick, D. (2003) : Earthquake Risk Reduction Zone Wiley & Sons Ltd, Sushex England. 5. Drake, F. (2000) :Global Warming the Science of Climate Change, Oxford University Press, New York. 6. Gere, J.M., Shah., H.C. (1984) : Terra Non Firme Understanding and Preparing for Earthquakes, WH Fremman& Company, New York. 7. Govt. of India, (2002), Drought2002 a Report (part I), Ministry of Agriculture, Dept. of Agriculture and Cooperation , New Delhi. 8. Govt. of India, (2002), Drought 2002 States Report (part II), Ministry of Agriculture, Dept. of Agriculture and Cooperation , New Delhi. 9. Govt. of India, (2004), Annual Reports, Ministry of Agriculture, Dept. of Agriculture and Cooperation, 1999-2000, 2002-2003, 2003-2004, New Delhi. 10. IGNOU (2005) :Understanding Natural Disasters, Shagun Offset Press, Noida. 11. IMD (1972) :Cyclone and safeguards, New Delhi. 12. Inca., M. (1990) : The Rising Seas, Earthscan, London. 13. IPCC (2001) : Climate Change, University of Cambridge. 14. Prakash, I. (1994) :Disaster Management – RastriyaPrahariPrakashan, Ghaziabad. 15. Roy., S. (2004) : Natural Disaster Management – a case study of Tornado, Abhijit		

			Publications, New Delhi. 16. Savindra S. (2015) : Environmental Geography, Pravika Publications, Allahabad. 17. Sharma, V.K. (1995) : Disaster Management (ed.), IIPA, New Delhi. 18. Singh, Tej (2006) : Disaster Management Approaches and Strategies, Akanksha Publishing House, New Delhi 19. Sinha, D.K. (2006) : Towards Basics of Natural Disaster Reduction, Reasearchco, Book Centre, New Delhi. 20. Thomas, B. (1993) : disaster response: A Handbook for Emergencies, CASA, New Delhi. 21. Ward, R. (1978) : Floods A Geographical perspective, Mac. Millan press Ltd. suggested e-learning materials:		

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
3	**ENVS ~~505~~ Energy Auditing and Conservation**	**After the completion of this course, students will be able to:** • **Describe Energy audits for building.** • **Describe energy conservation measures.** • **Explain energy efficient lighting technologies and its application in commercial and residential sectors.** • **Describe Energy storage technologies and Energy Auditing**	**Section A** a) Barriers to energy conservation, Key energy issues to 2025, Carbon dioxide emission, Energy Audits for building (Background, Energy Audit Procedures, Energy Management Programs & Energy Conservation Measures). b) Electrical Energy Management in Buildings (Principal Electricity Uses in Building, Strategies for Electricity End-Use Management), Heating, Ventilating and Air-Conditioning Control Systems (Modes of Feedback Control, Basic Control Hardware, Basic Control Systems Design Considerations & Example of HVAC Control Systems). c) Energy Efficient Lighting Technologies and Their Applications in the Commercial And Residential Sectors (Design of Energy-Efficient Lighting Systems, Lighting Technologies, Efficient Lighting Operation, Current Lighting Markets and Trends **Section B** a) Energy Efficient Technologies: Major Appliances and Space Conditioning Equipment (Description of Major Appliances and Space Conditioning Equipment, Current Production & Efficient Designs), Heat Pumps (Basic Principles, Solar-Assisted Heat Pump Systems &Geothermal Heat Pumps). b) Industrial Energy Efficiency and Energy Management (Energy Efficiency and Energy Management Improvement, Improving Energy Audits, Electricity End Uses and Electrical Energy Management). **Section C** a) Electric Motor System Efficiency (Motor System Efficiency & Energy Saving Applications).	**Discipline Elective**	**The course has been shifted to pool of discipline electives in III semester.**

			b) Energy Storage Technologies (Overview of Storage Technologies, Principal Forms of Stored Energy, Applications of Energy Storage, Specifying Energy Storage Devices, Specifying Fuels, Energy Storage: Direct Electric, Electrochemical, Mechanical, Direct Thermal & Thermochemical). **Recommended Books:** 1. ~~Abbi YP and Jain S., (2006) : Handbook on Energy Audit and Environment Management,(TERI Press).~~ 2. ~~Goswami D. Y., & Frank K., (2007) : Energy Management and Conservation Handbook (edited) (CRC Press (Taylor & Francis Group).~~ 3. ~~Goswami D. Y., & Frank K., (2015) : Energy Efficiency & Renewable Energy Handbook, (edited) Second Edition, CRC Press (Taylor & Francis Group).~~ 4. ~~PolimerosG., (1981) :Energy Cogeneration Handbook, (Industrial Press, Inc., New York.~~ 5. ~~ThrelkeldJ.L ., (1970) : Thermal Environmental Engineering, Second Edition (Prentice Hall).~~ 6. ~~Trinks, W ., Mawhinney, M.H., Shannon,R.A. Reed RJ., GarveyJ.R. (2003): Industrial Furnaces, SixthEdition, (John Wiley & Sons).~~ 7. ~~TurnerWC (2007) :Energy Management Handbook, Seventh Edition, (Fairmont Press Inc.).~~ 8. ~~Witte,LC.,SchmidtPS and BrownD.R., (1998) : Industrial Energy Management and Utilization (Hemisphere Publishing Corporation, Washington).~~		

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
4	**ENVS ~~508~~ Environmental Impact Assessment and Management**	**After the completion of this course, students will be able to:** • **Describe Scope of Environmental Impact Assessment and its Objectives.** • **Describe various approaches for various environmental impact studies** • **Illustrate various steps of Environmental Impact Assessment and its methodologies.** • **Construct Environmental Impact Assessment plan for Industrial projects**	**Section A** **Introduction:** a) Historical development of Environmental Impact Assessment (EIA) b) Definition and scope of EIA c) Objectives of EIA d) Basic EIA principles. **Impact study:** a) Approach for environmental impact studies b) EIA as planning tool c) EIA methodology d) Predictive model of impact assessment. **Section B** **Impact Prediction and assessment for air, water and noise: Air:** a) Knowledge of air quality, Air quality standards, Sources of pollutants, Effects of pollutions b) Conceptual approach for air impacts prediction. **Water:** a) Information on water quality (Surface water and ground water), water quality standards b) Identification and prediction of impact and assessment. **Noise:** a) Information on noise legislation and guidelines b) Methodology for noise-impacts prediction c) Assessment of impact significance. **Section C** **Environmental Risk Assessment (ERA) and Management in EIA:** Environmental risk assessment, treatment of uncertainty, key steps. **Management Plan**: a) Impact prediction, evaluation and mitigation b) Preparation of EIA plan for industrial project and	**Discipline Elective**	**The course has been shifted to pool of discipline electives in III semester.**

			functions c) Factors for consideration, managing the EIA process, Monitoring and auditing. ~~**Recommended Books:**~~ ~~**1. Anjaneyulu, Y. (2003). *Environmental Impact Assessment* (2nd ed.).Hyderabad, India: B.S.**~~ ~~**2. Attri S. D.,&Tyagi A. (2010*). Climate Profile of India*. Ministry of Earth Sciences, New Delhi, India**~~ ~~**3. Glasson J., Therivel R. & Chadwick A. (1999). *Introduction to Environmental Impact Assessment*(4th ed.). London, UK: Routledge.**~~ ~~**4. Lawrence, D. P. (2003). *Environmental Impact Assessment — Practical solutions to recurrent problems.*New Jersey, NJ:Wiley-Interscience.**~~ ~~**5. Petts, J. (1999). *Handbook of Environmental Impact Assessment*. New Jersey, NJ:Blackwell Science.**~~		

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
5	ENVS 510 Solid Waste Management	After the completion of this course, students will be able to: • Describe solid waste generation, composition and characterization. • Describe waste recycling, 3R technology and fly ash management. • Outline the landfill design. • Discuss monitoring and control of radiation pollution.	_____	_____ Recommended Books: 1. Agarwal, S. K. (1997). *Environmental Issues and Threats*. New Delhi, India: A P H. 2. Barrow, C. (1993). *Developing the Environment Problems and Management.*Abingdon, UK: Routledge 3. Dhamija, U. (2006). *Sustainable Solid Waste Management-Issues Policies and Structures*. New Delhi, India: Academic Foundation. 4. Hosetti, B. B., & Kumar, D. (1998).*Environmental Impact Assessment and Management*. New Delhi, India:Daya. 5. Manual on Municipal Solid Waste Management (2011).*Prepared by the Expert Committee constituted by the Government of India,* Ministry of Urban Development. 6. Peter, C. (1998). *Handbook of Environmental risk Assessment and Management*. New Jersey, NJ: Blackwell Science. 7. Rasure, K. A. (2007). *Solid Waste Management, Environment and Sustainable*	Reviewed outcomes and suggested e-learning materials No change in content

				***Development*. New Delhi, India: Serials.** **8. Salomons, W. &Forstner, S. L. (1990). *Environmental Management of Solid waste*.Heidelberg,Berlin: Springer-Verlag.** **9. Sundaresan, A. D., &Bhide, B. B. (1987). *Solid Waste Management in Developing countries*. New Delhi, India: INSDOC.** **Suggested e-learning materials:** **1. Solid waste Management https://nptel.ac.in/courses/104103020/42** **2. Hazardous waste Management https://nptel.ac.in/courses/120108005/module9/lecture9.pdf** **3. Landfill Engineering Systemhttps://nptel.ac.in/courses/105106052/downloads/Lecture-40.pdf** **4. Landfill Type and Liner Systems http://ce561.ce.metu.edu.tr/files/2013/11/liner-1.pdf** **5. Types of Landfill http://www.mfe.govt.nz/waste/guidance-and-technical-information/types-of-landfills** **6. Management of High Level Radioactive waste http://www.barc.gov.in/pubaware/nw.html** **7. Radioactive waste Managementhttp://www.barc.gov.in/pubaware/nw_n3.html**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
6	**ENVS _ Water Pollution Monitoring, Control Technology and Management**	**After the completion of this course, students will be able to:** • **Describe water pollution and water resource management** • **Describe waste water sampling method** • **Illustrate characterization of waste water.** • **Distinguish primary, secondary and tertiary waste water treatment methods.**		**Section A** Water pollution- Causes and Pollutants, Categories of waste water, generation of waste water, Water resource management. **Section B** Waste water sampling and monitoring ,Methods of analysis, determination of organic matter, inorganic substances, Physical characteristics of bacterial measurement **Section C** Waste water treatment, Basic processes of primary treatments; Pre treatment, sedimentation and floatation. Secondary treatments; Activated sludge process, Trickling filter, sludge treatment and disposal. Advanced waste water treatment, N-removal, P-removal, Advanced Biological Systems, Chemical oxidation, Removal of suspended solids, Dissolved solids. **Recommended Books:** **1. Bartram, J., & Balance, R. (2007). *Water Quality Monitoring. A practical guide to the design and implementation of freshwater quality studies and monitoring programmes.*London,UK:Chapman& Hall.** **2. Burke, G., Singh, B. R., & Theodore, L. (2000). *Handbook of Environmental Management and Technology*(2nd ed.).New York, NY: John Wiley & Sons.** **3. Eilbeck, W. J. & Mattock, G. (1987). *Chemical Processes in Waste Water Treatment.*Chichester, UK:EllisHorwood Limited.** **4. Gray, N. F. (1990). *Activated Sludge, Theory and Practice.* Oxford, UK:Oxford University Press.**	**The course has been shifted to core of III semester from the electives in III semester.**

				5. Helmer, R., &Hespanhol, I. (1997).*Water Pollution Control - A Guide to the Use of Water Quality Management Principles.*UNEP. Suffolk, Great Britain: St Edmundsbury Press. 6. Kostas, V., &Dimitra, V. (2012). *Water Quality Monitoring and Assessment.*Rijeka, Croatia:InTechOpen. 7. Loucks, D. P., &Beek, E. V. (2005).*Water Resources Systems Planning and Management An Introduction to Methods, Models and Applications, Studies and Reports in Hydrology.* UNESCO. 8. UNEP, (2008). *Water Quality for Ecosystem and Human Health*(2nd ed.). Ontario, Canada: UNEP 9. UNICEF, (2008). *Handbook on Water Quality.*New York. NY: Children's Fund UNICEF. Suggested e-learning materials: 1. Wastewater Management https://nptel.ac.in/courses/105105048/ 2. Water and Waste Water Engineering https://nptel.ac.in/courses/105104102/ 3. Industrial Waste Water Engineering https://nptel.ac.in/courses/105106119/36 4. Waste water sampling procedure http://www.epa.ie/licences/lic_eDMS/090151b28036bb01.pdf 5. Waste water Nutrient Removal https://www.des.nh.gov/organization/divisions/water/wmb/rivers/watershed_conference/documents/2009_fri_infastructure_3.pdf	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks

7	**ENVS 506L: Environment Lab-III**	**After the completion of this course, students will be able to:** • **Illustrate physical and chemical characterization of waste.** • **Illustrate the process of vermiculture.** • **Enlist major steps of Environmental Impact Assessment (EIA) process.** • **Determine sound level from various sources.**	• ~~Impact of land use patterns on biodiversity over a period of time~~(Field Survey). • ~~List of Impacts at the stage of construction and operation.~~ • ~~To collect and interpret various water sample data.~~ • ~~To conduct survey of microorganisms of water and soil~~. • To measure sound from different sources. • To record and analysis of climate trends by taking meteorological data of rainfall and temperature. • ~~Physical composition of solid waste / refuse~~ • Physical characterization of solid waste / refuse. • Construct the composting pit. • Construct the pit for vermiculture. • Planning and design of landfill sites. • EIA methods in Solid waste disposal- Leopold matrix and overlay. • Study of biogas plant. • ~~Determination of soluble and insoluble fraction in community solid waste.~~ • ~~Measurement of intensity of solar radiation.~~ • ~~Estimation of efficiency of solar photovoltaic panels~~ • ~~Effect of Shadow & tilt angle on solar photo voltaic panel~~ • ~~Study on solar photo voltaic panel in series and parallel combination~~ • ~~Study on charging characteristics of a lead acid battery using solar photo voltaic~~ • ~~Study on green house effect on solar flat plate collector~~	**1. Determination of Flouride in water sample.** **2. Determination of Sulphate in water sample.** 3. Physical characterization of solid waste / refuse. **4. To determine COD in waste water samples.** **5. Determination of VSS and TSS in soil/sludge samples** **6. Determination of available Phosphorous in soil/sludge samples** 7. EIA methods in Solid waste disposal- Leopold matrix and overlay. 8. To measure the intensity of sound from different sources. **9. To analyze Particulate matter in air samples** **10. To analyse SO_2 in air samples** **11. To analyse NO_2 in air samples** **12. To estimate Proline in plant leaves** 13. To record and analysis of climate trends by taking meteorological data of rainfall and temperature. 14. Construct the composting pit. 15. Construct the pit for vermiculture. 16. Planning and design of landfill sites. 17. Study of biogas plant. 18. Field Survey **Recommended Books:** **1. Lakshmi, G. S. (2012). *Environmental Science : A Practical Manual*. Delhi, India: B.S.** **2. Maiti, S.K. (2011). *Handbook of Methods in Environmental Studies. Vol. 1: Water and***	**Reviewed outcomes and suggested e-learning materials** **Some basic Environmental Science practical exercises on estimation of fluoride and COD wasintroduced in the course curriculum and some practical's were eliminated.**

			~~• Estimation of instantaneous efficiency of a solar liquid flat plate collector~~ ~~• Study on solar flat plate collector in series and parallel combination~~ ~~• Estimation of efficiency of solar air heaters~~ ~~• Performance evaluation of concentrating solar collector~~ ~~• Performance evaluation of solar cooker~~	***Wastewater Analysis.*** **Jaipur, India: Oxford Book Company.** **3. Maiti, S.K. (2011).** ***Handbook of Methods in Environmental Studies. Vol. 2: Soil and Air Analysis.*** **Jaipur, India: Oxford Book Company.** **4. Narasalah, G. L. (2012).*Environmental Science : A Practical Manual*. Delhi, India: B.S.** **Suggested e-learning materials:** **1. Environmental Science, http://download.nos.org/333coursee/prac_manual.pdf** **2. Virtual Lab http://www.vlab.co.in/** **3. Environmental Science Basics https://www.nios.ac.in/online-course-material/sr-secondary-courses/enviornmental-science-(333).aspx**	

~~ELECTIVES~~

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1	**ENVS ~~501~~ Air Pollution Monitoring, Control Technology and Management**	**After the completion of this course, students will be able to:** • **Describe various air pollutants and their sources.** • **Describe the consequences on human health.** • **Predict the control measures of air pollutant depending upon source and type.** • **Illustrate stack sampling and mitigation strategies of SOx and NOx**	**Section A** a) Air pollution: Definition, sources and effects. b) Air pollutants; Classification and properties, emission sources, major emissions from global sources and importance of Anthropogenic sources. c) Effects of air pollution on health, vegetation and materials damages. Photochemical smog. **Section B** a) Control techniques and equipments for air pollution, particulate emission control: Gravitational settling chambers, cyclone separators, fabric filters, electrostatic precipitator, wet scrubbers. b) Control of specific gaseous pollutants; control of SOx, control of NOx, control of hydrocarbons, and control of carbon mono-oxide **Section C** Air pollution sampling and measurement: Types of pollutant sampling and measurement, ambient air sampling, collection of gaseous air pollutants, collection of particulate pollutants, stack sampling, analysis of air pollutants **Recommended Books:** ~~1. Alan Andrews (2014), The Clean Air A Practical Guide To EU Air Quality Law, Clientearth274 Richmond Road London~~ ~~2. Arthur C Stern (1976.), AIR POLLUTION. Volume III Measuring, monitoring and surveillance of air pollution. THIRD EDITION.. Academic Press.~~ ~~3. Arthur C Stern (1986), AIR POLLUTION. Volume VII. Supplement to measuring, monitoring and surveillance and engineering control of air pollution. THIRD EDITION.. Academic Press.~~ ~~4. Buonicore A, Wayne T. Davis (1992). Air Pollution Engineering Mannual. Van Nostrand Reinhold, New York, USA.~~ ~~5. Buonicore A., Theodore L. (1994). Air Pollution Control~~		**This course has been shifted to core of III semester from the pool of discipline electives in III semester.**

			Equipment: Selection, Design, Operation and Maintenance. Springer-Verlag, New York, USA. 6. Burke G, Singh B R and Theodore L (2000). *Handbook of Environmental Management and Technology*, 2nd edition. John Wiley & Sons, Inc. New York. 7. Burke G.H., Singh B.R., and Theodore L. (2000). Handbook of Environmental Management and Technology (Second Edition). John Wiley & Sons, Inc.,New York, USA. 8. Cavaseno V. (1980). Industrial Air Pollution Engineering. Mcgraw-Hill Publications Co., New York, N.Y.,USA. 9. Cheremisinoff P.N. (1993). Air Pollution Control and Design for Industry. Marcel Dekker, Inc., New York, USA. 10. De Nevers N.(2000). Air Pollution Control Engineering (second edition). McGraw-Hill Companies, USA. 11. Franck, William and DeRose, (2004) Principles and Practices of Air Pollution Control, United States Air Pollution Training Institute (APTI) 12. Heinsohn R.J. and Kabel R.L.(1999). Sources and Control of Air Pollution. Prentice, New Jersey, USA. 13. James P Lodge(1988.), Methods of Air Sampling and Analysis. Third Edition. Lewis Publishers. 14. Kovacs, M. 1995. Pollution Control and Conservation. Ellis Horwood Ltd., Chichester.398p 15. Kumar S. and Kumar R. (2012) Air Quality – Monitoring and Modeling Published by InTechJanezaTrdine 9, 51000 Rijeka, C 16. Metcalf & Eddy, Inc. (1991). *Wastewater Engineering Treatment, Disposal, and Reuse*, 3rd edition, McGraw-Hill, New York. 17. Nicholas p. Cheremisinoff, (2002) handbook of Air pollution prevention and control, butterworth-heinemann of elsevier science. Printed in the United States of America		

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
2	**ENVS ~~502~~ Biodiversity and Conservation**	**After the completion of this course, students will be able to:** • **Explain importance of biological diversity.** • **Describe major threats to biodiversity.** • **Recognize and implement the various methods of biodiversity conservation with co-existence of various environmental pressures.** • **Identify different geographical biodiversity hotspots and mega-diversity centers.**	**ENVS 502 Biodiversity& Conservation** **Section A** a) Introduction to biodiversity concepts, significance, magnitude and distribution. b) Biodiversity trends, diversity gradients and related hypotheses methods for monitoring biodiversity trends. **c)** Threats to biodiversity, major causes, extinction's, vulnerability of species to extinction, IUCN threat categories, Red data book. **Section B** a) Principles of biodiversity conservation Ex situ and In situ methods of conservation, Genetical and evolutionary principles in conservation. b) Conservation of biological diversity and its significance- source of food, medicine, raw material, aesthetic, cultural and ecosystem services. c) Concepts, distribution and importance of Hot spots. d) Strategies for sustainable exploitation of biodiversity. **Section C** a) Conservation – efforts in India, Endangered flora & fauna of India. b) Ethan botany in India & selected medicinal plants. c) Wildlife conservation in India- Project Tiger, Project crocodile, silent valley controversy. Conservation of Himalayan, Gangetic ecosystems. **Recommended Books:** ~~1. Global biodiversity status of the earth's living resources. Published by Crapman and Hall, 2-6 Boundary Row, London SEI 8HN. Compiled by World Conservation Monitoring Centre.~~		**This course has been moved to semester II as a core paper.**

			2. Kovacs, M. (1995) : Pollution Control and Conservation, Ellis Horwood Ltd., Chichester. 398p 3. Kumar A., Biodiversity and environment. Published by A.P.M. Publishing Corporation, New Delhi. 4. Kumar and Asija. Biodiversity – Principles and conservation. Published by UpdeshPurohit for Agrobios, Jodhpur, India. 5. Mishra, R. (1968) : Ecology Work Book Oxford and IBH Publishing Co, Calcutta, pp. 244. 6. Odum, E.P. (1983) : Basic Ecology. Saunders College Publishing, Holt Saunders, Japan, 613. 7. Odum, E.P. Fundamentals of Ecology, Natraj Publisher, Dehradun 8. Singh, Vishwakarma. Forest environment and biodiversity. Daya Publishing House, Delhi. 9. Sinha, B.N. (1990) : Eco system Degradation in India. Ashish Publishing House, New Delhi. Tewari, D.N. Biodiversity and forest genetic resources. Published by InternationalBook Distributions, Dehra Dun		

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
3	**ENVS 503 Biotechnology Application to Environmental Science**	**After the completion of this course, students will be able to:** • **Describe heavy metal pollution and outline control measure of global warming.** • **Describe ozone depletion, acid rain and nuclear accidents** • **Describe biosensor development to monitor pollution** • **Explain the management of sludge and biodegradation of hydrocarbons.**	**Section A** a) Definition and Scope of Environmental Biotechnology; Environmental Pollution; Types, Causes and Effects of Soil, air, water, oil and heavy metal. b) Pollution, control measures. Social Issues- Green House Gases, Global Warming, Acid Rain, Ozone depletion, nuclear accidents and holocaust. c) Purification of waste water; Aerobic and anaerobic treatments; Laboratory methods for the detection of coli form organisms in water; Water recycling methods; Management of radioactive pollutants in water, VOC, COD BOD and BOD sensors. **Section B** a) Molecular biology tools for Environmental management, rDNA technology in waste treatment, Genetically modified organisms in Waste management, Genetic Sensors, Metagenomics, Bioprospecting, Nanoscience in Environmental management, Phytoremediation for heavy metal pollution, Biosensor development to monitor pollution. b) Biomass waste as renewable source of energy, Cellulose and Hemi cellulose as source of energy Biocomposting, Vermiculture, Biofertilizers, Organic farming, Biofuels, Biomineralization, Bioethanol and Biohydrogen, **Section C** a) Bioelectricity through microbial fuel cell,	**Discipline Electives**	**Reviewed outcomes and suggested e-learning materials** **No change in content** **Move to Discipline Electives**

			Conversion of Solid Waste to Methane; Biogas production, Management of Sludge and Solid waste treatment- Land filling, lagooning, Ecofriendly agriculture. b) Definition, Types- Ex situ and In situ Bioremediation; genetically Engineered Microbes for Bioremediation; Bioremediation of Ground Water; Biodegnidation of Hydrocarbons, Pesticides, Herbicides, Insecticides and Xenobiotics. **Recommended Books:** ~~1. Chakraborty K.D. Omen G.S. (1989) : Biotechnology and Bio degradation, Advances in Applied Biotechnology series, Vol. I, Gulf Publications Co. London.~~ ~~2. Foster C.F; lohnware D.A. (1987) : Environmental Biotechnlogy.Ellis Harwood Ltd.~~ ~~3. Sharma DL., Organic farming~~ ~~Thakur, I.S., (2006) : Environmental Biotechnology- Basic concepts and Applications.~~		

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
4	**ENVS 507 Environmental Health Management**	**After the completion of this course, students will be able to:** • **Explain the concept of environmental health.** • **Identify different environmental factors that affect health.** • **Discuss the preventive and protection measures for various water borne diseases.** • **Describe the seasonal changes and protection measures for various air borne bio-allergen.**	**Section A** a) Meaning of health: Physical, Mental and Social b) Environmental factors influencing health: Urbanization & congestion, pollution. c) Environmental health criteria, Concept of environmental health management **Section B** a) WHO classification of diseases and their distribution:Water borne diseases; Prevention and protection of community health from water borne diseases. b) Air borne bio-allergents; present in the ambient air, seasonal changes, mode of dispersal, disease intensity and control. **Section C** a) Effects of Physical Environment on Accidents, Crime, Suicide and Diseases of Man b) Effects of temperature, humidity, ionization, ultra violet radiation and acidity of air on skin, lungs, throat, nose, eye, nervous system. c) Effects of weather and climate on diseases, mental processes, working efficiency, traffic and industrial accidents, behaviour, suicide and suicide attempts, effect of thermal stress and altitude on the action of drug. **Recommended Books:** ~~1. Abdul, M., et.al. (2014) : Environmental~~	**Discipline Electives**	**Reviewed outcomes and suggested e-learning materials** **No change in content** **Move to pool of Discipline Elective**

			Deterioration and Human Health, Springer Dordrecht Heidelberg London. 2. Ahluwalia, V.K. (2015) : Environmental Pollution and Health, TERI, New Delhi. 3. Annalee, Y., et.al. (2001) : Basic Environmental Health, Oxford University Press, New York. 4. Kathryn, H. (2006) : Environmental Health Ecological Perspective, Jones & Bartlett Learning, Sudbury, Massachussetts. 5. Robert, H.F., Essentials of Environmental Health, 2nd Edition, Jones & Bartlett Learning, Sudbury, Massachussetts. Singh, A.L. (2010) : Environment and Health, B.R. Publishers, New Delhi.		

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
5	**ENVS ~~511~~ Water Pollution Monitoring, Control Technology and Management**	**After the completion of this course, students will be able to:** • **Describe water pollution and water resource management** • **Describe waste water sampling method** • **Illustrate characterization of waste water.** • **Distinguish primary, secondary and tertiary waste water treatment methods.**	**Section A** a) Water pollution- Causes and Pollutants b) Categories of waste water, generation of waste water c) Water resource management. **Section B** a) Waste water sampling and monitoring b) Methods of analysis, determination of organic matter, inorganic substances c) Physical characteristics of bacterial measurements. **Section C** a) Waste water treatment, Basic processes of primary treatments; Pre treatment, sedimentation and floatation. b) Secondary treatments; Activated sludge process, Trickling filter, sludge treatment and disposal. Advanced waste water treatment, N-removal, P-removal, Advanced Biological Systems, Chemical oxidation, Removal of suspended solids, Dissolved solids. **Recommended Books:** ~~1. Burke G, Singh B R and Theodore L (2000) :*Handbook of Environmental Management and Technology*, 2nd edition. John Wiley & Sons, Inc. New York.~~ ~~2. Daniel P. Loucks and Eelco van Beek (2005) : Water Resources Systems Planning and Management An Introduction to Methods, Models and Applications, Studies and Reports in Hydrology UNESCO PUBLISHING~~ ~~3. Eilbeck W J and Mattock G (1987). *Chemical Processes in Waste Water Treatment*, Ellis Horwood Limited.~~ ~~4. Gray N F (1990). *Activated Sludge, Theory and Practice*, Oxford University Press, Oxford.~~ ~~5. Jamie Bartram and Richard Balance (2007) Water Quality~~		**This course has been moved from elective pool of Semester III to core of semester III.**

			Monitoring. A practical guide to the design and implementation of freshwater quality studies and monitoring programmesPublished on behalf of United Nations Environment ProgrammePublished by E&FN Spon, an imprint of Chapman & Hall, 2-6 Boundary Row, London UK 6. Kostas Voudouris and DimitraVoutsa, (2012) Water Quality Monitoring and Assessment Published by InTechJanezaTrdine 9, 51000 Rijeka, Croatia 7. Metcalf & Eddy, Inc. (1991). *Wastewater Engineering Treatment, Disposal, and Reuse*, 3rd edition, McGraw-Hill, New York. 8. Richard Helmer and IvanildoHespanhol (1997) Water Pollution Control - A Guide to the Use of Water Quality Management Principles *Edited by*, United Nations Environment Programme, First edition 1997 © WHO/UNEP Printed in Great Britain by St Edmundsbury Press, Bury St Edmunds, Suffolk 9. UNEP, Water Quality for Ecosystem and Human Health, 2nd Edition Prepared and published by the United Nations Environment Programme Global Environment Monitoring System GEMS)/Water Programme. Burlington, Ontario, CANADA 10. UNICEF (2008) : Handbook on Water Quality, United Nations Children's Fund (UNICEF), New York.		

List of Discipline Electives

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1	**ENVS 503 Biotechnology Application to Environmental Science**	**After the completion of this course, students will be able to:** • **Describe heavy metal pollution and outline control measure of global warming.** • **Describe ozone depletion, acid rain and nuclear accidents** • **Describe biosensor development to monitor pollution** • **Explain the management of sludge and biodegradation of hydrocarbons.**		**Section A** Definition and Scope of Environmental Biotechnology; Environmental Pollution; Types, Causes and Effects of Soil, air, water, oil and heavy metal. Pollution, control measures. Social Issues- Green House Gases, Global Warming, Acid Rain, Ozone depletion, nuclear accidents and holocaust. Purification of waste water; Aerobic and anaerobic treatments; Laboratory methods for the detection of coli form organisms in water; Water recycling methods; Management of radioactive pollutants in water, VOC, COD BOD and BOD sensors. **Section B** Molecular biology tools for Environmental management, rDNA technology in waste treatment, Genetically modified organisms in Waste management, Genetic Sensors, Metagenomics, Bioprospecting, Nanoscience in Environmental management, Phytoremediation for heavy metal pollution, Biosensor development to monitor pollution. Biomass waste as renewable source of energy, Cellulose and Hemi cellulose as source of energy Biocomposting, Vermiculture, Biofertilizers, Organic farming, Biofuels, Biomineralization, Bioethanol and Biohydrogen, **Section C** Bioelectricity through microbial fuel cell,	**Reviewed outcomes and suggested e-learning materials** **No change in content** **Shifted to the pool of Discipline Electives**

				Conversion of Solid Waste to Methane; Biogas production, Management of Sludge and Solid waste treatment- Land filling, lagooning, Ecofriendly agriculture. Definition, Types- Ex situ and In situ Bioremediation; genetically Engineered Microbes for Bioremediation; Bioremediation of Ground Water; Biodegnidation of Hydrocarbons, Pesticides, Herbicides, Insecticides and Xenobiotics. **Recommended Books:** **1. Chakraborty, K. D., & Omen, G. S. (1989). *Biotechnology and Bio degradation, Advances in Applied Biotechnology series*. London, UK:Gulf.** **2. Rittmann, B. E. (2018). *Environmental Biotechnology*. New York, NY: Mcgraw-hill education.** **3. Sharma, D. L. (2002). *Organic farming*. Rajasthan: India:Agro-Bios.** **4. Thakur, I. S. (2006). *Environmental Biotechnology- Basic concepts and Applications*.New Delhi, India: I K International.** **Suggested e-learning materials:** **1. Nanobiotechnology in Environment https://nptel.ac.in/courses/102103045/download/mod6.pdf** **2. Biotechnology https://nptel.ac.in/courses/118107015/33** **3. Gene therapy in the treatment of diseasehttps://nptel.ac.in/courses/102103013/39**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
2	**ENVS_ Disaster Management and Mitigation Strategies**	**After the completion of this course, students will be able to:** • **Explain natural and manmade disaster and associated socio-economic impact .** • **Discuss key concepts, definitions and perspectives of disaster Management** • **Describe the Disaster Management Cycle.** • **Describe planning for hazard mitigation.**		**Section A** Introduction to Disaster and Hazards Hazards and Disaster: Definition and Difference; Types of Hazards and Disaster; causes and consequences, Prediction and Indicators of Natural Disasters, Natural Disasters – Earthquakes, Cyclones, Floods, Drought and Landslides, Man Made Disaster – Nuclear and Chemical **Section B** Impact of Disaster and Case Studies Social, Economic and Health impacts of Disaster, Floods - one case study with special reference to Brahmaputra Basin, Drought – one case study with special reference to Vidarbha and Telangana region, Earthquake – one case study with special reference to Himalayan region, Nuclear – Hiroshima and Nagashakhi **Section C** Natural Disaster Management and Preparedness Disaster Management: Prevention, Preparedness and Mitigation, Planning and control of Natural Disaster, National and State level planning for Hazard Mitigation, Role of Natural Disaster Management Authority **Recommended Books:** **1.BMTPC & CDMM (2003). *Landslide Hazard Zonation of India*. New Delhi, India.** **2.Decker, R. W. & Decker, B. B. (1998): *Volcanoes* (3rd ed.).NY, New York: WH Freeman & Company.** **3.Dowrick, D. (2003). *Earthquake Risk Reduction Zone*.Sushex, England: Wiley & Sons.** **4.Drake, F. (2000). *Global Warming the Science of Climate Change*.New York, NY: Oxford University Press.** **5.Gere, J. M. & Shah, H.C. (1984). *Terra Non***	**Reviewed outcomes and suggested e-learning materials** **This course was moved from core course of III semester to pool of discipline electives of III semester** **Shifted to the pool of Discipline Electives**

				FirmeUnderstanding and Preparing for Earthquakes*.** **New York, NY:WHFremman& Company.** **6.Govt. of India, (2002).** ***Drought 2002 a Report (part I), Ministry of Agriculture, Dept. of Agriculture and Cooperation*.** **New Delhi, India.** **7.Govt. of India, (2002).** ***Drought 2002 States Report (part II), Ministry of Agriculture, Dept. of Agriculture and Cooperation*.** **New Delhi, India.** **8.Govt. of India, (2004).** ***Annual Reports, Ministry of Agriculture, Dept. of Agriculture and Cooperation*, 1999-2000, 2002-2003, 2003-2004. New Delhi, India.** **9.IGNOU (2005):** ***Understanding Natural Disasters*.** **Noida, India: Shagun Offset Press.** **10. IMD (1972)** ***Cyclone and safeguards. **New Delhi, India.** **11. Inca, M. (1990).** ***The Rising Seas*.** **London, UK:Earthscan.** **12. Prakash, I. (1994).*Disaster Management.*Ghaziabad, India: RastriyaPrahari.** **13. Roy, S. (2004).** ***Natural Disaster Management – a case study of Tornado*.** **New Delhi, India:Abhijit.** **14. Savindra, S. (2015).** ***Environmental Geography*.** **Allahabad, India: Pravika.** **15. Sharma, V. K. (1995).** ***Disaster Management.*** **New Delhi, India: IIPA.** **16. Singh, T. (2006).** ***Disaster Management Approaches and Strategies*.** **New Delhi, India:Akanksha.** **17. Sinha, D. K. (2006).** ***Towards Basics of Natural Disaster Reduction*.** **New Delhi, India:Reasearch.** **18. Thomas, B. (1993).** ***Disaster Response: A Handbook for Emergencies*.** **New Delhi, India:CASA.** **Suggested e-learning materials:**	

				1. **Disaster Management https://swayam.gov.in/courses/4983-disaster-management** 2. **Natural and Man-Made Environment and Disasters https://nptel.ac.in/courses/122102006/9** 3. **Floods and Cyclones https://www.sac.gov.in/SACSITE/SAC-Flyers/menu-links/society/9.1%20FLOODS%20&%20CYCLONES.pdf** 4. **Surface and Ground water resources https://nptel.ac.in/courses/105105110/pdf/m6l02.pdf** 5. **Introduction to Engineering Seismology http://nptel.ac.in/courses/105108076/module6/lecture16.pdf**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
3	**ENVS_ Energy Auditing and Conservation**	**After the completion of this course, students will be able to:** • **Describe Energy audits for building.** • **Describe energy conservation measures.** • **Explain energy efficient lighting technologies and its application in commercial and residential sectors.** • **Describe Energy storage technologies and Energy Auditing.**		**Section A** Barriers to energy conservation, Key energy issues to 2025, Carbon dioxide emission, Energy Audits for building (Background, Energy Audit Procedures, Energy Management Programs & Energy Conservation Measures).Electrical Energy Management in Buildings (Principal Electricity Uses in Building, Strategies for Electricity End-Use Management), Heating, Ventilating and Air-Conditioning Control Systems (Modes of Feedback Control, Basic Control Hardware, Basic Control Systems Design Considerations & Example of HVAC Control Systems).Energy Efficient Lighting Technologies and Their Applications in the Commercial And Residential Sectors (Design of Energy-Efficient Lighting Systems, Lighting Technologies, Efficient Lighting Operation, Current Lighting Markets and Trends **Section B** Energy Efficient Technologies: Major Appliances and Space Conditioning Equipment (Description of Major Appliances and Space Conditioning Equipment, Current Production & Efficient Designs), Heat Pumps (Basic Principles, Solar-Assisted Heat Pump Systems & Geothermal Heat Pumps).Industrial Energy Efficiency and Energy Management (Energy Efficiency and Energy Management Improvement, Improving Energy Audits, Electricity End Uses and Electrical Energy Management). **Section C** Electric Motor System Efficiency (Motor System Efficiency & Energy Saving Applications).Energy Storage Technologies (Overview of Storage Technologies, Principal Forms of Stored Energy, Applications of Energy Storage, Specifying Energy Storage Devices, Specifying Fuels, Energy Storage: Direct Electric, Electrochemical, Mechanical, Direct Thermal & Thermochemical).	**Reviewed outcomes and suggested e-learning materials** **This course was shifted from core of III semester to pool of discipline elective in III semester.** **Shifted to the pool of Discipline Electives**

				Recommended Books: 1. **Abbi, Y.P., & Jain S. (2006). *Handbook on Energy Audit and Environment Management*. Delhi, India: TERI Press.** 2. **Goswami, D. Y., & Frank K. (2015). *Energy Efficiency & Renewable Energy Handbook*. Florida,Fl: CRC Press (Taylor & Francis Group).** 3. **Polimeros, G., (1981). *Energy Cogeneration Handbook*. New York, NY:Industrial Press.** 4. **ThrelkeldJ, L. (1970): *Thermal Environmental Engineering*(2nd Ed.). New Jersey, NJ: Prentice Hall.** 5. **Trinks, W., Mawhinney, M. H., Shannon, R. A. & Reed, R. J., & Garvey J. R. (2003). *Industrial Furnaces*(6thed.).New Jersey, NJ:JohnWiley& Sons.** 6. **Turner, W. C. (2007). *Energy Management Handbook*(7thed.). Georgia, USA: Fairmont Press.** 7. **Witte, L. C., Schmidt, P. S., & Brown, D. R. (1998). *Industrial Energy Management and Utilization*. Washington, WA: Hemisphere.** **Suggested e-learning materials:** **Energy Efficiency, Acoustics and daylighting in Building** **https://onlinecourses.nptel.ac.in/noc18_ce06/preview** 1. **Environment Management https://nptel.ac.in/courses/120108004/module9/lecture12.pdf** 2. **Energy Audit https://ecozensolutions.com/audit.pdf** 3. **Energy Management and Audit https://beeindia.gov.in/sites/default/files/1Ch3.pdf** 4. **Energy Conservation and waste heat recovery https://nptel.ac.in/courses/112105221**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
4	**ENVS 507 Environmental Health Management**	**After the completion of this course, students will be able to:** • **Explain the concept of environmental health.** • **Identify different environmental factors that affect health.** • **Discuss the preventive and protection measures for various water borne diseases.** • **Describe the seasonal changes and protection measures for various air borne bio-allergen.**		**Section A** Meaning of health: Physical, Mental and Social, Environmental factors influencing health: Urbanization & congestion, pollution.Environmental health criteria, Concept of environmental health management **Section B** WHO classification of diseases and their distribution:Water borne diseases; Prevention and protection of community health from water borne diseases. Air borne bio-allergents; present in the ambient air, seasonal changes, mode of dispersal, disease intensity and control. **Section C** Effects of Physical Environment on Accidents, Crime, Suicide and Diseases of Man, Effects of temperature, humidity, ionization, ultra violet radiation and acidity of air on skin, lungs, throat, nose, eye, nervous system. Effects of weather and climate on diseases, mental processes, working efficiency, traffic and industrial accidents, behaviour, suicide and suicide attempts, effect of thermal stress and altitude on the action of drug. **Recommended Books:** **1. Abdul, M. et.al. (2014). *Environmental Deterioration and Human Health*. Dordrecht Heidelberg London, England:Springer.** **2. Ahluwalia, V. K. (2015). *Environmental Pollution and Health*. New Delhi, India:TERI.** **3. Annalee, Y. et.al. (2001). *Basic Environmental***	**Reviewed outcomes and suggested e-learning materials** **No change in content** **Shifted to the pool of Discipline Elective**

				***Health*. New York, NY: Oxford University Press.** **4. Kathryn, H. (2006). *Environmental Health Ecological Perspective*. Sudbury, Massachussetts, MA: Jones & Bartlett.** **5. Robert, H. F. (2012). *Essentials of Environmental Health*(2nd ed.).Sudbury, Massachussetts, MA: Jones & Bartlett.** **6. Singh, A. L. (2010). *Environment and Health*. New Delhi,India:B.R.** **Suggested e-learning materials:** **1. Indoor Environmental Delhi http://textofvideo.nptel.ac.in/112107208/lec38.pdf** **2. Introduction to Environmental Health http://ocw.jhsph.edu/courses/environmentalhealth/lectureNotes.cfm** **3. The effects of temperature on human healthhttps://www.oulu.fi/sites/default/files/content/Ikaheimo_TM_Temperature_and_human_health_28102014.pdf**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
5	**ENVS _ Environmental Impact Assessment and Management**	**After the completion of this course, students will be able to:** • **Describe Scope of Environmental Impact Assessment and its Objectives.** • **Describe various approaches for various environmental impact studies** • **Illustrate various steps of Environmental Impact Assessment and its methodologies.** • **Construct Environmental Impact Assessment plan for Industrial projects**		**Section A** **Introduction:** Historical development of Environmental Impact Assessment (EIA) Definition and scope of EIA, Objectives of EIA, Basic EIA principles. **Impact study:** Approach for environmental impact studies EIA as planning tool, EIA methodology Predictive model of impact assessment. **Section B** **Impact Prediction and assessment for air, water and noise: Air:** Knowledge of air quality, Air quality standards, Sources of pollutants, Effects of pollutions, Conceptual approach for air impacts prediction. **Water:** Information on water quality (Surface water and ground water), water quality standards, Identification and prediction of impact and assessment. **Noise:** Information on noise legislation and guidelines, Methodology for noise-impacts prediction, Assessment of impact significance. **Section C** **Environmental Risk Assessment (ERA) and Management in EIA:** Environmental risk assessment, treatment of uncertainty, key steps. **Management Plan**: Impact prediction, evaluation and mitigation Preparation of EIA plan for industrial project and functions Factors for consideration, managing the EIA	**The course has been shifted to pool of discipline electives in III semester. From the core course.** **Shifted to the pool of Discipline Electives**

				process, Monitoring and auditing. **Recommended Books:** **1. Anjaneyulu, Y. (2003). *Environmental Impact Assessment* (2nd ed.).Hyderabad, India: B.S.** **2. Attri S. D.,&Tyagi A. (2010*). Climate Profile of India*. Ministry of Earth Sciences, New Delhi, India** **3. Glasson J., Therivel R. & Chadwick A. (1999). *Introduction to Environmental Impact Assessment*(4th ed.). London, UK: Routledge.** **4. Lawrence, D. P. (2003). *Environmental Impact Assessment – Practical solutions to recurrent problems.*New Jersey, NJ:Wiley-Interscience.** **5. Petts, J. (1999). *Handbook of Environmental Impact Assessment*. New Jersey, NJ:Blackwell Science.** **Suggested e-learning materials:** **1. Environment Impact Assessment, http://www.moef.nic.in/division/introduction-8 https://nptel.ac.in/courses/120108004/module3/lecture3.pdf** **2. EIA Documentation and Processes https://nptel.ac.in/courses/120108004/module4/lecture4.pdf** **3. EIA, EMP and EA https://nptel.ac.in/courses/123105001/36**	

S.N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
6	**ENVS_ Environmental Physics**	**After the completion of this course, students will be able to:** • **Apply the concepts and laws of physics that govern the environment.** • **Measure different environmental parameters.** • **Describe applications of laser and detection of environmental pollutants by laser absorption.** • **Describe LiDAR technique and its applications.**		**Section-A** The scope of environmental physics Laws of thermodynamics, reversible and irreversible thermodynamical process and entropy, Specific heats, Gas Laws for isothermal and adiabatic processes, Lapse rate Water and Water Vapour: vapour pressure, dew point, saturation vapour pressure deflect, specific and relative humidity, Transport laws: General transfer equation, molecular transfer process, diffusion coefficients Radiation Laws: black body radiations, Wien's law, Stefan's law, Planck's law, Cosine law for emission and absorption, reflectivity, radiance and irradiance, Wind chill, Hypothermia **Section-B** Radiation Environment- Solar Radiation: solar constant, sun-earth geometry, attenuation in the atmosphere, solar radiation at the ground; Terrestrial Radiation; Cloudless skies, Cloudy skies, Microclimatology of radiations (interception): Direct and diffused solar radiations, Shape factors, canopies of black leaves, Microclimatology of radiations (absorption and reflection): radiative properties of natural materials **Section-C** Laser applications, Laser light transmission through the atmosphere, molecular absorption and particle scattering techniques for detection of molecules of pollutants by absorption of laser, Remote monitoring capabilities of laser systems, LiDAR technique and its applications, Microwaves; Environmental aspects of microwave radiations, Microwave decomposition of toxic vapour stimulants. **Recommended Books:**	**Reviewed outcomes and suggested e-learning materials** **This course has been shifted from core course of II semester to discipline electives Pool of III semester**

				1. Garg, S. C., Bansal, R. M., &Ghosh, C. K, (2017). *Thermal Physics*. New Delhi, India: McGraw Hill. **2. John, M. L. &Unsworth M. H. (2013). *Principles of Environmental Physics* (4th ed.).London, UK: Academic Press.** **3. Wei, G., Schmoldt, D., &Slusser J. R. (2010). *UV Radiation in Global Climate Change: Measurements, Modeling and Effects on Ecosystem*. Netherland: Springer** **4.Boeker, E., & Van Grondelle, R. (2011). *Environmental physics: sustainable energy and climate change*(3rd ed.). New Jersey, NJ: John Wiley & Sons.** **Suggested e-learning materials:** **1. Laws of Thermodynamics https://onlinecourses.nptel.ac.in/noc17_mm16/preview** **2. Radiation heat radiation https://nptel.ac.in/courses/112108149/pdf/M9/Student_Slides_M9.pdf** **3. An introduction to underground mine environment and ventilation, https://nptel.ac.in/courses/123106002/MODULE%20-%20III/Lecture%201.pdf** **4. Lidar basic principles and applications, https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000017GE/P001697/M024733/ET/1509971402LIDARbasicprincipleandapplications(1.pdf**	

FOURTH SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1	ENVS __P Project	After completion of this course students should be able to: • Demonstrate competence for independent work in the field of Environmental Science and Technology. • Develop competency in , collection, classification, interpretation • Develop skills to analysis the collected data. • Handle the complex tasks of lab experiments including project report writing.			Reviewed outcomes

List of Reading Electives

S. No.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	ENVS___R Agroforestry	After completion of this course students should be able to: • Describe agroforestry and agroforestry interventions. • Assess the role of Agroforestry as a sustainable land-use activity. • Describe Nutrient cycling and role of agroforestry in soil and water conservation • Describe various energy plantation methods.		Agroforestry - definition and scope. Tropical deforestation, rising demands of fuel wood, fodder and timber, social, ecological and economic reasons for agroforestry. Traditional agroforestry systems: shifting cultivation, taungya, homegardens. Recent trends in Silviculture and Energy plantations. Trees in agricultural fields and farm boundaries. Commercial crops under shade of planted trees as well as natural forests. Agroforestry for wasteland development and temperate agroforestry practices. Nutrient cycling and role of agroforestry in soil and water conservation. Nitrogen fixation, improvement in soil physico-chemical properties. Soil organic matter status and soil organic matter, Soil fertility considerations in agroforestry nutrient needs of trees and crops. Recommended Books : 1. Chundawat, B. S., &Gautam, S. K. (2016). *Textbook of Agroforestry*. New Delhi, India: Oxford &Ibh. 2. Jose, S. (2009). *Agroforestry for Ecosystem Services and Environmental Benefits (Advances in Agroforestry)*. Dordrecht Netherlands: Springer 3. Mukherjee, A. (2016). *Agroforestry and Watershed Management: An Interlocked System*. New Delhi, India: Random. 4. Raj, A. J. (2017). *Agroforestry Theory and Practices*. Jodhpur, India: Scientific. Suggested e-learning materials: 1. Introductory Agroforestry http://ecoursesonline.iasri.res.in/course/view.php?id=157 2. Forestry Technologies http://agritech.tnau.ac.in/forestry/agroforestry_index.html	Introduction of New Course Reading Elective-II has been introduced in Semester IV along with Project

S. No.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	ENVS___R Energy Resources and Conservation	After completion of this course students should be able to: • Describe the non-conventional sources of energy. • Explain concepts on energy utilization and conservation. • Emphasize energy conservation strategies in residential, industrial and transportation sector. • Describe National Energy Policy.		Introduction: Energy, work and power. Classification of energy resources, An overview of the current global and National Energy Scenario. Fossil Fuels: Sources, exploration of oil, coal, natural gas, shale; Exploitation of Fossil fuels and their Environmental consequences. Nuclear Energy: Nuclear fission and Fusion; Nuclear fuel cycle, Nuclear reactor and nuclear power, Renewable and Alternative Energy Sources, Solar energy, Solar power, Photovoltaic cells; Wind power; Geothermal energy; Ocean energy. Environmental consequences of biomass resource harnessing, Energy Conservation: National Energy Policy, Energy efficient appliances, BEE Label, Modes of Energy Conservation in residential, industrial and transportation sector. Recommended Books : 1. Agarwal, S. K. (2003). *Nuclear Energy: Principles Practice and Prospects.* New Delhi, India: APH. 2. Chaturvedi, P. (1995). *Bio-Energy Resources.* New Delhi, India: Concept. 3. Dayal, M. (1997). *Renewable Energy: Environment and Development.* New Delhi, India: Konark. 4. Mahajan, V. S. (1991). *National Energy: policy, crisis and growth*. New Delhi, India: Ashish. 5. Markuszewski, R., &Blaustein, B. D. (1986). *Fossil fuels utilization. Environmental concerns*. Washington, DC: American Chemical Society. 6. Vandana, S. (2002). *Alternative Energy*. New Delhi, India: APH. Suggested e-learning materials: 1. Biodiesel production https://nptel.ac.in/courses/102105058/52 2. Sustainability through Green Manufacturing Systems: An Applied Approach https://nptel.ac.in/courses/112104225/22	Introduction of New Course Reading Elective-II has been introduced in Semester IV along with Project

S.N.	Course List	Learning Outcomes	Existing Syllabus	77	Suggested Syllabus	Remark

3.	**ENVS___R Man and Environment**	**After the completion of this course, students should be able to:** • **Describe the complex interactions of humans and ecological systems in the natural world.** • **Synthesize and apply a wide range of scientific literature in the ecological and environmental science.** • **Interpret a wide range of scientific literature in ecology and environmental science.** • **Apply the information in the realms of environmental sciences and sustainability.**		**Human Population, its Growth and Distribution, Environmental Deterioration associated with population growth, Man Induced Environmental Changes, Types of Human Activities, Impact of Human Activities such as Deforestation, Mining and Industrialization. Environmental Awareness- Need and Role in Betterment of Environment Concept and Significance of Environmental Movements, Environmental Movements in India with special reference to The Bishnoi Movement, Chipko Movement, Appiko Movement, Narmada Bachao Andolan, Silent Valley Movement. Components of natural and built environment: Resources and human settlements, modifications in natural environment, causes and consequences.** **Recommended Books :** **1. BalAnand, S. (2005). *An Introduction to Environmental Management*. Mumbai, India : Himalaya.** **2. Chandana, R. (2008). *A Geography of population*. New Delhi, India: Kalyani.** **3. Chopra, G. (2006). *Population Geography*. New Delhi, India: Commonwealth.** **4. Chorley, R. J., Schumm, S. A., &Sugden, D. E. (1984). *Geomorphology*. London,UK: Methuen and Company.** **5. Dayal, P. (1994). *A Text Book of Geomorphology*. New Delhi, India: Kalyani.** **6. Rapoport, A. (2016). *Human aspects of urban form: towards a man—environment approach to urban form and design*. Oxford, U.K. : Elsevier Pergamon Press.** **Suggested e-learning materials:** 1. **Environment and Ecology** **https://nptel.ac.in/courses/122102006/** 2. **Ecological Degradation and Environmental Protection** **https://nptel.ac.in/courses/109104045/35#**	**Introduction of New Course**

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	ENVS___R Water and Sustainable Development	After the completion of this course, students should be able to: • Classify major causes of exploitation of water resources, particularly in the Indian and Asian context. • Summarize rainwater harvesting and water conservation measures. • Describe methods of Irrigation management. • Describe importance of Wetlands and its conservation.		Water and sustainable development. Water and human health – Access to safe drinking water and sanitation; public health issues. Water and food production – Role of irrigation in food security. Shifts in cropping patterns, Rain-fed agriculture, increasing use of groundwater. Environmental, economic and social implications of exploitation of ground water resources. Water and human amenities – Urban water supplies; exploitation, conservation and rainwater harvesting. Wetland, its use and abuse with Ramsar Convention. Urban floods, storm water drainage and integrated urban water management (IUWM). Irrigation management – canals and micro-irrigation. Recommended Books : 1. Asawa, G. L. (2005). *Irrigation and Water Resources Engineering*, New Delhi, India: New Age. 2. Biswas, A. K., Jellau, M., & Stout, G. (1993). *Water for sustainable development in 21st century – A Global perspective*. New Delhi, Inida: Oxford University Press. 3. David, L. F. (2007). *Water Policy for Sustainable Development*. Baltimore, Maryland: Johns Hopkins University Press. 4. Jain, S. K., & Singh, V. P. (2003). *Water Resources Systems Planning and Management*. Amsterdam, Netherlands: Elsevier. Suggested e-learning materials: 1. Water, Society and Sustainability https://onlinecourses.nptel.ac.in/noc18_hs36/preview 2. Irrigation Efficiencies - II and Irrigation Methods and their Suitability https://nptel.ac.in/courses/105102159/15	Introduction of New Course

S. No.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
5.	GEOG ___ R Environmental Challenges and Disaster Management	After the completion of this course, students should be able to: • Explain approaches to study environmental development and crisis. • Describe world energy crisis with its causes and suggested measures for improvement. • Describe several environmental problems their causes, consequences and mitigation. • Depict the major disasters and their management with the help of case studies.		Environment:-Definition and types of Environment; Environmental Development Crisis:-Introduction and its causes; Energy Crisis:- Concept, Causes and Remedies; Environmental issues associated with Green Revolution; Impact of Urbanization on Environment. Deforestation:- Concept, Causes, Effects and Conservation; Desertification:- Concept, Causes, Impacts and Preventions; Water Scarcity:- Causes ; Methods of Rain Water Harvesting (special reference to Traditional Methods); Acid Rain:- Causes, Consequences and Mitigation Measures; Solid Waste:- Introduction, Types and Management. Disaster:- Definition and Classification; Natural Disaster:- Nature and Types; Flood:- Causes, Impacts and Methods of Management; Earthquake:- Introduction, Types, Causes, Effects and Mitigation; Case Studies:- Bhuj Earthquake-2001,Tsunami (Southern India)-2004 and Kedarnath Disaster-2013. * Note – Stencils are to be permitted during the examination. Recommended Books : 1. Gautam, A. (2010). *Environmental Geography*. Allahabad, India:ShardaPustakBhawan. 2. Ghosh,G.K. (2015). *Disaster Management*.New Delhi, India:A.P.H. 3. Singh, S. (2002). *Physical Geography*.Gorakhpur, India: Vasundhara. Suggested e-learning materials: 1. Deforestation:- Concept, Causes, Effects https://www.livescience.com/27692-deforestation.html 2. Acid Rain:- Causes, Consequences and mitigation measures https://www.conserve-energy-future.com/causes-and-effects-of-acid-rain.php 3. Solid Waste:- Introduction, Types and Management https://www.indiawaterportal.org/topics/solid-waste	Introduction of New Course Reading Elective-II has been introduced in Semester IV along with Project

S. N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark

6.	**GEOG R India: Socio-Political and Environmental Scenario**	**After the completion of this course, students should be able to:** • **Understand the current issues related with boundaries, water sharing, agricultural disparities, food security in India.** • **Describe problems in Agricultural Development.** • **Discuss Gender Issues and Women Safety.** • **Find the role of non – conventional energy resources for solving energy crisis.**		**Relation of India with neighbouring countries and border disputes with China and Pakistan. Drought problems, Interlinking of rivers as a solution of water crises and disputes of river water sharing with reference to Narmada, Krishna, Cauvery and Sutlej-Yamuna Link (SYL). Problems and disparities in agricultural development, food security and farmer suicides in India. Energy crisis in India and its solution with the help of nuclear, solar, hydro and wind power. Gender issues and women safety, poverty and unemployment.** **Recommended Books :** 1. **Deshpande, C.D. (1992).*India,A Regional Interpretation*. New Delhi, India:ICSSR& Northern Book Centre.** 2. **Gallaher, C. et al. (2012). *Key Concepts in Political Geography* (Reprint). New Delhi, India: Sage.** 3. **Hussain, A. (2007). *Political Geography*. New Delhi, India: Vishvabharti.** 4. **Singh, R. L. (Ed.).(1971). *India - A Regional Geography*. Varanasi, India: National Geographical Society.** 5. **Tirtha, R.,&Gopal, K.(1996).*Emerging India.* Jaipur, India: Rawat.** 6. बंसल, एस. सी. (2011). *भारतकाभूगोल.* मेरठ,भारत: मीनाक्षी. **Suggested e-learning materials:** 1. **Interlinking of rivers https://www.geoecomar.ro/website/publicatii/Nr.19 2013/12_mehta_web_2013.pdf** 2. **Farmer suicides http://www.ipcinfo.org/fileadmin/user_upload/fsn/docs/Agriculture%20and%20rural%20development%20in%20India.pdf** 3. **Food Security https://dfpd.nic.in/LwB3AHIAaQB0AGUAcgBlAGEAZABkAGEAdABhAC8AUABvAHIAdABhAGwALwBNAGEAZwBhAHoAaQBuAGUALwBEAG8AYwB1AG0AZQBuAHQALwA=1_93_1_Original.pdf** 4. **Gender Issues in India https://www.indiacelebrating.com/social-issues/gender-inequality-in-india/**	**Introduction of New Course**

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
7.	GEOG __ R Rajasthan: Challenges and Prospects	After the completion of this course, students should be able to: • Describe the major environmental, socio economic problems of Rajasthan. • Explain desertification, Aravalli development, agriculture and tourism of Rajasthan. • Analyze existing state and national policies in terms of socio economic conditions. • Aware society regarding existing policies related to child marriage, Female feticide and other Social problems.		Major Canal Irrigation Project and Its impact; Desertification and Desert Development programmes; Identification of drought prone areas and mitigation, problem of mining and Aravalli Development Programme, Problems and measures of Agricultural development; Programmes for forest conservation; Poultry farming, Planning for livestock development; Role of Tourism in the economy. Socio- economic issues and Government policies and programmes: child marriage, female feticide, female education, gender discrimination and caste; unemployment and poverty . Recommended Books : 1. Singh, G. (2010). *Geography of India*(9th ed.). Delhi, India: Atma Ram. 2. शर्मा, आर. (2010). *राजस्थानकाभूगोल.* उदयपुर, भारत: हिमाशुं. 3. शर्मा एच. एस.,एवंशर्मा, एम. एल. (2015). *राजस्थानकाभूगोल.*जयपुर, भारत:पचंशील. 4. सक्सैना, एच. (2014). *राजस्थानकाभूगोल.*जयपुर, भारत:राजस्थानहिन्दीग्रंथअकादमी. Suggested e-learning materials: 1. Indira Gandhi Canal https://www.rajras.in/index.php/indira-gandhi-canal/ 2. tourist spots in Rajasthan http://www.transindiatravels.com/rajasthan/tourist-places-to-visit-in-rajasthan/ 3. Problem of Desertification http://www.cazri.res.in/annals/1993/1993JA-1.pdf.	Introduction of New Course Reading Elective-II has been introduced in Semester IV along with Project

S. No.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
8.	GEOG___R Transforming India	After the completion of this course, students should be able to: • Assess the ongoing governmental policies applicable to socio-economic and health sectors. • Aware society about the injustice caused to women in terms of Triple Talaq. • Explain current livelihood struggle in the society and the role of skill development in enhancing quality of life. • Suggest the measures of improvement in the policies.		Transforming India into a digitally empowered society and development through digitalization, its effects and problems. Demonetization- a step to less cash to cash less economy. Indian youth as a change agent and quality of education for empowering Indian youth, Skill development and empowering youth, Population pressure in job sector and creating livelihood opportunities. Swachh Bharat Mission and Sanitation revolution for clean and healthy society, Ayushman Bharat Yojana- a step towards Health for all. Beti Bachao Beti Padhao- a step for girl's development and Triple Talaq in India- an injustice for women or religious issue. Recommended Books : 1. Ghosh, J., Chandrashekra, C.P.,&Patnaik, P.(2017).*Demonetisation Decoded*. New York, NY:Routledge. 2. Panigrahi, R.L.(2005*). Population problems in India*. New Delhi, India: DPH. 3. Sinha,M., &Sinha, R.K.(Ed). (2008). *Swachh Bharat, A clean India*. New Delhi, India:Prabhat. Suggested e-learning materials: 1.Transforming India http://transformingindia.in/ 2.Digital India https://www.indianeconomy.net/splclassroom/what-is-digital-india/ 3.Demonetization http://www.mbauniverse.com/group-discussion/topic/business-economy/demonetisation 4.Skill Development in India https://www.indiainfoline.com/article/article-latest/skill development-in-india-gaps-and-opportunities 118092700366_1.html 5.Swachh Bharat Mission https://www.mapsofindia.com/my-india/society/swachh-bharat-abhiyan-making-india-clean-more 6.Beti Bachao and Beti Padhao http://www.mbauniverse.com/group-discussion/topic/social-issues/beti-bachao-beti-padhao	Introduction of New Course Reading Elective-II has been introduced in Semester IV along with Project

S. N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
9.	GEOL___ R Geo Tourism	After the completion of this course, students should be able to: • Elucidate the criterion require for designating geotour sites. • Explore the geological and geographical attributes of the geosites. • Develop a geo-conservation plan for geotour sites. • Evaluate the potential of geosites for revenue generation.		Definition and scope of Geotourism. Principles of Geotourism. Geoconservation Plans. Introduction to geodiversity and Geopark. UNESCO's Global Geopark development program. Overview of GSI monuments and geotour sites-Sendra Granite of Pali District Rajasthan, Lonar Lake of Buldana District Maharastra, Peninsular Gneiss at Lalbagh Bangalore Karnataka, Natural Arch in Tirumala hills, Chitoor District-Barr Conglomerate, Pali District Rajasthan, Marine Gondwana Fossil Park, Fossil Wood Parks, Siwalik Fossil Park, Stromatolite Parks, Columnar Basalt, Pillow Lava, Pyroclastic Rocks, Nepheline Syenite, Welded Tuff, Charnockite, Great Boundary Fault, Eparchaean Unconformity, Tirumala hills. World's major geotour sites. Recommended Books : 1. Chen, A. (2015). *The Principles of Geotourism*. Beijing, China: Springer-Verlag. 2. Dowling, R.,& Newsome, D. (Eds.). (2018). *Handbook of Geotourism*. Gloucestershire, UK: Edward Elgar. 3. Dowling, R., & Newsome, D. (Eds.). (2005). *Geotourism*. Oxford, UK: Elsevier. 4. Newsome, D.,& Dowling, R. (Eds.). (2010). *Geotourism: The Tourism of Geology and Landscape*. Oxford, UK: Goodfellow. Suggested e-learning materials 1. UNESCO geological heritage and geo-tourism in Peruhttp://www.unesco.org/new/en/media-services/single view/news/unesco_geoparks_geological_heritage_and_geo_tourism_in_peru/ 2. Geotourismhttps://link.springer.com/referenceworkentry/10.1007%2F978-3-319-01669-6_93-1 3. Geotourism in India https://www.gsi.gov.in	Reading Elective-I was Introduced in III semester Introduction of New Course

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
10.	GEOL___R Indian Mineral Deposits, Economics and Mining Ethics	After the completion of this course, students will be able to: • Explain the distribution of mineral resources in India. • Evaluate the mineral resources and reserves in Indian and global perspective. • Familiarize with the concept of mineral legislation and policies. • Delineate the different environmental issues associated with mining activities.		Introduction to types and distribution of various mineral deposits in India. Occurrences of important metallic, non-metallic/industrial and fuel mineral deposits of India. Mineral economics and its major concept. Introduction for Global mineral resources. Conservation and substitution of minerals; changing pattern of mineral consumption, Growth of mineral industry and economy, Mineral industry and its adverse effect to the environment. Environmental baseline data needed for mine planning-Its acquisition and documentation during different stages of exploration. Nature and extent of environmental problems due to surface and underground mining. Legislation and control measures for mining. Mineral legislation in Indian context (The Mines and Minerals Regulation and Development Act, 1957). Reclamation and restoration of mined land. Recommended Books : 1. Arogyaswamy, R.N.P. (1995). *Courses in Mining Geology*(4th ed.). New Delhi, India: Oxford and IBH. 2. Banerjee, D. K. (1998). *Mineral Resources of India*(2nd ed.). Kolkata, India: The World Press. 3. Chatterjee, K.K. (1993). *An Introduction to Mineral Economics* (2nd ed.).Bangalore, India: New Age International. 4. Sharma, N.L.,& Ram, K.S.V. (1964). *Introduction to India's economic minerals*. Dhanbad, India: Dhanbad. 5. Sinha, R.K.,& Sharma, N.L. (1988). *Mineral Economics* (4th ed.).New Delhi, India: Oxford & IBH. Suggested e-learning materials: 1. Mineral and energy resources http://ncert.nic.in/ncerts/l/legy207.pdf 2. Economic Minerals of India: https://www.researchgate.net/publication/315831629_Economic_Minerals_of_India.	Introduction of New Course

S. No.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
11.	**GEOL____R Innovation and Entrepreneurship in Earth Sciences**	**After the completion of this course, students should be able to:** • **Understand necessary steps to open a new venture.** • **Gain an understanding of creating products or services, launching innovative projects and making R&D investments in a start-up context.** • **Develop marketing strategies for tools and technical products used in earth sciences.** • **Familiarize with the legal concepts and financial planning for a successful new venture.**		**An overview of Entrepreneurs and Entrepreneurship. Evolution and Growth of Earth Science. Entrepreneurship in India, Starting small business. Planning-Organization and Management. Basic layout of Proposal for seeking loan from financial institution, Legal requirements, Basic Financial Planning and problems. Case study of successful Earth Science Entrepreneurs in India Earth Science component in Government of India PSU (MECL, NHPC Mini Ratna, ONGC, NTPC, CIL Maharatna) and in MNC (Larsen and Toubro, Tata, Reliance, Vedanta, Dalmiya groups, Aditya Birla). Entrepreneurs Skills and Competencies. Earth Science technology for harnessing Innovation. Challenges of new startups, Marketing Strategies development, Tools and techniques for market Assessments, Methods and sources for market survey and Market Information. Presentation of Market Survey Report.** **Recommended Books :** **1. Clarysse, B. (2011). *The Smart Entrepreneur: How to Build for a Successful Business*. London, UK: Elliott & Thompson.** **2. Sethi, A. (2016). *From Science to Startup: The Inside Track of Technology. Entrepreneurship*.Göttingen, Germany: Copernicus & Springer.** **3. Westhead, P.,& Wright, M.(2013). *Entrepreneurship. A very short introduction*. Oxford, UK: Oxford University Press.** **Suggested e-learning materials:** **1. Sustainability, Innovation and Entrepreneurship https://nptel.ac.in/courses/110107094/26** **2. New Enterprises https://ocw.mit.edu/courses/sloan-school-of-management/15-390-new-enterprises-spring**	**Introduction of New Course** **Reading Elective-II has been introduced in Semester IV along with Project**

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
12.	GEOL____Natural Hazards and Disasters	After the completion of this course, students should be able to: • Explain the key concepts, definitions, perspectives of all hazards and management. • Describe prevention and mitigation of natural hazards. • Depict the preparedness response and recovery management of natural disasters. • Elucidate the sustainable development methods in disaster mitigation.		Introduction to Disasters and Hazards, Processes (Internal and External), Types of Hazards: causes and consequences, Prediction and Indicators of Natural Disasters, Socio-economic and Health impacts of Natural Disasters. Natural Disasters – Earthquake: Processes, Magnitude, Intensity and Impact. Volcanism: Types, Risks and Impact. Tsunami and Cyclone: Types, Causes, processes and Impact. Floods: Introduction, Magnitude, Frequency, Zonation and Impact. Mass Wasting: Classification, causes and Impact. Disaster Management: Prevention, Preparedness and Mitigation, Planning and control of Natural Disaster. Case Studies: Nepal Earthquake, Kedarnath Disaster, Bhuj Earthquake 2001. Recommended Books : 1. Bolt, B.A. (1988). *Earthquakes.* New York, NY: WH Freeman & Company. 2. Decker, R. W. & Decker, B. B. (2005). *Volcanoes* (4th ed.). New York, NY: WH Freeman & Company. 3. Dowrick, D. (2003). *Earthquake Risk Reduction Zone.* England,UK:John Wiley& Sons. 4. Gere, J.M.,& Shah, H.C. (1984). *Terra Non Firme Understanding and Preparing for Earthquakes.* New York, NY: WH Freeman & Company. 5. IGNOU (2005). *Understanding Natural Disasters*. eGyanKosh, Noida, India: Shagun Offset Press. 6. Keller, E.A.,&Devecchio, E.D. (2015). Natural Hazards (4th ed.). New York, NY: Pearson. 7. Keller, E.A. (1978). *Environmental Geology*(9th ed.). North Carolina, NC: Bell & Howell. 8. Montgomery, C.W. (2013). *Environmental Geology* (10th ed.). New York, NY:Mc-Graw-Hill. 9. Prakash, I. (1994). *Disaster Management*. Ghaziabad,India:RastriyaPrahari. 10. Sharma, V.K. (1995). *Disaster Management.* New Delhi, India: Indian	Introduction of New Course

				Institute of Public Administration (*IIPA*). 11. **Singh, S. (2015). *Environmental Geography*. Allahabad, India: Pravalika.** **Suggested e-learning materials:** **1. Introduction to Natural hazards** **https://epgp.inflibnet.ac.in/ahl.php?csrno=17** **https://onlinecourses.nptel.ac.in/noc19_ce14/preview** **2. Disasters and Hazards** **https://ndma.gov.in/en/**	

Note: Yellow highlighted and bold content illustrate the modification in the syllabus.

ANNEXURE II

BANASTHALI VIDYAPITH
SCHOOL OF EARTH SCIENCES

Name of the Programme:M. Phil. (Geography)

Programme Educational Objectives:

Banasthali Vidyapith is an epitome of tradition and modernity. Vidyapith aims to preserve and inculcate the essential values and ideals of Indian culture. It believes in simple living and high thinking. Our educational ideology is based on the concept of fivefold education focusing on physical, practical, aesthetic, moral and intellectual aspects in order to develop a balanced personality.

Geography is concerned with human and physical environmental systems and their interaction, mapping and measuring natural and man-made resources, designing ways of using them, analyzing the distribution of welfare, recognizing and averting hazards and reviewing social institutions. Man's lifestyle is influenced by physical aspects in its immediate surroundings and Geography act as a bridge between man and its environment.Geography is also related to human dimension wherein man using the resources and creates its economic dimension. Various arenas of human aspects such as business, trade, commerce, agriculture, industry, navigation, military operations, spacecraft and administration needs Geography as a foundation.

Students will gain profound knowledge of current research problems, approaches, and insights regarding the interactions between the environment and society in the context of global change. Students learn to integrate scientific theories, findings, and procedures in order to analyze and model human-environmental systems.

The main objectives of the Master of Philosophy Geography programme are:

- **To develop skills of assessing contrasting theories, explanations and policies; collecting, critically judging, evaluating and interpreting varied forms of evidence; preparing maps and diagrams; employing various methods of collecting and analyzing spatial and environmental information; combining and interpreting different types of evidence to tackle specific problems; and recognizing the ethical and moral dimensions of study.**
- **To develop oral presentation and report writing skills; and, make meaningful contributions to improving legal/administrative structures and procedures relevant to the environment and sustainable development.**
- **To conduct independent research of a professional quality and describe specific research techniques and explain the literature and concepts in the conduction of original research.**
- **To communicate the results of research in both oral and written forms; Entails demonstrating skills in oral presentation and the writing of formal papers during coursework, and ultimately, a dissertation.**

- **The opportunity to develop large-scale research management skills by completing a research thesis under academic supervision and guidance.**
- **To raise sensitivity for ethical codes of conduct, social values with help of eco-feminism, gender equality, social balance and respect for each strata of the society.**

Programme Outcomes:

- **PO1: Geography Knowledge: The outcomes of the course are achieved both through focused study of selected specialized aspects of geographical research and through development of more general research skills and methods. Develop in-depth knowledge of some substantive area(s) of geography and geographical research; develop their capacity to frame research questions, to derive appropriate research designs, and develop awareness of alternative approaches.**
- **PO2: Planning abilities:A comprehensive understanding of techniques and a thorough knowledge of the literature, applicable to their own research; demonstrated some self-direction and originality in tackling and solving problems, and acted autonomously in the planning and implementation of research.**
- **PO3:Design/development of solution for problems: The research skills strengthen them to formulate hypothesis about any form of social, economic and environmental problems and collect facts to prove it.**
- **PO4: Problem analysis: analyses the research problems occurring in our social and physical environment and develop methodology to depict and solve them. Demonstrate originality in the application of knowledge, together with a practical understanding of how research and enquiry are used to create and interpret knowledge in their field; shown abilities in the critical evaluation of current research problems and research techniques and methodologies.**
- **PO5: Modern tool usage: Use remote sensing and GIS techniques in medical, urban & rural settlements, environment, agriculture, resource, tourism and several other aspects from a geographical perspective. The applications can further enhance research in the discipline and contribute towards a better living environment. Acquired the skills to use library and internet resources independently and become critical and skilled readers of geographical and other research publications.**
- **PO6: Leadership skills: : develop a capability to manage research, including data management, conducting and disseminating research, working in a team, and understanding codes of research practice and research ethics.**
- **PO7: Professional Identity: understand, analyze and contribute towards the discipline adopting professions as an educator, researcher and specialist in different arenas of geography; Develop their capacity to frame research questions, to derive appropriate research designs, and develop awareness of alternative approaches; develop a competence and confidence in using a range of quantitative methods of gathering, analyzing and interpreting evidence.**
- **PO8: Geographical Ethics:Apply ethical principles in personal, professional and social levels. Demonstrate behavior that recognizes cultural and personal variability in values, communication and lifestyles. Use ethical frameworks; apply ethical principles while making decisions and take responsibility for the outcomes associated with the decisions.**
- **PO9: Communication: Communicate effectively with the Earth Science community and with society at large, by discussing their research at several levels in the form of conferences, seminars and symposium. They are able to comprehend and write effective presentations, documentation, research publications and with writing communicate their ideas at regional, national and international levels.**

- **PO10: The Geographer and society:Students contribute as a researcher by identifying socio-economic and environment problems and suggest measures, solutions to overcome the problems. Nevertheless, geographical specialists play an important role in the national development. With the help of most talented geographers, geographical theories are as much as the solution of the great problems of the society and economy, for which they requires a synthetic geographical approach.**
- **PO11: Environment and sustainability: employing various methods of collecting and analyzing spatial and environmental information; combining and interpreting different types of evidence to tackle environmental problems; and recognizing the ethical and moral responsibility towards sustainability.**
- **PO12: Life- long learning: students develop lifelong learning towards major issues and develop an attitude to depict them through their publications and presentation. They also become critical and skilled readers of geographical and other research publications. The research provides them an essential strength to describe or solve problem associated to different zones of the discipline. Students are familiar with an appropriate range of intellectual and methodological traditions within geographical research and the social sciences.**

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FIRST SEMESTER

Existing Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
~~EDU 617L~~	~~Sessional and Lab work (Teaching Practice)~~	~~0~~	~~0~~	~~4~~	~~2~~
~~EDU 619~~	~~Teacher, Teaching and Higher education~~	~~4~~	~~0~~	~~0~~	~~4~~
GEOG 607	Research Methodology and Statistical analysis in Geography	4	0	0	4
Semester wise Total		8	0	4	10

Proposed Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
GEOG 607	**Research Methodology and Statistical analysis in Geography**	**4**	**0**	**0**	**4**
GEOG___L	**Digital Cartography and Geoinformatics Lab**	**0**	**0**	**8**	**4**
GEOG___	**Pedagogy in Geography**	**4**	**0**	**0**	**4**
GEOG___	**Term Paper**	**0**	**0**	**24**	**12**
GEOG__R	**Reading Elective I**	**0**	**0**	**0**	**2**
	Total	**8**	**0**	**32**	**26**

SECOND SEMESTER

~~Existing Scheme~~					
Course Code	~~Course Name~~	~~L~~	~~T~~	~~P~~	~~C~~
	~~Elective~~	~~4~~	~~0~~	~~0~~	~~4~~
	~~Reading Elective~~	~~2~~	~~2~~	~~0~~	~~4~~
~~**GEOG 604**~~	~~Digital Cartography and Geoinformatics~~	~~2~~	~~0~~	~~0~~	~~2~~
~~**GEOG 604L**~~	~~Digital Cartography and Geoinformatics Lab.~~	~~0~~	~~0~~	~~4~~	~~2~~
	~~Semester wise Total~~	~~8~~	~~2~~	~~4~~	~~12~~

Proposed Scheme					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
GEOG___D	**Dissertation**	**0**	**0**	**36**	**18**
GEOG___S	**Seminar**	**0**	**0**	**8**	**4**
GEOG___R	**Reading Elective II**	**0**	**0**	**0**	**2**
GEOG___R	**Reading Elective III**	**0**	**0**	**0**	**2**
	Total	**0**	**0**	**44**	**26**

Elective

Course Code	**Course Name**	**L**	**T**	**P**	**C**
~~GEOG 601~~	~~Advanced Economic Geography~~	**4**	**0**	**0**	**4**
~~GEOG 603~~	~~Advanced Geomorphology~~	**4**	**0**	**0**	**4**
~~GEOG 605~~	~~Geography of Environmental Management~~	**4**	**0**	**0**	**4**
~~GEOG 606~~	~~Population Studies~~	**4**	**0**	**0**	**4**
~~GEOG 608~~	~~Rurban Geography~~	**4**	**0**	**0**	**4**
~~GEOG 609~~	~~Social Geography~~	**4**	**0**	**0**	**4**

List of Reading Electives

Course Code	**Course Name**	**L**	**T**	**P**	**C**
GEOG___R	**Climate Change and Future Crisis**	**0**	**0**	**0**	**2**
GEOG___R	**Contemporary Social Challenges in India**	**0**	**0**	**0**	**2**
GEOG___R	**Industrialization and Regional Development**	**0**	**0**	**0**	**2**
GEOG___R	**Resource: Challenges and Management**	**0**	**0**	**0**	**2**
GEOG___R	**Solid Waste Management for a Smart City in India**	**0**	**0**	**0**	**2**
GEOG___R	**Tourism and Heritage**	**0**	**0**	**0**	**2**

Reading Elective

Course Code	Course Name	L	T	P	C
GEOG 602R	Advanced Geography of India	2	2	0	4
GEOG 610 R	Study of Geosphere	2	2	0	4

THIRD SEMESTER

Course Code	Course Name	L	T	P	C
GEOG 701D	Dissertation	0	0	24	12
GEOG 702 S	Seminar	0	0	8	4
Semester Wise Total		0	0	32	16

Note: Duration of M.Phil. Programme has been changed into 2 semesters instead of 3 semesters.

Name of the Programme:M. Phil. (Geography) **ANNEXURE III**

Course Details:

FIRST SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	~~EDU617L: SESSIONAL &LAB WORK (TEACHING PRACTICE)~~	~~**After the completion of this course, students should be able to:**~~ ~~• acquaint the students with the scenario of higher education in India and expected teacher's role in higher education.~~ ~~• enable students to identify and use different teaching competencies, methods and media required for effective teaching.~~ ~~• enhance the~~	~~1. Practice in Simulation – 15 Pds.~~ ~~2. Methods based planning – 10 Pds.~~ ~~3. Practice in real classroom 20 Pds.~~ ~~Seminar – 15 Pds.~~		**Replaced by New Course**

		~~ability to instruct and evaluate, as a teacher in higher education.~~ • ~~develop sensitivity towards major issues related to different dimensions of higher education.~~			
2.	~~Teacher, Teaching and Higher education~~	~~**After the completion of this course, students should be able to:**~~ • ~~acquaint the students with the scenario of higher education in India and expected teacher's role in higher education.~~ • ~~enable students to identify and use different~~	~~Course Outline:~~ ~~1. Overview of Higher Education in India: Purpose and Functions of Higher Education. Functions of Regulatory Bodies - UGC, AICTE, NCTE, DEC, NAAC.~~ ~~2. Role of Teacher in Higher Education: Teacher's Role - Curriculum development, Instructional, Institutional, Research related and Social. Professional Development of Teachers - Role of ASC.~~ ~~3. Pre-requisites of Teacher in Higher Education: Teaching Competencies -~~		

		~~teaching competencies, methods and media required for effective teaching.~~ • ~~enhance the ability to instruct and evaluate, as a teacher in higher education.~~ • ~~develop sensitivity towards major issues related to different dimensions of higher education.~~	~~Introduction, Questioning, Board Work, Explanation, Use of Support Material, Stimulus Variation, Probing and Closure. Methods for teaching - Lecture, Discussion, Project, Workshop and Seminar. Media for effective teaching. 4. Designing of Instruction and Evaluation: Instructional Planning. Modes of Evaluation in Higher Education. 5. Major issues in Higher Education: Government and Private Participation, Women Participation, Globalization of Higher Education, Quality Issues.~~ ~~References:~~ ~~1. Aggarwal, J.C., (2012), " Principles, Methods & Techniques of Teaching," Vikas Publishing House Pvt. Ltd., New Delhi.~~ ~~2. Association of Indian Universities, (2003),"Globalization of Indian Higher Education", New Delhi.~~ ~~3. Bawa, M.S., Nagpal, B.M., (2011), "Developing Teaching Competencies," Viva Books, New Delhi.~~		

			4. Dhar, B.B., (2009), "Higher Education System," A.P.H. Publishing Corporation, New Delhi. 5. Dhir, R.N., (2006), "Higher Education", Abhishek Publications, Chandigarh. 6. Kamalkar, G., (2014), "Higher Education in Indian- Emerging Challenges", Commonwealth Publishers Pvt. Ltd., New Delhi. 7. Kidwani, A.R., (2011), "Higher Education- Issues and Challenges", Viva Books, New Delhi. 8. Kidwani, A.R., (2014), "New Directions in Higher Education", Viva Books, New Delhi. 9. Mangal, S.K., Manga. U., (2014), "Essentials of Educational Technology", PHI Learning Private Limited, Delhi. 10. Manoharan, P.K., (2009), "Higher Education," A.P.H. Publishing Corporation, New Delhi. 11. Panchmukhi, P.R. Debi,S. (2008), "Educational Data Bank for Higher Education", Serials Publications, New Delhi. 12. Patnaik, J. (2001), "Higher Education in		

			~~Information Age", Authors Press, New Delhi.~~ ~~13. Sen, R., (2009), "Women and Higher Education System," Crescent Publishing Corporation, New Delhi.~~ ~~14. Shafi, Z.S. (2008), " Reforms and Innovations in Higher Education", Association of Indian Universities, New Delhi.~~ ~~15. Sharma, S.R., (2000), "Effective Classroom Teaching-Modern Methods, Tools & Techniques," Mangal Deep Publications, Jaipur.~~ ~~16. Thamarasseri, I., (2012), "Essentials of Educational Evaluation," Kanishka Publishers, New Delhi.~~		
3.	GEOG 607 Research Methodology and Statistical Analysis in Geography	**After the completion of this course, students should be able to:** • **formulate research proposals, hypothesis, data analysis and referencing.** • **Develop skill in data collection and sampling**	1. Research: Meaning and types of Research; Literature Review, Research Methodology 2. Hypothesis: Meaning and Basic concept of hypothesis testing 3. Research Design: Meaning, need and Importance 4. Data Collection : Types and sources of data, Methods of Data collection, classification of	Research: Meaning and types of Research; Literature Review, Research Methodology; Hypothesis: Meaning and Basic concept of hypothesis testing; Research Design: Meaning, need and Importance; Data Collection : Types and sources of data, Methods of Data collection, classification of data; designing of a Questionnaire; Data Interpretation Analysis; Sampling: Meaning and Types of Sampling; Chapter scheme, **References and bibliography** Multi-variate Analysis: Multiple correlation; Regression Analysis; Composite Indices; Principal Component Analysis; Time Series Analysis (Temporal Analysis); Writing of Abstract, Articles, Report,Thesis and **Plagiarism** **Recommended Books :** **1. Ahuja, R. (2014). *Research Methods.* Jaipur, India: Rawat.** **2. Alvi, Z. (2005). *Statistical Geography Methods and Applications.* Jaipur**	**Added content for enrichment**

		techniques. • **develop skill in multi-variate analysis for the applications of statistical methods in research.** • **able to write abstract, report, articles and thesis.**	data; designing of a Questionnaire; Data Interpretation Analysis 5. Sampling: Meaning and Types of Sampling 6. Chapter scheme, ~~Review of literature~~ ~~7. Concept of Plagiarism~~ 8. Multi-variate Analysis 9. Statistical Applications ~~Adpoting~~ I. Multiple correlation & Regression Analysis II. Composite Indices III. Basics of Principal Component Analysis IV. Time Series Analysis (Temporal Analysis) V. ~~Preparation and~~ Writing of abstract, Articles, report ~~format~~ and thesis Books Recommended: 1. Ahuja, R., (2009), Research Methods, RawatPublications, Jaipur. 2. Cole, John P. and Cuchlaine a. M. King (1968) Quantitative Geography, Techniques and Theories in Geography, John Wiley and Sons Ltd., London. 3. Elhance, D.N. (1972): Fundamentals of	**and New Delhi, India: Rawat.** **3. Dabson, S. J. (2017). *Statistical Analysis of Geographical Data An Introduction.* U.K.: John Wiley and Sons.** **4. Gupta, S.P.(2012).*Statistical methods*. New Delhi, India:Sultan Chand and sons.** **5. Jackson, L.S. (2009). *Research Methods and Statistics*. New Delhi, India: Cengage Learning.** **6. Kothari, C. R., &Garg, G. (2014). *Research Methodology Methods and Techniques* (3rd ed.). New Delhi, India: New age International.** **7. Kumar, R. (2016). *Research Methods A step-by-step Guide for Beginners* (Rev. ed.). Australia: Pearson Education and Dorling Kindersley.** **8. Mahmood, A. (2017). *Statistical Methods in Geographical studies*(6th ed.). New Delhi, India: Rajesh.** **9. Mishra, H. N., &Singh,V.P. (Eds.). (1998).*Research Methodology : Social, spatial and policy dimensions*. Jaipur, India: Rawat.** **10. Rao, G.N. (2012). *Research Methodology and quantitative Methods.* Hyderabad, India: B.S.** **11. Sarkar, A. (2013). *Quantitative Geography- Techniques and Presentations.* New Delhi: OrientBlackswan.** **12. नागर, के. एन. (2018). *सांख्यिकीय के मूलतत्व.* मेरठ,भारत: मीनाक्षी.** **Suggested E-resources:** 1. Research Design **http://libguides.usc.edu/writingguide/researchdesigns** 2. Chi-square test and its application in hypothesis testing **http://www.j-pcs.org/article.asp?issn=2395-5414;year=2015;volume=1;issue=1;spage=69;epage=71;aulast=Rana**	

			Statistics, KitabMahal, Allahabad. 4. Frank Harry and Steven C. Althoen (1994): Statistics Concepts and Applications, Cambridge University Press. 5. Gupta, S.P., (1979) and revised edition, Statistical Methods, Sultan Chand and sons, New Delhi. 6. Guthrie, G., (2010), Basic Research Methods – An entry to Social Science Research, Sage Publications, New Delhi. 7. Hammond, R. and PatrikMcCullagh (1974): Quantitative Methods in Geography, Clarendon Press, Oxford. 8. Kothari, C.R., (1990), Research Methodology Methods and Techniques, WishwaPrakashan, New Delhi. 9. Mahmood, A., (1998), Statistical Methods in Geographical studies, Rajesh Publications, New Delhi. 10. Mishra, H.N. and Singh, V.P, (1998), Research Methodology, Rawat Publications, Jaipur.		

			11. Mishra, R.P., (1989), Research Methodology, Concept Publishing Company, New Delhi. 12. Prasad, H., (1992), Research Methods and Techniques in Geography, Rawat Publications, Jaipur. 13. Sarkar, A, (2013), Quantitative Geography; Techniques and Presentations, Orient Blackswan, Pvt. Ltd., New Delhi. 14. Smith, David M. (1975): Patterns in Human Geography, An introduction to Numerical Methods, Crane Russak& Company, Inc New York. 15. Taylor G., Peter J. (1977): Quantitative Methods in Geography, An Introduction to Spatial Analysis. Hougt on Miffin Company, Bost on, USA.		
3.	GEOG ___L Digital Cartography and GeoinformaticsLab	**After the completion of this course, students will be able to:**		**Digital Cartography - Meaning, Scope and Significance; Impact of geo-information technology on cartography; Comparison between digital and manual cartography;Cartographic methods and techniques: Graphs and Diagrams - Line diagram, Bar diagram, Pie diagram, Pyramid diagram;**	**New Course Introduced**

		• develop skill related to digital cartography – diagrammatic representation of data • develop skills in data generation, mapping for the implementation in planning. • develop skill of surveying using Global Positioning System. • enrich students about applications of geospatial technologies in various fields.		Mapping techniques - Dot, Choropleth, Isopleth; Thematic mapping – types and methods, Map Compilation: base data, thematic data; Remote Sensing: Platforms and Sensors; Resolution of Remote Sensing data: spatial, spectral, radiometric and temporal; Procurement of Satellite Imagery; Geographic Information Systems (GIS): Definition and Components, Spatial data in GIS- Raster and Vector; Image Classification – Supervised and Unsupervised, accuracy assessment;GPS- Introduction and Basic Components; Applications of Geospatial Technology in Agriculture mapping, Landuse/Landcover analysis, Urban change and Watershed management; Surveying with Global Positioning System(GPS)- Rapid static positioning technique and Stop & Go technique. Recommended Books : 1. Bhatta, B. (2011). *Remote Sensing and GIS (2nd ed.)*. New Delhi, India: Oxford University Press. 2. Campbell, J. B., & Wynne, R. H. (2011). Introduction to Remote Sensing (5th ed.). New york, NY: Guilford 3. Cracknell, A. P., &Hayer, L. (2009). *Introduction to Remote Sensing*. New York, NY: Taylor and Francis. 4. Cromley, G. R.(1992).*Digital Cartography*.New Jersey, NJ: Prentice Hall. 5. Ganesh, A.,&Narayanakumar, R. (2006). *GPS Principles and Applications.* Delhi, India: Satish Serial. 6. George, J.,&Jeganathan (2018). *Fundamentals of Remote Sensing*(3rd ed.). Hyderabad, India: Universities Press. 7. Gopi, S. (2013). *Global Positioning System- Principles and Applications.* New Delhi, India: McGraw Hill. 8. Kumar, S. (2014). *Basics of Remote Sensing and GIS*, New Delhi, India: University Science Press Laxmi. 9. Lillesand T. M., Kiefer, R. W., &Chipman, J. W. (2008). *Remote Sensing and Image Interpretation*(6th ed.).New York, NY: Wiley and	

				Sons. **10. Lo, C. P., & Albert, K. W. Y. (2002). *Concepts and Techniques of Geographic Information System*(2nd ed.).New Delhi, India: Prentice-Hall.** **11. Michael, N. D. (2000). *Fundamentals of Geographic Information Systems*. New York, NY: John Wiley & Sons.** **12. Nag, P.,&Kudrat, M. (1998). *Digital Remote Sensing.* New Delhi, India: Concept** **13. Paine, D. P., &Kisher, J. D. (2012). *Aerial Photography and Image Interpretation* (3rd ed.). Australia: John Wiley & Sons.** **14. Palet, A. N. (1992). *Remote Sensing Principles &Application*.Jodhpur,India: Scientific.** **15. चौनियाल,डी. डी. (2010).*सुदूरसर्वेदन एवंभौगोलिकसूचनाप्रणार्ली.* इलाहबाद, भारतः शारदापुस्तकभवन.** **Suggested e-learning materials:** **1. Principles and applications of GIS https://www.environmentalscience.org/principles-applications-gis** **2. GPS and Applications https://www.cfa.harvard.edu/space_geodesy/ATLAS/applications.html**	
4.	**GEOG_____Pedagogy in Geography**	**After the completion of this course, students will be able**		**Overview of Higher Education in India: Purpose and Functions of Higher Education. Functions of Regulatory Bodies - UGC, AISHE, NCTE, NAAC; Role of Teacher in Higher Education: Teacher's Role - Curriculum**	**New Course Introduced**

		to: • **Describe higher education, its function and purpose.** • **Learn about the different functions of regulatory bodies** • **Elucidate the prerequisites and methods of teaching** • **Learn about the evaluation process in teaching**		**development, Instructional, Institutional, Research related and Social; Professional Development of Teachers - Role of Academic Staff College; Pre-requisites of Teacher in Higher Education: Teaching Competencies - Introduction, Questioning, Board Work, Explanation, Use of Supporting Materials, Methods for teaching - Lecture, Discussion, Laboratory work, Field Survey, Project, Workshop and Seminar;Mediafor effective teaching; Designing of Instructions and Evaluation: Instructional Planning; Modes of Evaluation in Higher Education.** **Books Recommended:** **1. Aggarwal, J. C. (2012). *Principles, Methods & Techniques of Teaching*. (2nd Rev.ed.). New Delhi, India: Vikas.** **2. Bawa, M.S., &Nagpal, B. M., (Ed.).(2011). *Developing Teaching Competencies*. New Delhi, India: Viva Books.** **3. Dhar, B. B. (2009). *Higher Education System*. New Delhi, India: A.P.H.** **4. Kamalkar, G. (2014). *Higher Education in Indian-Emerging Challenges*. New Delhi, India: Commonwealth.** **5. Kidwani, A. R. (Ed.). (2014). *New Directions in Higher Education*. New Delhi, India: Viva.** **6. Mangal, S. K.,& Manga. U., (2014). *Essentials of Educational Technology*. New Delhi, India: P.H.I.** **7. Manoharan, P. K. (2009). *Higher Education*. New Delhi, India: A.P.H.** **8. Patnaik, J. (2001). *Higher Education in Information Age*. New Delhi, India: Authors Press** **9. Shafi, Z. S. (2008). *Reforms and Innovations in Higher Education*. New Delhi, India: Association of Indian Universities.** **10. Sharma, S. R., (2000). *Effective Classroom Teaching-Modern Methods, Tools & Techniques*. Jaipur, India: Mangal Deep.** **11. Thamarasseri, I. (2012). *Essentials of Educational Evaluation*. New Delhi, India: Kanishka.** **12. गोयल, एम. (2007). *भूगोलशिक्षण*.नईदिल्ली, भारत : वन्दना** **13. दुबे, एस. के. (2014). *भूगोलशिक्षणविधियाँ*.जयपुर, भारतः याकिंगबुक्स.**	

				14. प्रसाद, जी. (2007). *भूगोलशिक्षण.*नईदिल्ली, भारत : डिस्कवरी. **Suggested e-Learning material:** **1.Functions of Regulatory Bodies** **https://mhrd.gov.in/regulatory-bodies** **2.Field survey-** **http://ncert.nic.in/textbook/pdf/legy305.pdf**	
5.	**GEOG____Term Paper**	**After the completion of this course, students will be able to:** • **Understand the aspects of research area and formulate research problem.** • **Develop analytical skill** • **analyze the data and write research articles** • **Develop presentation skill**			
6.	GEOG__R **Reading Elective I**				

SECOND SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	Elective				
2.	Reading Elective				
3.	GEOG 604 DIGITAL CARTOGRAPHY AND GEOINFORMATICS	After the completion of this course, students should be able to: • Explain functioning of remote sensing. • Describe different platforms, spectral signatures and properties of EMR. • Differentiate thermal and microwave Remote sensing. • Elucidate applications of remote sensing in agriculture, forestry, water resources and urban studies.	**Remote Sensing** 1. Remote Sensing : Functioning and Platforms 2. Properties of EMR and Electromagnetic Spectrum, Interaction of EMR with earth's surface and atmosphere, 3. Spectral Signatures 4. Basic principle of Thermal and Microwave Remote Sensing 5. Applications of Remote Sensing inAgriculture, Forestry, Urban Studies and Water Resource. **Books Recommended:** 1. C.P. Lo and Alber t K.W. Yeung (2002): Concepts and Techniques of Geographic Information System, Pr entice-Hall of India Private Limited, New Delhi. 2. Dent Borden D. (1990): Cartography, Thematic Map Design, Wim.C. Brown Publishers. 3. Ian Haybood et.al. (2002): An Introduction to Geographical Information System. 4. Kang-tsung Chang (2002): Geographic Information System, Tata-McGr aw Hill, New Delhi. 5. Keats, J.S. (1973): Cartographic Design and production Longman, London 6. Keith C. Clarke (1997): Getting Started with Geographic Information Systems, Prentice Hall, New Jersey. 7. Kr aak, M.J. and FerjanOrmeling (2003): Car tography, Visualization of Geospatial Data, Pear son Education Limited, Patparganj, Delhi, India. 8. Michael N. Demer s (2000): Fundamentals of Geographic information Systems, John Wiley and Sons, Inc, New York. 9. Misra R.P. and A. Ramesh (1989): Fundamentals of Cartography, Concept Publishing Company New Delhi. 10. Monkhouse, F.J. and H.R. Wilkinson (1967) Maps and Diagrams, B.T. Publications Pvt. Ltd., Delhi 1989. 11. Paul, A. Longley et.al. (2011): Geographic Information Systems and Science, John Wiley and Sons Ltd. New York. 12. Peter A. Burrough and Rachael A. McDonnell (1998): Principles of Geographic Information Systems, Oxford University Press.		**Removed due to change in scheme**

			13. Raisz Erwin (1962): Principles of Cartography, McGr aw Hill, New York. 14. Robinson, Arthur and et.al.(2005): Elements of Cartography, John Wiley and Sons, New York. 15. Singh L.R. and R.N. Singh (1975): Map work and Practical Geography, Central Book Depot, Allahabad. 16. Singh R.L. (1979): Elements of Practical Geography, Kalyani Publishers, New Delhi.		
4.	GEOG 604L Digital Cartography and Geoinformatics Lab	After the completion of this course, students will be able to: • develop skill related to digital cartography diagrammatic representation of data • develop skills in data generation, mapping for the implementation in planning. • develop skill of surveying using Global Positioning System. • enrich students about applications of geospatial technologies in various fields.	Introduction to Cartography A. Digital Cartography (Lab.) 1. Introduction of digital cartography 2. Graphical Presentation of Data: Line diagram, Bar diagram, Pie diagram, Pyramid diagram 3. Map Generalization: Map layout B. GIS and GPS: (Lab.) 1. Components of GIS 2. Data Base Management system 3. Drafting materials: Base map, Completion for thematic mapping, Preparation of thematic maps. 4. Introduction to GPS and its Applications Books Recommended: 1. C.P. Lo and Alber t K.W. Yeung (2002): Concepts and Techniques of Geographic Information System, Pr entice-Hall of India Private Limited, New Delhi. 2. Dent Borden D. (1990): Cartography, Thematic Map Design, Wim.C. Brown Publishers. 3. Ian Haybood et.al. (2002): An Introduction to Geographical Information System. 4. Kang tsung Chang (2002): Geographic Information System, Tata McGr aw Hill, New Delhi. 5. Keats, J.S. (1973): Cartographic Design and production Longman, London 6. Keith C. Clarke (1997): Getting Started with Geographic Information Systems, Prentice Hall, New Jersey. 7. Kraak, M.J. and FerjanOrmeling (2003): Car tography, Visualization of Geospatial Data, Pear son Education Limited, Patparganj, Delhi, India. 8. Michael N. Demer s (2000): Fundamentals of Geographic information Systems, John Wiley and Sons, Inc, New York. 9. Misra R.P. and A. Ramesh (1989): Fundamentals of Cartography, Concept Publishing Company New Delhi. 10. Monkhouse, F.J. and H.R. Wilkinson (1967) Maps and Diagrams, B.T. Publications Pvt. Ltd., Delhi 1989.		**Replaced by new course in Semester I**

			~~11. Paul, A. Longley et.al. (2011): Geographic Information Systems and Science, John Wiley and Sons Ltd. New York.~~ ~~12. Peter A. Burrough and Rachael A. McDonnell (1998): Principles of Geographic Information Systems, Oxford University Press.~~ ~~13. Raisz Erwin (1962): Principles of Cartography, McGr aw Hill, New York.~~ ~~14. Robinson, Arthur and et.al.(2005): Elements of Cartography, John Wiley and Sons, New York.~~ ~~15. Singh L.R. and R.N. Singh (1975): Map work and Practical Geography, Central Book Depot, Allahabad.~~ ~~16. Singh R.L. (1979): Elements of Practical Geography, Kalyani Publishers, New Delhi.~~		
5.	**GEOG__D Dissertation**	**After the completion of this course, students will be able to:** • **formulate research proposals, hypothesis, collection of data** • **develop skill in analysis of data and testing of hypothesis** • **extract results and conclusions.** • **provide suggestions for the development of research area.**			**Introduced with new scheme**
6.	**GEOG__S Seminar**	**After the completion of this course, students will be able to:** • **identify and formulate research problem** • **develop skills in data analysis** • **develop presentation skills**			**Introduced with new scheme**

		• **provide suggestions of related research problem**			
7.	GEOG___R **Reading Elective II**				**Introduced with new scheme**
8.	GEOG___R **Reading Elective III**				**Introduced with new scheme**

Elective

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	~~GEOG 601 ADVANCED ECONOMIC GEOGRAPHY~~	~~After the completion of this course, students should be able to:~~ ~~• Explain concept of economic geography.~~ ~~• Illustrate theories and measures of economic development.~~ ~~• Calculate agricultural efficiency of an agricultural field.~~ ~~• Analyze changing cropping patterns~~	~~1. Concept of Economic Geography, nature and pattern of economic activities: primary, secondary and tertiary activities.~~ ~~2. Recent themes and concepts in Economic Geography,~~ ~~3. Concept of economic resource, Resource evaluation, Resource planning and management~~ ~~4. Economic Development: Theories and Measures of economic development.~~ ~~5. Theories of Industrial Location and Localization(Weber, Hoover, Losch, Pred), Industrial Regions of the World and India,~~ ~~6. World Trade Organization, Globalization and its impact on World Economy.~~ ~~7. Agricultural land use and cropping pattern, measures of Agricultural efficiency, crop combination regions (J. C. Weaver and K. K. Doi).~~ ~~8. Concept of location of Agricultural activities, Agricultural typology, changing cropping pattern.~~ ~~9. Modern concepts in Agriculture Geography: sustainable development, agribusiness, contract farming, dry land farming, cropping systems.~~ ~~Books Recommended:~~ ~~1. Clark, G. L., Feldman, M.P. and Gertler, M.S. (eds.) (2000): The Oxford~~		**Removed due to change in scheme**

			Handbook of Economic Geography. Oxford University Press, Oxford and New York. 2. Conking, E. C. and Yeates, M. (1996) "Man's Economic Environment" McGraw – Hill Book Company. 3. Freeman, T. W. (1972): Geography and Planning. Freeman and Company, New York. 4. Friedman, J. and Alonso, W. (1964) Regional Development and Planning: A Reader, The M. I. T. 5. Gautam, Alka, (2010), Advanced Economic Geography, ShardaPustakBhawan, Allahabad 6. Guha, J.L. and P.R.Chatturaj (1994) Economic geography- A Study of Resources, The World PressPvt. Ltd. Calcutta 7. Gupta, P and Sadasyuk, G. (1968): Economic Regionalization of India: Problems and Prospects. Census of India, New Delhi 8. Hanif M. (2005): Encyclopedia of Agriculture Geography, Anmol Publications PVT Ltd. 9. Hartshorn, T. A. and Alexander, J. W. (1988) 'Economic Geography', Prentice Hall, New Delhi. 10. Leong, Gon Cheng & Morgan, Gilliam C.: (1973) Human and Economic Geography, Oxford University Press. 11. Ramesh, A. (ed.) (1984): Resource Geography. Heritage Publishers, New Delhi. 12. Shafi Mohammed (2000): Agricultural Geography of South Asia., MacMillan Publishers India 13. Siddharth, K. (2006) Economic Geography, Kisalaya Publications, New Delhi.Singh&Dhillon (2004): Agriculture Geography (3rd Edition), Tata McGraw – Hill. 14. Singh, R.L. (Ed.): (1966) Applied Geography, BHU press, Varanasi. 15. Wheeler J. O. Mullar, O. M. Thrall, G. I. and Timothy, J. F. (1988) "Economic Geography", John Wiley and Sons Inc. New York. 16. कुमार, प्रमीला एवं शर्मा, श्रीकमल (2008) कृषिभूगोल, मध्य प्रदेशहिन्दी *ग्रन्थअकादमी, भोपाल।* 17. जाट, बी. सी. (2006) आर्थिकभूगोल, पंचशीलप्रकाशन, जयपुर।		

			18. हुसैन, माजिद (2000) कृषिभूगोल, रावतपब्लिकेशन, जयपुर। 19. मामोरिया, चतुर्भुज(2008)आर्थिकभूगोल, साहित्य भवनपब्लिकेशन, आगरा। 20. एस. डी. कौशिक एवंमडॉ. अल्कागोतम(2011)संसाधनभूगोल, रस्तोगी एण्ड रस्तोगीपब्लिकेशन। 21. शर्मा, हरिशचंद्र, (1983)भारतकाआर्थिकभूगोलतथाभारतीय अर्थशास्त्र, रमेशबुकडिपो, जयपुर। 22. सिंह जे. (2009)संसाधनभूगोल, सधापब्लिकेशन, नईदिल्ली। 23. सिंह के. एन., और सिंह जे. (2003)आर्थिकभूगोल के मूलतत्व, ज्ञानोदय प्रकाशन, गोरखपुर। 24. सिंह, काशीनाथ(2009)आर्थिकभूगोल के मूलतत्व : संसाधनउपयोग, संरक्षण एवंआर्थिकविकासका अध्ययन, ज्ञानोदय प्रकाशन। 25. सिंह, काशीनाथ(2009)आर्थिकभूगोल के मूलतत्व : संसाधनउपयोग, संरक्षण एवंआर्थिकविकासका अध्ययन, ज्ञानोदय प्रकाशन, गोरखपुर।		
2.	**GEOG 603 ADVANCED GEOMORPHOLOGY**	After the completion of this course, students should be able to: • Explain scope, approaches and fundamental concepts of geomorphology • Identify erosion surface of an area and describe geomorphology of a region. • Explain origin and development of land forms. • Apply geomorphological knowledge in hazard management, hydrology, Urbanization and Agriculture	1. Scope of Geomorphology, methods and approaches to the study of landforms. 2. Fundamentals concepts of Geomorphology 3. Evolution of landforms according to Davis, Penck and King. 4. Geomorphic processes and their classification. 5. Endogenitic Forces: Secular and Sudden forces; Earthquakes and Volcanic activities. 6. Exogenitic Forces: Weathering and mass wasting. Erosional processes: river, glacial, coastal, Karst and wind. 7. Slopes forms and processes: Models of slope development, views of Davis, Penck, Wood and King. 8. Erosion Surface; Techniques of identification and correlation. 9. Introduction to Geomorphological mapping methods and application of GIS in geomorphology (Concept of DEM & DTM) 10. Regional geomorphology – Case study of KumaunHimalay, Chotanagpur region and Lower Chamble Valley. 11. Application of Geomorphology in Agriculture, Urbanization, Hydrology and Hazard management. Books Recommended: 1. Ahmed, E. (1985): Geomorphology. Kalyani Publishers, New Delhi. 2. Bloom.A. L. (1998/ 2001): Geomorphology. 3rd edition. Prentice Hall of India, New Delhi. 3. Chorley, R.J., Schumm S A and Sugden D E. (1984): Geomorphology. Methuen and Company Ltd., London.		**Removed due to change in scheme**

			4. Dayal, P. (1994): A Text Book of Geomorphology. Kalyani Publishers, New Delhi. 5. Fairbridge, R.W. (ed.) (1968): Encyclopaedia of Geomorphology, Reinhold Book Corporation., New York 6. Gregory, K.J. and Walling, D.E. (1973): Drainage Basin Form and Process. Edward Arnold, London. 7. Jog, S. R. (ed.) (1995): Indian Geomorphology (2 vols.). Rawat Publications, Jaipur 8. Kale, V. and Gupta, A. (2001): Introduction to Geomorphology. Orient Longman, Hyderabad. 9. King, C.A.M. (1966): Techniques in Geomorphology. Edward Arnold, London. 10. Pethick, J. (2000): An Introduction to Coastal Geomorphology. Arnold, London. 11. Sharma, H. S., (1980): Perpective of Geomorphology (4 Volumes), Concept Publications, New Delhi 12. Sharma, H. S., (1987): Tropical Geomorphology – Study of Morpohogenitic Regionalization of Rajasthan, Concept Publications, New Delhi 13. Sharma, P. R. (ed.), (1993): Applied Geomorphology in Tropics. Rishi Publications, Varanasi. 14. Singh, S. (2004): Geomorphology. PrayagPustakBhawan, Allahabad. 15. Sparks, B.W. (1986): Geomorphology. Longmans, London. 16. Thornbury, W.D. (2005): Principles of Geomorphology. John Wiley and Sons, New York. **17.** Wooldridge, S.W. and Morgan, R.S. (1959): The Physical Basis of Geography- An Outline of Geomorphology. Longman, London.		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	GEOG 605 GEOGRAPHY OF ENVIRONMENTAL MANAGEMENT	After the completion of this course, students should be able to: • Explain conservation and importance of biodiversity. • Elucidate eco-feminism, eco-socialism and	1. Environment: Fundamentals of Environment 2. Biodiversity: meaning, importance and types; Biodiversity hot spots; Loss of Biodiversity and its conservation 3. Environmental Degradation: Meaning and types of degradation; Quality Assessment of Soil and Water. 4. Environmental Impact Assessment and Strategies; Case Studies: Tehri Dam, SardarSarovar Project 5. Concept of Sustainable Development 6. Concept of Eco-feminism and Eco-socialism 7. Environmental Challenges and Management in India: Desertification, Mining, Deforestation, Waste Disposal and Big Dam Controversy – Issues related with high dams (Narmada Sagar Project, Silent Valley); Eutrophication of Wetlands		**Removed due to change in scheme**

		environmental challenges. • Discuss environmental movements, degradations and disasters. • Explain importance of environmental impact assessment.	8. Environmental Movements in India: Chipko Movement and Narmada BachaoAndolan 9. Case studies Associated with Environmental Degradation: Famines in Tribal belt of Rajasthan; Jhum Cultivation in Meghalaya 10. Disaster: A case study of Uttrakhand disaster (Kedarnath disaster, 2013). Books Recommended: 1. Bhattacharya, N.N. (2011), Biogeography, Rajesh Publications, New Delhi. 2. Chandna R.C., (2010), Environmental Geography, Kalyani publishers, New Delhi. 3. Gautam A., (2010), Environmental Geography, ShardaPustakBhavan, Allahabad. 4. Jadhav, S.B., (2012), Environmental Geography, ChandralokPrakashan, Kanpur. 5. Moirangleima, Kh. (2010), Sustainable Management of Wetlands Central Valley of Manipur, B.R. Publishers, New Delhi. 6. Nag, P., et.al, (1997), Geography and Environment, (ed.) Concept Publishing Company, New Delhi. 7. Raghavan, .K. M., (2014), Environmental Geography and Disaster Management, Navyug Books International, Delhi. 8. Salahuddin, M., (2011), Waste Management in an Urban Area, B.R. Publishers, New Delhi. 9. Saxena H.M., (2011), Environmental Geography, Rawat Publications, Jaipur. 10. Singh Onkar, et.al. 1993, Frontiers in Environmental Geography, (ed.) Concept Publishing Company, New Delhi. 11. Singh Savindra, (2010), Environmental Geography, PrayagPustakBhavan, Allahabad.		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	GEOG 606 POPULATION STUDIES	After the completion of this course, students should be able to: • Elucidate population changes and its measures. • Discuss about poverty alleviation,	1. Population Geography: Nature, Approaches (Behavioural and System) 2. Methodological Problems in data collection 3. Basic Source of Data with special reference to India, Problems of handling population data. Mapping and presentation of population data. 4. Population Change and its Measures: Crude Birth Rate, Fertility Rate, Age Specific Birth Rate, Total Fertility Rate, Crude Death Rate, Infant Mortality Rate, Maternal Mortality Rate 5. Determinants of Fertility and Mortality 6. Migration- Type, Determinants and Consequences, Models (W.J. Reilly, GeorageK.Zipf,		**Removed due to change in scheme**

		employment generation and national population policy of India. • Generate maps of population data. • Explain population growth, composition and distribution in India.	S.A. Stouffer, Ravenstein, and Lee) 7. Population factors in development planning 8. Population Growth and Distribution in India 9. Fertility and Mortality in India 10. Urbanization in India 11. Population compositions in India: Literacy rate, Sex ratio and Work force 12. Child marriage and Female foeticide in India 13. Poverty alleviation and employment generation in India, 14. National Population policy of India 2000. Books Recommended: 1. Chandna, R.C, (2009) A Geography of Population, 8th edition, Kalyani Publishers, New Delhi. 2. Hassan, M.I (2009) Population Geography, Rawat Publication, Jaipur 3. Jhingan, M.L., Bhatt. B.K., Desai, J.N: (2005) Demography, Vriada Publication 4. M. Raza and Y.P. Aggrwal (1984)," Inequalities in the levels of Literacy in India: The regional Dimension," in Shafi and Raza (eds.), Spectrum of Modern Geography, Concept: New Delhi. 5. NewBold Bruce ,K.: (2012) Population geography, Rawat Publication, Jaipur 6. Ranade, P.S: (1990) Population Dynamics in India, Ashish Publishing House, Delhi 7. Sharma R.K: (2007) Demography and Popultion Problems, Atlantic Publishers, Delhi 8. Tripathi R.K: (2008) Population Geography, Commounwealth Publication, Delhi		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
5.	GEOG 608 RURBAN GEOGRAPHY	After the completion of this course, students should be able to: • Explain origin, evolution, classification and dispersion of settlements.	1. Geographical dimensions of settlements, techniques and tools of settlement geography, 2. Settlements: origin and evolution, classification and dispersion of settlements, 3. Rural settlements: Pattern and morphological components of rural settlements, 4. Process of development of rural morphology, morphology of an Indian village and rural dwelling, rural service centres and their identification, 5. Rural Problems, schemes and developmental programmes, 6. Origin and evolution of towns, stages of evolution of cities, 7. Urbanization, urban morphology, stages of development of urban morphology, theories of urban		**Removed due to change in scheme**

		• Identify rural service centers of an area. • Analyze rural and urban settlement system. • Describe problems related to rural and urban settlements and discuss sustainable planning.	morphology (Concentric Zone theory, Sector theory and Mutliple Nuclei theory) 8. Urban land use, morphology of an Indian city (Jaipur) 9. Urban system analysis : Rank size rule, the Law of Primate city 10. Rural urban fringe, suburb, satellite town, conurbation, umland 11. Urban problems, Urban planning and Master plan, Sustainable urban planning, National Urbanization policy. Books Recommended: 1. Bansal, Suresh Chandra, (2010), Urban geography, MeenakshiPrakashan, Meerut 2. Mandal, R.B., (2010), Urban Geography: a text-book, Concept Publications, New Delhi, 3. Pacione, Michael, (2009), Urban geography: a global Perspective, Routledge, London. 4. Singh, R.Y. (2005): Geography of Settlements. Rawat Publications, Jaipur and New Delhi. 5. Singh, S.B. (1977): Rural Settlement Geography. U.B.B.P., Publications, Gorakhpur. 6. Tiwari, R. C. (2000): Settlement Geography; PrayagPustakBhawan Allahabad. 7. Taylor, Griffith, (1958), Urban geography, Methuen, London 8. Verma, L.N., (2008), Urban geography, Rawat Publications, Jaipur. 9. मौर्य एस.डी.(2009) : अधिवासभूगोल, शारदापुस्तकभवन, इलाहबाद। 10. बंसलसुरेशचन्द्र (2009) : ग्रामीणबस्तीभूगोल, मिनाक्षीप्रकाशन, मेरठ। 11. तिवारीआर. सी. (2006) : अधिवासभूगोल, प्रयागपुस्तकभवन, इलाहबाद। 12. सिंह रामयज्ञ (2005) : अधिवासभूगोल, रावतपब्लिकेशन, जयपुर एव नईदिल्ली 13. सिंह इन्दिरा (2008) : अधिवासभूगोल, यूनिवर्सिटीपब्लिकेशन, नईदिल्ली।		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
6.	GEOG 609 SOCIAL GEOGRAPHY	After the completion of this course, students should be able to: • Explain social interaction and stratification.	**Section – A** a) Nature & Approaches to the study of Social Geography b) Definition, origin and types of society c) Social process – social interaction d) Social stratification e) Caste – Origin and its theories, Recent changes in caste system **Section – B** a) Social organization & Groups b) Social well being c) Human Development – Parameter and Index. Recent Trends in Human Development		**Removed due to change in scheme**

		• Describe human races and cast system. • Elucidate social wellbeing, human development and social planning. • Discuss about gender issues and status of woman in India	d) Population growth, Distribution & Problems e) Human Races : Origin, Evolution and classification of Human Races According to G. Taylor f) Quality of Socially Environment : Globalization and social transformation **Section – C** a) Indian Society in Historical Perspective b) Social changes in India c) Human Development in India d) Gender issues and status of woman in India e) Social Planning in India Books Recommended: 1. Ahmad Aijazuddin, (1999) Social Geography. Rawat Publications, Jaipur. 2. BallabhAnand, (2005) A Handbook of Social Geography, Akansha Publishing House, New Delhi 3. Hamnett Chris, (1996) Social Geography, A Reader, Arnold, Co-published in The US, New York. 4. Jr. Del Casino & J. Vincent, (2009) Social Geography, A Critical Introduction. Wiley-Blackwell, A John Wiley & Sons, Ltd. Publication, United Kingdom 5. Kumar Ashok, (2004) Social Geography of India, Anmol Publication Pvt. Ltd., New Delhi. 6. MehtaniSubhah&Sinha, (2010) Social Geography. Commonwealth Publishers Pvt. Ltd., New Delhi. 7. Mohanthy G.S., (2005) Social & Cultural Geography, Isha Books, Delhi 8. PanditApoorva, (2010) Watershed Development Inputs & Social Change, Understanding the Changing Culture of Child Nutrition. Rawat Publications, Jaipur. 9. Peet Richard, (2003) Radical Geography, Alternative Viewpoints on Contemporary Social Issues, Rawat Publications, Jaipur. 10. मौर्य एस. डी. (2010) सामाजिकभूगोल, शारदापुस्तकभवन, इलाहबाद।		

Reading Elective

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	GEOG 602R ADVANCE GEOGRAPHY OF INDIA	After the completion of this course, students should be able to: • Explain geopolitics of the Indian ocean and describe Physiographic	1. India as a geographical unit and geopolitics of the Indian Ocean 2. Physiographic divisions and Geology of India 3. Climate of India: Diversity in the unity of Indian Monsoon 4. Forest Resource: Forest conservation and Social forestry 5. General demographic status with special reference to sex ratio and literacy 6. Trends of urbanization in India. 7. Human development index of India		**Removed due to change in scheme**

		divisions of India. • Interpret land utilization and trends of urbanization in special context of India. • Elucidate forest conservation and social forestry in Indian context. • Describe agricultural regions and multipurpose projects of India	8. Multipurpose projects with special reference to Tehri and Chambal Project 9. Land utilization 10. Agricultural Regions of India according to ICAR 11. Mineral Resource of India and Problems of mining activities 12. Historical perspective of Indian Industries 13. Trends and pattern of foreign trade of India 14. Emerging tourism industry of India 15. Management of Urban solid waste Books Recommended: 1. Khullar D.R. (2014) India : a Comprehensive Geography, Kalyani Publication, Ludhiyana 2. Krishnan, M.S., (2012) Geology of India and Burma, CBS Publication, New Delhi. 3. Mishra, V.C. (1967) Geography of Rajasthan, National Book Trust, New Delhi. 4. Puri, G. S. (1960) Indian forest Ecology, Oxford Book and Stationary, New Delhi. 5. Raychaudhary. S.P. (1966) Land and Soil, National Book Trust, New Delhi. 6. Singh Gopal, (2010) Geography of India, Atma Ram Publication, Delhi 7. Spate, O. H. K., &Learrmonth, A.T.A., India & Pakistan, London. 8. Wadia, D. N., (1957) Geology of India, Macmillan, London. 9. हुसैनमाज़िद, सिंह रमेश (2015) भारतकाभूगोल, टाटामैक्ग्राहिलप्रकाशन, नईदिल्ली। 10. मामोरियाचतुर्भुज (2009) भारतकावृहतभूगोल, साहित्य भवनआगरा। 11. बंसलसुरेशचन्द्र (2011) भारतकाभूगोल, मीनाक्षीप्रकाशन, मेरठ। 12. सिंह गोपाल (2006) भारतकाभूगोल, आत्माराम, दिल्ली। 13. सक्सैनाहरिमोहन (2014) राजस्थानकाभूगोल, राजस्थानहिन्दीग्रंथअकादमीप्रकाशन। 14. शर्माराजकुमार (2010) राजस्थानकाभूगोल, हिमाशुंपब्लिकेशंन, उदयपुर। 15. शर्मा एच. एस.एवं शर्मा एम.एल. (2015) राजस्थानकाभूगोल, पचंशीलप्रकाशन, जयपुर		

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	GEOG 610R STUDY OF GEOSP HERE	After the completion of this course, students should be able to: • Explain origin of solar system and interior of	1. General introduction of solar system and its origin by inter-Stellar Dust Hypothesis of Otto Schmid. 2. Study of Geological Time scale. 3. Interior of the Earth according to Seismology. 4. Plate tectonic theory and its applications. 5. Normal Cycle of Erosion and interruptions in Erosion cycle. 6. Introduction of general features of ocean floor and origin of continental Shelf, continental		**Removed due to change in scheme**

		~~the Earth.~~ • ~~Describe relief of ocean and classify the different ocean deposits.~~ • ~~Interpret maps with ocean currents, pressure and wind belts.~~ • ~~Illustrate different terrestrial, atmospheric and oceanic phenomenon.~~	~~slope, Abyssal plain and Oceanic Deeps.~~ ~~7. Introduction of ocean deposits and their classification on the basis of sources and depth.~~ ~~8. Causes of origin of currents and currents of the Atlantic, Pacific and Indian Ocean.~~ ~~9. Types and Origin of Tides (Equilibrium and Stationary wave theories)~~ ~~10. Type of coral reef s and their origin (Daly's Glacial control theory)~~ ~~11. Factors controlling solar insolation, heating and cooling of atmosphere, regional distribution of Temperature.~~ ~~12. Introduction of pressure and wind belts, shifting of pressure belts,~~ ~~13. Introduction of cyclone and anticyclone and origin of temperate cyclone.~~ ~~14. Causes and effects of global environmental Problems; Ozone depletion, Green House effect, Global warming~~ ~~15. Climate change; Evidences and ConsequencesBooks Recommended:~~ ~~1. Alka, G., (2011), BhoutikBhoogol, Rastogi Publications, Meerut.~~ ~~2. Critchfield, H., (1975) General Climatology, Prentice-Hall, New York.~~ ~~3. Dayal, P., (1996) A Text book of Geomorphology, Shukla Book Depot, Patna,~~ ~~4. Khullar, D.R., (2012), Physical Geography, Kalyani Publishers, New Delhi.~~ ~~5. King, C. A. M., (1975) Oceanography for Geographers, E. Arnold, London.~~ ~~6. Sharma, H.S., (2012) BhoutikBhoogol, Panchshil Publications, Jaipur~~ ~~7. Singh, S., (2009), BhoutikBhoogol, VasundharaPrakashan, Gorakhpur.~~ ~~8. Singh, S., (2009), Physical Geography, PrayagPustakBhawan, Allahabad.~~ ~~9. Strahler A.N. and Strahlar, A.H. (1984): Elements of Physicalgeography, John Wiley& Sons. New York~~ ~~10. Strahler, A. N. and A. H. Strahler, (1992) Modern Physical Geography, John Wiley & Sons.~~ 11. ~~Strahler, A. N., (1973) Environmental Geo-Science, Hamilton Publishing, Santa Barbara,~~		

THIRD SEMESTER

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	**~~GEOG701D Dissertation~~**	**~~After the completion of this course, students will be able to:~~** **~~• formulate research proposals, hypothesis,~~**			**Introduced with new scheme in semester II**

		~~collection of data~~ • ~~develop skill in analysis of data and testing of hypothesis~~ • ~~extract results and conclusions.~~ • ~~provide suggestions for the development of research area.~~			

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	~~GEOG702S Seminar~~	~~After the completion of this course, students will be able to:~~ • ~~identify and formulate research problem~~ • ~~develop skills in data analysis~~ • ~~develop presentation skills~~ • ~~provide suggestions of related research problem~~			Introduced with new scheme in semester II

Reading Electives

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
1.	GEOG___ R Climate change and future crisis	After the completion of this course, students will be able to: • Explain and analyze climate change. • Predict consequences of climate change over several sectors of economy. • Analyze effects of climate variability ondomestic livestock. • Describe current and past climate change policies in India.		Climate Change; Global warming and regional effect; Projected impact of climatic change in Asia over fisheries, human settlement, food supply, farming systems, health; Climate change and diseases; Climate Change and El-Nino; Impact of climate change on agriculture, soil, desertification (special reference to Rajasthan); Effects of climate variability on domestic livestock; Economics of climate change; Climate change policies of India. Books Recommended: 1. Singh.A.(2015). *Climate Change and Agriculture*. Jaipur, India:Oxford Book Company. 2. Sharma, H.S.(2018). *Climate Change and Natural resource: A study of Indian Deserts*. New Delhi, India:Global. 3. Baros, V., & Field, C.B.(2014). *Climate Change, Impacts Adaptation and Vulnerability Part B Regional Aspect.*, New York, NY:Cambridge University Press. 4. Cowie, J.(2007). *Climate change and Biological Impacts*. Cambridge, UK:Cambridge University Press. 5. Agarwal, S.K.(2013). *Global Warming and Climate change*. New Delhi, India: A.P.H. 6. Romm, J.(2018). *Climate change what everyone needs to know*. New Delhi, India:Oxford University Press. Suggested e-learning materials: 1. El-Nino and climate Change https://blogs.ei.columbia.edu/2016/02/02/el-nino-and-global-warming-warming-whats-the-connection/ 3. Economics of climate change https://bfi.uchicago.edu/events/CC-climate 4. Climate change policies in India http://envfor.nic.in/division/india-taking-climate-change-24-recent-initiatives	New Course has been introduced

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
2.	**GEOG___ Contemporary Social Challenges in India**	**After the completion of this course, students will be able to:** • **Analyze the socio cultural environment in India with respect to parameters like sex ratio, fertility and mortality.** • **Understand about the causes and consequences of Gender discrimination in Indian society** • **Status of women and domestic violence in Indian society and need of women empowerment** • **Aware about the government policies concerning them.**		**Socio-cultural transformation and its relation with environment; Social diversity, Social well-being and Quality of life in India with reference to major religion; Gender inequality in sex ratio, fertility, mortality and child marriage in India; Causes and consequences of Gender discrimination in Indian society with special reference to Literacy and occupational structure; Status of women and domestic violence in Indian society and need of women empowerment in modern India; Government Laws. policies/schemes and International commitments to women empowerment.** **Books Recommended:** 1. **Ahmad, A. (2006). *Social Geography* (Reprint).Jaipur, India: Rawat.** 2. **Chandana, R. C. (2014). *A Geography of population (11th ed.)*. New Delhi, India: Kalyani.** 3. **Jetli, K. N. (2010). *Human and Natural Resource of India.* New Delhi India: New Century** 4. **Khullar, D. R. (2014). *India, A Comprehensive Geography.(3rd ed.)*. Ludhiyana, India: Kalyani.** 5. **Mehtani, S.,&Sinha, A. (2010). *Social Geography*. New Delhi, India: Commonwealth** 6. **Ranade, P. S. (1990). *Population Dynamics in India*. New Delhi, India: Ashish.** 7. **Singh, G. (2010). *Geography of India.*(9th ed.). Delhi, India: Atma Ram** 8. **Syed, M.H. (2010). *Social and Cultural Transformation in India*. New Delhi, India: Anmol** **Suggested e-learning materials:** 1. **Women Empowerment** https://www.indiacelebrating.com/social-issues/women-empowerment/ 2. **Socio-culture Transformation** http://www.yourarticlelibrary.com/society/essay-on-socio-cultural-dynamics-in-indian-society/4022 3. **Social Diversity** http://egyankosh.ac.in/bitstream/123456789/8326/1/Unit-16.pdf 4. **Gender Inequality** https://www.indiacelebrating.com/social-issues/gender-inequality-in-india/ 5. **Gender Discrimination** http://www.dailyexcelsior.com/gender-discrimination-india/ 6. **Occupational Pattern** https://www.ijmra.us/project%20doc/2018/IJRSS_JANUARY2018/IJMRA-13135.pdf 7. **Domestic Violence** https://www.youthkiawaaz.com/2010/02/domestic-violence-in-india-causes-consequences-and-remedies-2/	**New Course has been introduced**

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
3.	GEOG___ R Industrialization and Regional Development	After the completion of this course, students will be able to: • describe and ascertain the concepts and theories to industrial location, industrial decentralization and agglomeration. • To map and explain world industrial regions and associated factors of growth and problems. • To assess the impact of growth of industries over environment and • Suggests measures for the improvement.		Industries and their linkage, Aspects for the location of Industries and optimum industrial location, characteristics and problems of Industrial centralization, decentralization and agglomeration; World industrial problems with special reference to developed and developing countries.Regional imbalances in industrialization and role of Industrialization for the regional development with special reference to India and USA.Government policies and efforts for the development of industrialization with special reference to India.Impact of industrialization on environment; Industrial Hazards and Health. **Books Recommended:** 1. Gautam, A. (2010). *Advanced Economic Geography.* Allahabad, India: ShardaPustakBhawan. 2. Guha, J.L.,&Chattoraj, P.R. (2009). *Economic geography – A Study of Resources.*(9th ed.). Kolkata, India: The World Press. 3. Hartshorn, T. A., & Alexander, J. W. (2009). *Economic Geography.* (8th ed.). New Delhi, India: Prentice Hall. 4. Leong, G. C.,& Morgan, G. C. (2010). *Human and Economic Geography*. (2nd ed.). New Delhi, India: Saurabh 5. Sharma, T.C. (2013). *Economic Geography of India*. Jaipur, India: Rawat 6. Siddharth, K. (2018). *Economic Geography.* (3rd ed.). Allahabad, India: KitabMahal. 7. गौतम, ए. (2015). *आर्थिकभूगोल.* मेरठ, भारतः रस्तोगी. 8. प्रताप, आर. (2006).*औद्योगिकभूगोल.*नईदिल्ली, भारतः यूनिवर्सिटी. 9. मामोरिया, सी. (2012). *आर्थिकभूगोल(द्वितीय सं.).*आगरा, भारतः साहित्य भवन. 10. सिंह, के. एन., एवं सिंह,जे. (2010). *आर्थिकभूगोल के मूलतत्व।(11 वाँ सं.).*गोरखपुर, भारतः ज्ञानोदय. 11. सिंह, के. (2009). *आर्थिकभूगोल के मूलतत्व : संसाधनउपयोग, संरक्षण एवंआर्थिकविकासका अध्ययन(11 वाँ सं.).वाराणसी, भारतः ज्ञानोदय.* 12. लोढ़ा आर. (2009).*औद्योगिकभूगोल*(चतुर्थ सं.).जयपुर, भारतः हिन्दीग्रन्थअकादमी. **Suggested e-learning materials:** 1. Industrial centralization and decentralization https://ebrary.net/7783/management/centralisation 2. Regional imbalances in industrialization http://www.yourarticlelibrary.com/india-2/top-9-causes-responsible-for-regional-imbalances-in-india/63001 3. Industry and Environment https://postconflict.unep.ch/publications/sudan/07_industry.pdf 4. Industrial Hazards	New Course has been introduced

				https://www.slideshare.net/ShmmonAhmad/industrial-hazard-pdf	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
4.	GEOG___ R Resource: Challenges andManagement	After the completion of this course, students will be able to: • Analyze the resources and their scarcity. • Depict the problems arising from resourcescarcity. • Describe resource related problems. • Suggest measures to conserve resources like water, forest, energy, biodiversity etc.		Resource and Technological Development Stages; Use and misuse of resources;Resource depletion and emerging issues: desertification, deforestation, Loss of Biodiversity, Energy crises, water scarcity and conflicts; Future prospects of energy resources with special reference to India;Resource disputes: river water sharing in India (Narmada, Krishna, Cauvery and Sutlej Yamuna Link-SYL); Conservation of resources (Water, Forest and Energy);Community participation and resource management;Watershed as a unit of resource management; Resource management in India with special reference to arid regions. **Books Recommended:** 1. Gautam, A. (2010). *Advanced Economic Geography.* Allahabad, India: ShardaPustakBhawan. 2. Guha, J.L.,&Chattoraj, P.R. (2009). *Economic geography – A Study of Resources.*(9th ed.). Kolkata, India: The World Press. 3. Hartshorn, T. A., & Alexander, J. W. (2009). *Economic Geography.* (8th ed.). New Delhi, India: Prentice Hall. 4. Jetli K Narindra (2010). *Human and Natural Resource of India.* New Delhi India: New Century 5. Khullar, D. R. (2014). *India, A Comprehensive Geography.(3rd ed.)*. Ludhiyana, India: Kalyani. 6. Leong, G. C.,& Morgan, G. C. (2010). *Human and Economic Geography*. (2nd ed.). New Delhi, India: Saurabh 7. Pandey B.M (2005) (Ed.) (2005). *Natural Resource Management.* New Delhi, India: Mittal 8. Qazi S.A. and Qazi N.S (2007). *Natural Resource Conservation.* New Delhi, India: APH 9. Siddharth, K. (2018). *Economic Geography.*(3rd ed.). Allahabad, India: KitabMahal. 10. Singh, Gopal. (2010). *Geography of India.*(9th ed.). Delhi, India: Atma Ram. 11. Trivedi P.R. (2010). *Natural Resource Conservation*. New Delhi, India: APH 12. बंसल, एस. सी. (2015). *भारतकाभूगोल*(तृतीय संस्करण.). मेरठ, भारतःमीनाक्षी. 13. मामोरिया, सी. (2018). *भारतकावृहतभूगोल.*आगरा, भारतःसाहित्य भवन. *14.* सिंह, के. (2009). *आर्थिकभूगोल के मूलतत्व : संसाधनउपयोग, संरक्षण एवंआर्थिकविकासका अध्ययन (11 वाँ सं).*वाराणसी, भारतः *ज्ञानोदय.* 15. सिंह, जे. (2009). *संसाधनभूगोल.* नईदिल्ली, भारतः राधा. **Suggested e-learning materials:** 1. Resource Scarcity https://www.ipinst.org/wp-content/uploads/2015/06/rscar0408.pdf	New Course has been introduced

				2. Resource Scarcity and adequacy **http://www.yourarticlelibrary.com/economy/important-ideas-concepts-developed-in-economy/25276** **3. Use and misuse of natural resource** **https://www.ugc.ac.in/oldpdf/modelcurriculum/Chapter2.pdf** **4. Economic development and Resource** **https://helpsavenature.com/how-do-natural-resources-affect-economic-development.** **5. Watershed and resource management** **http://kiran.nic.in/pdf/publications/Watershed_Development.pdf**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
5.	**GEOG___ R Solid Waste Management for a Smart City in India**	**After the completion of this course, students will be able to:** • **understand about the concept, characteristics, rules of solid waste management** • **learn about biochemical processes and energy recovery from municipal solid waste.** • **learn about the collection,**		**Course content:** Municipal Solid Waste Management: Characteristics and Quantities, Collection, Transportation, Segregation, Processing and Disposal of Municipal Solid Waste, Landfill; Biochemical Processes and Composting; Energy Recovery from Municipal Solid Waste; Current Issues in Solid Waste Management; Construction and Demolition (C&D) Waste Management – Overview; C&D Waste – Regulation, Beneficial Reuse of C&D Waste Materials; MSW Rules 2016, Electronic Waste (E-Waste) Management – Issues and Status in India;, E-Waste Management Rules 2016 and Management Challenges, Swachh Bharat Mission so far. **Books Recommended:** **1.** Bhatia, S.C. (2007). *Solid &Hazardous Waste Management*. New Delhi, India: Atlantic. **2.** Hosetti, B.B. (2016). *Prospects & Perspectives of Solid waste Management.* New Delhi, India: New Age International. **3.** Singh, J. and Ramanathan, A.L. (Ed.), (2015). *Solid waste Management Present & Future Challenges.* New Delhi, India: I.K. International. **4.** Yasmin, S. (2013). *Solid waste Management.* New Delhi, India: Global Research. **5.** Mohd, S. (2011). *Waste Management in an Urban Area.*New Delhi, India: B. R. **Suggested e-learning materials:** **1.** MSW Management Rules 2016, Govt. of India **http://cpcb.nic.in/** **2.** Electronic Waste Management Rules 2016, Govt. of India **http://cpcb.nic.in/**	**New Course has been introduced**

		transportation, segregation, composting and disposal of Municipal solid Waste • **assess the issues and challenges of Solid Waste Management faced in India**		3. Biochemical Processes and Composting **http://ecochem.com/t_compost_faq2.html** 4. Energy Recovery from Municipal Solid Waste **https://www.epa.gov/smm/energy-recovery-combustion-municipal-solid-waste-msw**	

S.N.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remark
6.	**GEOG___ R Tourism and Heritage**	**After the completion of this course, students will be able to:** • **describe tourism, its major concepts, development and trends associated with it.** • **able to identify major**		**Geographical Basis of Tourism and Infrastructure for the development of Tourism; Types of tourism; Identification of tourism sites for regional development; Heritage sites and their significance in tourism; Impacts of Tourism: Physical, Economic & Socio- Cultural; New trends in Tourism: creation& development of tourists spots; Growth, Policies and challenges of Tourism in India and Rajasthan; Tourism organizations and their role for the development of Tourism and employment; Role of foreign capital and impact of Globalization on tourism; Physical and Social barriers of Tourism and solutions.** **Books Recommended:** 1. **Bhatia, A. K. (2002). *Tourism Development: Principles and Practices*. New Delhi, India: Sterling pub.** 2. **Chen, A. (2015). *The Principles of Geotourism*. Beijing, China: Springer-Verlag.** 3. **Cooper, C., & Cooper, R. (2012). *Worldwide Destinations: The Geography of Trevel and Tourism*. New York, NY: Routledge.** 4. **Dowling, R., & Newsome, D. (Eds.). (2005). *Geotourism*. Oxford, UK: Elsevier.** 5. **Garg, D. (2009). *Geography of Tourism*. New Delhi, India: Mohit.**	**New Course has been introduced**

		tourist sites, heritage sites • understand policies and challenges of tourism in India and Rajasthan • explain the role of tourist organizations, foreign capital and globalization on tourism		6. Jayapalan, N. (2013). *An Introduction to Tourism.* New Delhi, India: Atlantic. 7. Kamra, K. K. (2104). *Tourism An Overview*, New Delhi, India: Kanishka. 8. Kaushal, P., & Sharma, S. P. (2011). *Ecological and Environmental Impact of Tourism*. New Delhi, India: Kanishka. 9. Micheal, H. C., & Page, J. S. (2014). *Geography of Tourism and Receration*, New York, NY: Routledge. 10. Nelson, V. (2013). *An Introduction to the Geography of Tourism*. Jaipur, India: Rawat. 11. Pathania, K. S., & Kumar, A. (2008). *Tourism in India,* New Delhi, India: Regal. 12. Sharma, S. P. (2011) :*Tourism Education Principales,Theories and Practices.* (2nd ed.). New Delhi, India: Kanishka. 13. नेगी,जगमोहन. (2007).*पर्यटन एवं यात्रा के सिद्धान्त*।नईदिल्ली, भारतः तक्षशिला। 14. शुक्ला,राजेश एवं शुक्ला,रश्मि (2009).*पर्यटनभूगोल*।नईदिल्ली, भारतः अर्जुन। 15. सारण, बी. आर. (2008).*पर्यटनउत्पाद एवंप्रबन्ध*।नईदिल्ली, भारतः कनिष्क। Suggested e-learning materials: 1. Concept of Tourism https://unstats.un.org/unsd/tradeserv/Workshops/Madrid/IWTS_Item09(Philippines).pdf 2. Concept and types of Tourism http://oer.nios.ac.in/wiki/index.php/Forms_of_Tourism 3. Impact of Tourism http://trcollege.edu.in/articles/74-development-and-impact-of-tourism-industry-in-india 4. Growth of Tourism in India http://www.yourarticlelibrary.com/tourism/growth-of-tourism-in-india-its-impact-on-employment-and-economic-development/14110 5. Impact of Globalization on tourism https://www.asianentrepreneur.org/globalization-tourism/	

Note: Duration of M.Phil. programme has been changed into 2 semesters instead of 3 semesters with new course scheme.

BANASTHALI VIDYAPITH

SCHOOL OF EARTH SCIENCES

MASTER OF TECHNOLOGY (REMOTE SENSING)

Annexure- 13

Name ofProgramme: M. Tech. (Remote Sensing)

Programme Educational Objectives:

Banasthali Vidyapith is an epitome of tradition and modernity. Vidyapith aims to preserve and inculcate the essential values and ideals of Indian culture. It believes in simple living and high thinking. Our educational ideology is based on the concept of fivefold education focusing on physical, practical, aesthetic, moral and intellectual aspects in order to develop a balanced personality.

Realizing the potential of Remote Sensing Technology in Natural Resource management, Banasthali Vidyapith, took the lead in establishing the first Remote Sensing M.Tech. Programme for Women in India to cater the human resource development in scientific field of remote sensing. M.Tech. students carried out their dissertation research at various esteemed institutions and multinational industries, i.e., ISRO, DRDO, and NIH.

The M.Tech. Remote Sensing programme offers a flexible and complete education in the field of Remote Sensing technology and Geoinformatics. Students will comprehend the major Earth surface imaging systems and Geomatics based research & development. The integrated Remote Sensing technology plays a major role in natural resource management and develops multidisciplinary research environment.

The main objectives of the M.Tech. Remote Sensing programme are:

- **To strengthen the ability for assessing and solving the real-time geospatial problems.**
- **To inculcate skills for developing realistic solutions to the challenges of emerging field of earth observation technology.**
- **To provide an adequate professional and technical environment that assists both in academia and industries**
- **To acquire skills in leaning modern earth observation techniques such as SAR, hyper-spectral, thermal and LiDAR scanning for mapping, modeling and monitoring.**
- **To prepare students for solving complex engineering problems by using innovative research.**

Programme Outcomes (PO)

PO1: Remote Sensing Knowledge: Describe the standard principle and concepts of advance 'Earth Observation' (EO) Technologies that ensure the effective use of Geoinformatics based generic applications to solve concurrent global and regional environmental problems.

PO2: Problem Analysis: Formulate robust, generic and ubiquitous research methodologies and approaches based on 'close-to-far' range remote sensing technology to resolve issues associated with natural resources.

PO3: Design/Development of Solutions: Develop and distribute free tools and realistic solutions based on Geoinformatics that can assist in natural resource management, environmental resiliency and infrastructure to expedite information sharing, which can be adapted and tailored to societal needs.

PO4: Conduct investigations of complex problems: Implement the Geoinformatics based operational research methods and optimization techniques in the extension of Geospatial policy for both academia and industrial arena. Share professional acumen to provide intellectual solutions for the complex geospatial problems with valid conclusions.

PO5: Modern tool usage: Construct, relate, and implement suitable geospatial techniques, industrialized resources, and cutting-edge Information Technology (IT) tools to forecast and modeling to manifold engineering activities with generous societal benefits.

PO6: Remote Sensing professionals and society: Implement the contemporary technical information and improved understanding of mapping sciences to encourage the development of responsible societal applications of Remote Sensing, Geographical Information Systems (GIS) and associate technologies.

PO7: Environment and sustainability: Perceive and relate the acceleration and impact of earth observation science, resource use, which increased the urgency to obtain quantitative, timely information about the environment at a variety of scales in space and time.

PO8: Professional ethics: Identify the significance of transparency in sharing of geospatial information in terms of a national policy to ensure data availability, accessibility, and quality to meet development goals of national mapping and imaging agencies, in accordance with issues associated to national security and intellectual integrity.

PO9: Individual and team work: Contribute as a team leader as well as individual in multi-disciplinary research groups in order to achieve common goals. Offer rational decisions based on objectivity to solve complex geospatial problems.

PO10: Communication: Empathize with relative arguments derived by the professionals during execution of the various global technological events. Create, design and disseminate effective reports, scientific articles and deliver presentations from different platforms.

PO11: Project management and finance: Demonstrate considerate interactions and knowledge of the remote sensing technology in real-time project management. Implement principles of project management into fields of applied remote sensing and interdisciplinary environments.

PO12: Life-long learning: Develop an attitude to ensure independent learning with value-added motivation in promptly changing scenario of global technical competence. Retain life-long intellect based on attained technological skills for sustainable development.

Programme Scheme:

Semester I

Existing					
CourseCode	**Course Name**	**L**	**T**	**P**	**C**
RS502	Applied Statistics and Research Methodology	4	0	0	4
RS504	Fundamentals of Geographic Information Sciences and Digital Cartography	4	0	0	4
RS505	GIS Programming and Scripting	4	0	0	4
RS506	Microwave, Thermal and Hyperspectral Remote Sensing	4	0	0	4
RS508	Principles of Remote Sensing	4	0	0	4
RS502L	Applied Statistics and Research Methodology Lab	0	0	2	1
RS504L	Fundamentals of Geographic Information Sciences and Digital Cartography Lab	0	0	4	2
RS505L	GIS Programming and Scripting Lab	0	0	2	1
RS506L	Microwave, Thermal and Hyperspectral Remote Sensing Lab	0	0	2	1
RS508L	Principles of Remote SensingLab	0	0	2	1
	Total:	**20**	**0**	**12**	**26**

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
RS504	**Fundamentals of Geographic Information Sciences and Digital Cartography**	**4**	**0**	**0**	**4**
RS508	**Principles of Remote Sensing**	**4**	**0**	**0**	**4**
RS__L	**Remote Sensing Lab-I**	**0**	**0**	**6**	**3**
RS__L	**Remote Sensing Lab-II**	**0**	**0**	**6**	**3**
	Discipline Elective I	**4**	**0**	**0**	**4**
	Discipline Elective II	**4**	**0**	**0**	**4**
RS__	**Term Paper-I/Minor Project-I/Seminar-I**	**0**	**0**	**8**	**4**
	Total:	**16**	**0**	**20**	**26**

Semester II

Existing					
CourseCode	**Course Name**	**L**	**T**	**P**	**C**
RS501	Applications of remote sensing	4	0	0	4
RS503	Digital image processing	4	0	0	4
RS507	Photogrammetry, Global Positioning System and mobile mapping	4	0	0	4
RS509	Spatial database systems, analysis and modeling	4	0	0	4
RS510	Spatial decision supports systems	4	0	0	4
RS501L	Applications of remote sensing Lab	0	0	2	1
RS503L	Digital image processing Lab	0	0	4	2
RS507L	Photogrammetry, Global Positioning System and mobile mapping Lab	0	0	2	1
RS509L	Spatial database systems, analysis and modeling Lab	0	0	4	2
	Total:	**20**	**0**	**12**	**26**

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
RS503	**Digital Image Processing**	4	0	0	4
RS507	**Photogrammetry, Global Positioning Systems and Mobile Mapping**	4	0	0	4
RS__L	**Remote Sensing Lab-III**	**0**	**0**	**6**	**3**
RS__L	**Remote Sensing Lab-IV**	**0**	**0**	**6**	**3**
	Discipline Elective III	**4**	**0**	**0**	**4**
	Open Elective	**4**	**0**	**0**	**4**
RS__	**Term Paper-II/Minor Project-II/Seminar-II**	**0**	**0**	**8**	**4**
	Total:	**16**	**0**	**20**	**26**

Semester III

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
	Reading Elective-I	0	0	4	2
RS603P	Project (Part-I)	0	0	48	24
	Total:	**0**	**0**	**52**	**26**

Proposed					
CourseCode	**Course Name**	**L**	**T**	**P**	**C**
	Reading Elective I	0	0	0	2
RS603P	Project (Part I)	0	0	48	24
	Total:	**0**	**0**	**48**	**26**

ReadingElective I

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
RS~~601R~~	~~Geoinformatics in Human Settlement Analysis~~	0	0	4	2
RS~~602R~~	~~Pattern Recognition and Processing~~	0	0	4	2
RS~~605R~~	~~Remote Sensing in Environment Studies~~	0	0	4	2

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**

SemesterIV

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
	Reading Elective-II	0	0	4	2
RS604P	Project (Part-II)	0	0	48	24
	Total:	**0**	**0**	**52**	**26**

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
	Reading Elective II	0	0	0	2
RS604P	Project (Part II)	0	0	48	24
	Total:	**0**	**0**	**48**	**26**

Reading Electives II

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
RS~~606R~~	Remote Sensing in hydrology and Water Resources	0	0	4	2
RS~~607R~~	~~Remote Sensing in Resource Management~~	0	0	4	2
RS~~608R~~	~~Spatial Modeling and Resource Model~~	0	0	4	2

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**

List of Discipline Electives

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
RS___	Applications of Remote Sensing	4	0	0	4
RS	Applied Statistics and Research Methodology	4	0	0	4
RS ___	**Geospatial Entrepreneurship**	4	0	0	4
RS___	**Geospatial Intelligence**	4	0	0	4
RS___	GIS Programming and Scripting	4	0	0	4
RS___	Microwave, Thermal and Hyperspectral Remote Sensing	4	0	0	4
RS___	Spatial Database Systems, Analysis and Modeling	4	0	0	4
RS	**Spatial Decision Supports Systems**	4	0	0	4

List of Reading Electives

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
RS___R	**Environmental Remote Sensing and Modeling**	**0**	0	0	2
RS___R	**Geo-informatics for Resource Management**	**0**	0	0	2
RS___R	**Geospatial BigData: Challenges and Opportunities**	**0**	0	0	2
RS___R	**Open Source Software, Services and Utility Application**	**0**	0	0	2
RS___R	**Remote Sensing in Hydrology and Water Resources**	**0**	0	0	2
RS___R	**Spatial Planning and Urban Development**	**0**	0	0	2

Note:

Semester I

Introduction of Discipline electives and Term Paper –I/Minor Project-I/Seminar-I .

RS502L Applied Statistics and Research Methodology Lab has been removed.

RS508L Principles of Remote SensingLab and RS506L Microwave, Thermal and Hyperspectral Remote Sensing Lab has been combined in Remote Sensing Lab-I

RS504L Fundamentals of Geographic Information Sciences and Digital Cartography Lab and RS505L GIS Programming and Scripting Lab has been combined in Remote Sensing Lab-II

Semester II

Introduction of Discipline elective, open elective and Term Paper –II/Minor Project-II/Seminar-II.

RS503L Digital image processing Lab and RS501LApplications of remote sensing Lab has been combined in Remote Sensing Lab-III

RS507L Photogrammetry, Global Positioning System and mobile mapping Lab and RS509L Spatial database systems, analysis and modeling Lab has been combined in Remote Sensing Lab-IV

Semester III

RS601R Geoinformatics in Human Settlement Analysis has been replaced by new course RS___R Spatial Planning and Urban Development

RS602R Pattern Recognition and Processing has been replaced by new course RS___R Geospatial BigData: Challenges and Opportunities

RS605R Remote Sensing in Environment Studies has been replaced by new course RS___R Environmental Remote Sensing and Modeling

Semester IV

RS607R Remote Sensing in Resource Management has been replaced by new course RS___R Geo-informatics for Resource Management

RS608R Spatial Modeling and Resource Model has been replaced by new course RS___R Open Source Software, Services and Utility Application

Pool of Reading electives has been introduced in III and IV semester

NOTE: Yellow highlighted and bold content illustrate the modification in the syllabus.

BANASTHALI VIDYAPITH

SCHOOL OF EARTH SCIENCES

MASTER OF TECHNOLOGY (REMOTE SENSING)

Annexure-14

Name of Programme:M. Tech. (Remote Sensing)

Course Details:

FIRST SEMESTER

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	**RS ~~502:~~ Applied Statistics and Research Methodology**	**After the completion of this course, students should be able to:** • **Formulate research problems using geo-statistical methods.** • **Apply statistical knowledge to the geospatial variability.** • **Define research problems and selection of survey methods.** • **Writing project proposal for various funding**	**Section A** **DATA DISTRIBUTION AND BASIC STATISTICS** Scope and importance of statistics, Source of data-primary and secondary, Collection of data-sampling methods; Random and systematic method; Organization of data-array, Frequency, Class intervals, Histograms, and distribution, Presentation of data-Tables, Diagrams; Geometric form (Bar diagrams, Pie-diagrams), Frequency diagrams (histogram, polygon), Arithmetic line graphs (time series graph); Data grouping, Geographical data- Discrete and continuous series, Scales of measurement, Measures of central tendency-Mean, Median, Mode, Quartiles, Arithmetic mean, Geometric mean, Harmonic mean, Quadratic mean and their interrelated relations; Measures of dispersion-Absolute dispersion (range, quartile deviation, mean deviation, standard deviation); Relative dispersion (Coefficient of quartile deviation, Coefficient of variation), Moments, Skewness, Kurtosis **Section B** **CORRELATION, PROBABILITY AND HYPOTHESIS TESTING** Correlation-meaning, Scatter diagram, standard deviation, Variance, Measures of Correlation-Karl Pearson's method (Two variables ungrouped data) Spearman's rank correlation methods.	**Discipline Elective**	**This course has been shifted from core course of I semester to elective Pool**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		agencies.	Probability-Binomial, Normal, and Poisson distribution; Theory of Sampling - Sampling distributions of means and proportions, Standard errors, Confidence interval estimation for population means, Standard deviations, Testing of Hypothesis – Large and small sample test. **BASIC CONCEPT OF RESEARCH METHODOLOGY** Definition of Research Problem, Identification of problems of regional and Local level, Considerations in selection of problem, Research process, Review of literature, Research objectives and research questions, Research scheme/design. **Section C** **DATA COLLECTION, ANALYSIS AND REPORTS** Methods of data collection, Survey methods, Samples-Type and methods, Data processes and analysis, Reporting of results, References, Future scope of work. **PREPARATION OF RESEARCH PROJECTS** Writing of proposals, Objectives of project, Research hypothesis and design, Research Questions, Scope of project, Brain storming sessions, Finalization of methodology, Review of similar studies and present level of research, Time scheduling (PERT), Financial estimates, Submission of Proposal. Project planning, Project activities/tasks, Feasibility, Resource requirements and allocation, Project management software, Project review, Project Completion-Quality assurance, Evaluation of individual tasks, Financial auditing, Problems and opportunities in Projects. ~~**TEXT BOOK**~~ ~~T1 Paul L. Meyer: Introductory Probability and Statistical Applications, Addison Wesley~~ ~~T2 Gupta. S. C. and Kapoor. V. K., 2000," Fundamental of~~		

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			~~Mathematical Statistics" S Chand Publication, New Delhi~~ ~~T3 CR Kothari, 2004, Research Methodology Methods and Technique, New Age International Pvt Ltd. New Delhi~~ ~~T4 S L Gupta and Hitesh Gupta, 2011 Research Methodology Text and Cases with SPSS Applications, International book House Pvt. Ltd., New Delhi.~~ ~~**REFERENCE BOOKS**~~ ~~R1 Murray R. Spiegel, (1981), Theory and Problems of Statistics, Schaum's Outline Series~~		
2.	**RS 504: Fundamentals of Geographic Information Sciences and Digital Cartography**	**After the completion of this course, students should be able to:** • **Differentiate GIS and science of map making, non-spatial vs. spatial data.** • **Georeference the Topomaps and imagery and handle geospatial database.** • **Describe concepts of**	**Section A** **FUNDAMENTAL GEOGRAPHIC CONCEPTS FOR GIS** Basic concepts about spatial information: Brief history and definition of GIS, Manual mapping Vs GIS mapping, Geometrical feature and real word Pictures, Variables- Points, Lines and Areas, Network and Surface, Application and Trends of GIS including Desktop GIS, Mobile GIS, Web GIS. Basic Objectives and Component of GIS – details of hardware, software and management **MAP AND MAP PROJECTION** Basic Concept, Categories of maps, Interpretation of topographic maps, Coordinate system, Polar and Cartesian, Map projections, Grouping of map Projections-Conical projection, Cylindrical projection, Azimuthal Projection; Mercator, Transverse Mercator, Polyconic, Lambert and UTM. **GEOGRAPHICAL DATA, MODEL AND DATA INPUT**	**Section A** **Fundamental Geographic Concepts For GIS** Basic concepts about spatial information: Brief history and definition of GIS, Manual mapping Vs GIS mapping, Geometrical feature and real word Pictures, Variables- Points, Lines and Areas, Network and Surface, Application and Trends of GIS including Desktop GIS, Mobile GIS, Web GIS. Basic Objectives and Component of GIS – details of hardware, software and management **Map and Map Projection** Basic Concept, Categories of maps, Interpretation of topographic maps, Coordinate system, Polar and Cartesian, Map projections, Grouping of map Projections-Conical projection, Cylindrical projection, Azimuthal Projection; Mercator, Transverse Mercator, Polyconic, Lambert and UTM. **Geographical Data, Model and Data Input**	**The learning outcomes and Suggested e-learning material have been reviewed.** **The topics of DBMS concepts to fill the gap is added and the generalization of topics is added to cover the**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		database management system within spatial analytical framework. • **Design and frame initial requirements for WebGIS development.**	Conceptual models of real world phenomena, Geographical data models; Fundamentals of data storage: entities or Fields, Introduction to database system: Definition, Purpose, Data abstraction, Instances, Schema, DDL, DML, database manager, RDBMS~~, Relationship and primary/secondary/composite key.~~ Information organization and data structure; Basic file structures, Tabular databases, Advantages of databases, Types of Databases-Hierarchical systems, Network systems, Relational systems and Object-oriented database systems (OODS); Data models - Entity relationship model, Relational model **Section B** **SPATIAL DATA INPUT AND EDITING** Spatial and Non-spatial data base, spatial data model: Geo relational Vector data model, Object based vector data model, Geodatabase, Raster data model, Hybrid relational database Vs Object orientation. Comparative analysis of spatial database, GIS data Requirement, sources and collection, Methods of data capture-scanning, digitization and associated errors; Conversion from other digital Sources, Attribute data input and management, creating digital data-remote sensing; GPS; data exchange; generating data from existing data; metadata; Different kinds of geospatial data, ~~Detecting and evaluating errors,~~ Topological relationships; Creation of topology and error correction; Edge matching, Data quality measurement and assessment, Digital output options. **DATA STORAGE, INTEGRATION AND MANAGEMENT** Data retrieval; Data compression; ~~Thematic mapping;~~ GIS and integration of other types of data; GIS and Remote Sensing data Integration, Image storage formats, ~~Types of uncertainty in a GIS,~~Sources of errors in GIS database: Errors through processing, Errors associated with overlaying of polygons, ~~Data quality parameters: Positional accuracy, Attribute accuracy, Logical consistency, Completeness lineage, Handling errors in GIS,~~ Survey of	Conceptual models of real world phenomena, Geographical data models; Fundamentals of data storage: entities or Fields, **Information organization and data structure; Basic file structures, Tabular databases,** Introduction to database system: Definition, Purpose, Data abstraction, Instances, Schema, **Database Languages,** database manager, RDBMS**, keys.** Advantages of databases, Types of **Data Model**-Hierarchical systems, Network systems, Relational systems and Object-oriented database systems (OODS); Entity relationship model, **Attribute data query, SQL** **Section B** **Spatial Data Input and Editing** Spatial and Non-spatial data base, spatial data model: Geo relational Vector data model, Object based vector data model, Geodatabase, Raster data model, Hybrid relational database Vs Object orientation. Comparative analysis of spatial database, GIS data Requirement, sources and collection, Methods of data capture-scanning, digitization and associated errors; Conversion from other digital Sources, Attribute data input and management, creating digital data-remote sensing, GPS; data exchange; generating data from existing data; metadata; Different kinds of geospatial data, **Topological relationships; Creation of topology and error correction,**Edge matching, Data quality measurement and assessment, Digital output options. **Data Storage, IntegrationandManagement** Data retrieval; Data compression; GIS and integration of other types of data ; GIS and Remote Sensing data Integration, Image storage formats, Sources of errors in GIS database: Errors through processing, Errors associated with overlaying of polygons, Survey of available data, Public access to geographic information; Digital libraries, National & Global Standard -	**broader category of components.** **Topics reframed to maintain the contiguity.** **Detail descriptions are added.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			available data, Public access to geographic information; Digital libraries, National & Global Standard - NSDI, GSDI; Global geospatial portals, OGC. **Section C** **INTRODUCTION TO VECTOR DATA ANALYSIS** Logical, Boolean, Arithmetical operation and function, Attribute data query, SQL, Topological relationships; Creation of topology and error correction; Overlay operations (union and intersection), Feature base topological function –buffer, Eliminate, dissolve, Layer based overlay analysis~~: point to polygon, line to polygon~~, clip, erase, split, identity, union and intersection **INTRODUCTION TO RASTER DATA ANALYSIS** Raster Data base and structure, Local operations, Neighbourhood operations, Zonal operations ~~**TEXT BOOKS**~~ ~~T1 Burrough, Peter A. and Rachael McDonnell, 1998, 'Principles of Geographical Information Systems' Oxford University Press, New York.~~ ~~T2 Kang tsung Chang 2002, 'Introduction to Geographic Information Systems' Tata McGraw Hill, New Delhi.~~ ~~T3 C.P. Lo and Albert K.W.Yeung 2005 "Concepts and Techniques of Geographic Information Systems" Prentice Hall of India, New Delhi.~~ ~~**REFERENCE BOOKS**~~ ~~R1 Magwire, D. J., Goodchild, M.F. and Rhind, D. M. Ed. 1991,~~	NSDI, GSDI; Globalgeospatial portals, OGC. **Section C** **Introductionto Vector data Analysis** Logical, Boolean, Arithmetical operation and function, Overlay operations (union and intersection), Feature base topological function –buffer, **point in polygon,** Layer based overlay analysis: **Reclassification, point in polygon, line in polygon, polygon on polygon, (Eliminate, dissolve,**clip, erase, split, identity, union and intersection) **Introduction to Raster Data Analysis** Raster Data base and structure, Local operations, Neighbourhood operations, **Extended Neighbourhood**,Zonal operations. **Recommended Books:** **1. Burrough, P. A., & McDonnell, R. (1998). *Principles of Geographical Information Systems*(3rd ed.). New York, NY: Oxford University Press.** **2. Chang, K.T. (2002). *Introduction to Geographic Information Systems*(3rd ed.). New Delhi, India: Tata McGraw Hill.** **3. Clarke, K. C., Parks,B.O.,&Crane, M. P. (Eds.). (2002). *Geographic Information Systems and Environmental modelling*. New Delhi, India: PHI Learning.** **4. Drummond, J., Billen, R., Joao, E.,& Forrest, D. (Eds.). (2006). *Dynamic and Mobile GIS*. New York, NY:CRC Press.** **5. Harvey, F. (2008). *A Primer of GIS*. New York, NY: The Guilford Press.**	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			~~'Geographical Information Systems: Principles and Applications', Longman Group, U.K.~~ ~~R2 Clarke. Keith C., Parks Bradley O. And Crane Michael P Ed. 2002, "Geographic Information Systems and Environmental modelling, PHI Learning Pvt Ltd, New Delhi~~ ~~R3 Drummond. J., Billen. R., Joao. E., and Forrest. D., Ed 2007, "Dynamic and Mobile GIS" CRC Press, New York.~~ ~~R4 Francis Harvey, 2009 "A Primer of GIS" Rawat Publication, Jaipur~~	**6. Lo, C.P., &Yeung, A. K.W. (2005). *Concepts and Techniques of Geographic Information Systems*(2nd ed.). New Delhi, India: Prentice Hall India Learning.** **7. Magwire, D. J., Goodchild, M.F., &Rhind, D. M. (1991). *Geographical Information Systems: Principles and Applications.* Harlow, England: Longman Scientific & Technical.** **Suggested e-learning materials:** **1. Introduction to GIS https://nptel.ac.in/courses/105102015/1** **2. Spatial Analysis https://nptel.ac.in/courses/105102015/25** **3. Introduction to geographic information systems, overlaying operations https://swayam.gov.in/courses/3691-introduction-to-geographic-information-systems** **4. Digital Elevation Models and Applications https://swayam.gov.in/courses/4395-digital-elevation-models-and-applications** 5. **Interpolation https://nptel.ac.in/courses/105102015/14**	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
3.	**RS ~~505~~: GIS Programming and Scripting**	**After the completion of this course, students should be able to:** • **Describe object-oriented models and functional modeling in GIS Framework.** • **Explain concepts of common language infrastructure and class library.** • **Explain .NET and Python programming languages for geospatial tool development.** • **Rationalize the concepts of WebGIS, Server, and geo-processing functionalities.**	**Section A** **INTRODUCTION TO OBJECT ORIENTED** Introduction to Object Oriented modelling and Design**;** Definition object oriented (OO), Object modelling Concepts, OO methodology, OO themes, Introduction to OO modelling techniques: Modelling, modelling techniques, object model, Dynamic Model and Functional Model, relationship among models. Object Modelling:Object and Classes: Object modelling concepts in details: links, association, generalization, inheritance, metadata, etc. A sample Object Model**.** Dynamic Modelling:Dynamic modelling concepts. A sample dynamic model, Relation of object and dynamic model with example. Functional Modelling:Functional Modelling Concepts, A sample functional model. **Section B** **. NET FRAMEWORK** Concept of .NET framework, Common Language Infrastructure, Base Class Library and Framework Class Library ~~Understanding Visual Basic .NET terminology specifications, design, code, test, and document Visual Basic .NET programs maintenance, repair, and enhance Visual Basic .NET programs create custom dialog boxes, clocks, menus, and animation effects manage text files and use encryption and sorting algorithms master programming fundamentals, including variables, decision structures, loops, and functions~~ **Section C** **PYTHON PROGRAMMING** Introduction to Python, variables, built- in data types, statements and	**Discipline Elective**	**This course has been shifted from core course of I semester to elective Pool .** **The learning outcomes and Suggested e-learning material have been reviewed.** **the content is reframed to enforce the in-depth extends must for learning object-oriented programming skills** **The repeated content is removed to maintain the level of detailing and an essential**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			expressions, strings, lists, python objects. Conditional statements- ~~controlling flow,~~ commenting scripts, Modules and packages, function, classes, Geoprocessing Python Scripts: Importing ArcPy, accessing data, accessing toolboxes, intersection, union and buffering, querying **Web GIS Development** Introduction to Web GIS, Principles, Architecture - Web Server, Map Server and Data Server, Technologies for WebGIS applications, Scripting for serving maps, map editing and geoprocessing functionalities for GIS server ~~**TEXT BOOKS:**~~ ~~T1 Pimpler E., "Programming ArcGIS 10.1 with python cookbook". Packt Publishing.2013~~ ~~T2 Fu P., Sun J., "Webgis principles and applications". ESRI press.2011~~ ~~T3 Zandbergen P.A., "Python scripting for ArcGIS". ESRI Press.2013~~ ~~T4 Zhuang V., Wrazien D., Wang M., Huang X., "Programming ASP.NET for ArcGIS Server". Thomson. 2005~~		**component for programing logic is introduced.**
4.	**RS ~~506:~~ Microwave, Thermal and Hyperspectral Remote Sensing**	**After the completion of this course, students should be able to:** • **Explain concepts and components of satellite radar imaging.**	**Section A** ~~MICROWAVE REMOTE SENSING~~ Concept of Microwave remote sensing and its components- Wavelength, Frequency and Pulse; Penetration of Radar signals : Skin depth, Azimuth and Range direction, Look angle, Depression angle, Incident angle and Polarization, Slant Range, Ground Range, Range Resolution, Azimuth Resolution, RAR/SLAR and SAR : Concepts, Radar Image geometry: Layover, Foreshortening, Radar Relief Displacement, Speckle and Shadows, Radar Equation, Radar Image interpretation variables : Surface roughness,	**Discipline Elective**	**This course has been shifted from core course of I semester to elective Pool.** **The learning outcomes and**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		• **Explain different microwave sensors data (SLC and GRD) and their characteristics .** • **Describe pre-processing requirements and discuss SAR image processing techniques.** • **Rationalize outlook of SAR, thermal, and hyperspectral images.**	Dielectric properties, Volume Scattering. Backscattering, Radar Interferometry, Application of Microwave remote sensing, Satellite Imaging Radars, Ground Penetration Radar **Section B** **THERMAL INFRARED REMOTE SENSING** Introduction to Thermal IR radiation Properties and Laws: ~~Kinetic Heat, Temperature, Radiant Energy and Flux, Methods of transferring heat,~~ Thermal properties of terrain: emissivity, Thermal capacity, Thermal conductivity, Thermal Inertia, Reflectance to temperature, Geometry of Thermal Images, Thermal IR multispectral scanners and Bands, Thermal Image Interpretation, Application of Thermal IR Remote Sensing. ~~LIDAR~~ ~~LIDAR Principles, LIDAR Profiling, Processing of LIDAR image data, LIDAR Intensity, Types of Imaging LIDAR, Applications of LIDAR~~ **Section C** **HYPERSPECTRAL REMOTE SENSING** History of Hyperspectral Imaging, Spectral Radiometry – Principle, solid angle, Radiance Vs. Reflectance, Spectroscopy- Introduction, reflectance spectroscopy, absorption processes – charge transfer, electronic & vibrational, Spectral library- concept, parameters controlling the spectra-spectral range, bandwidth, FWHM, spectral sampling, S/N ratio, BRDF, Illumination; continuum, Imaging Spectrometers, sensors – airborne &spaceborne. ~~**TEXT BOOKS:**~~		**Suggested e-learning material have been reviewed.** **Unit heading is modified with adequate relevance with course content** **Content is reordered by adding significant inescapable fundamentals and introductory part of advanced technical headings associated with GPR and Radar Imaging.** **Newly added content/topi**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			~~T1 Woodhouse, I.H., 2006, 'Introduction to Microwave Remote Sensing' CRC Press.~~ ~~T2 Jensen, J.R., "Remote Sensing of the Environment An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi, 2000.~~ ~~T3 George Joseph, "Fundamentals of remote sensing", Universities press (India) Pte Ltd., Hyderabad, 2003.~~ ~~T4 Campbell J.B., Wynne R.H., "Introduction to Remote Sensing", T5 BorengasserM., HungateW.S., Watkins R. "Hyperspectral Remote Sensing: Principles and Applications", CRC Press.2007~~ ~~T6 Thenkabail P.S., Lyon J.G., Huete A. "Hyperspectral Remote Sensing of Vegetation ", CRC Press.2011~~		**cs are required for underpinning the essential component for further research** **work in microwave imaging based earth observations .** **Necessary technical contents are added that strengthen the fundamental as well as methodological approach for temperature retrieval using satellite imaging.** **The**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
					LiDARrelated topics are shifted to the DIP course of the second semester of M.Tech. RS, accordingly. **Topics are reorganized accordingly.**
5.	**RS 508: Principles of Remote Sensing**	**After the completion of this course, students should be able to:** • **Explain fundamental principles of earth observation or imaging.** • **Differentiate various earth imaging satellites and sensors.** • **Know the appropriate use of aerial**	**Section A** **BASIC PRINCIPLES AND EMR RESPONSE** Definition of Remote Sensing: advantages and limitations, Electro-Magnetic Radiation (EMR)- spectrum properties, wavelength regions and their applications, Atmospheric interferenceand Atmospheric windows, Interaction of EMR with matter, Fundamentals of Radiometry: concept & laws, radiance, reflectance, Spectral signature and its response for Soil, Vegetation and Water; Ground Truthing, uses of ground data, equipment used. **CAMERAS AND SENSOR** Cameras and sensor classification: active and passive, optical – infrared sensors, microwave sensors, data reception and data product: ground segment organization, data product generation, georeferencing and resampling. **Section B** **PHOTO INTERPRETATION**	**Section A** **Basic Principles and EMR Response** Definition of Remote Sensing: advantages and limitations, Electro-Magnetic Radiation (EMR)- spectrum properties, wavelength regions and their applications, Atmospheric interference and Atmospheric windows, Interaction of EMR with matter, Fundamentals of Radiometry: concept & laws, radiance, reflectance, Spectral signature and its response for Soil, Vegetation and Water; Ground Truthing, uses of ground data, equipment used. **Cameras and Sensor** Cameras and sensor classification: active and passive, optical – infrared sensors, microwave sensors, data reception and data product: ground segment organization, data product generation, georeferencing and resampling. **Section B** **Photo Interpretation**	**The learning outcomes and Suggested e-learning material have been reviewed.** **The relevant detail is added to enrich the concept in depth.** **Recent available platforms and satellites are added.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		photographs for different applications. • **Explain the importance of ground truthing and ground equipment's used in validation process.**	Photo interpretation techniques, Fundamentals and elements of visual photo interpretation, Satellite image vs. Aerial photo interpretation, Digital and analog methods of Image Interpretation. **DIGITAL IMAGE CHARACTERISTICS** Concepts of digital image and its characteristics, Spectral, Spatial, Radiometric and Temporal resolution, Image data storage and retrieval, Types of image displays, Colour port and spectral band, B/W image, Gray Image, True/Pseudo Image and Standard FCC. **Section C** **PLATFORMS AND SATELLITES** Evolution of Indian Space programme, Introduction to Weather, Communication and Earth Observation satellites systems: IRS series of satellites. Global earth Observation Systems: Landsat, SPOT, IKONOS, Quickbird, Terra, Aqua, Radarsat, NOAA, EO-1, Data dissemination sources. ~~**TEXT BOOKS:**~~ ~~T1 Jensen, J.R., "Remote Sensing of the Environment-An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi, 2000.~~ ~~T2 George Joseph, "Fundamentals of remote sensing", Universities press (India) Pte Ltd., Hyderabad, 2003.~~ ~~T3 Lillesand, Thomas M. and Kiefer, Ralph, W., "Remote Sensing and Image Interpretation", 4th Edition, John Wiley and Sons, New York, 2000.~~ ~~T4 Moffitt F. H. and Mikail E.M "Photogrammetry", 3rd edition,~~	Photo interpretation techniques, Fundamentals and elements of visual photo interpretation, Satellite image vs. Aerial photo interpretation, Digital and analog methods of Image Interpretation. **Digital Image Characteristics** Concepts of digital image and its characteristics, Spectral, Spatial, Radiometric and Temporal resolution, Image data storage and retrieval, Types of image displays, **Look-up Tables (LUT) , Spatial profile and Spectral profile,** Colour port and spectral band, B/W image,Gray Image, True/Pseudo Image and Standard False Colour Composite (FCC). **Section C** **Platforms and Satellites** Evolution of Indian Space programme, Introduction to Weather, Communication and Earth Observation satellites systems: IRS series of satellites. Global earth Observation Systems: Landsat, SPOT, IKONOS, QuickBird, Terra, Aqua, RADARSAT, NOAA, EO-1, **Sentinel, RISAT, ASTER**, Data dissemination sources. **Recommended Books:** **1. Jensen, J. R. (2007). *Remote Sensing of the Environment - An Earth Resources Perspective* (2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall.** **2. Joseph, G., &Jeganathan, C. (2018). *Fundamentals of Remote Sensing* (3rd ed.). Hyderabad, India: Universities Press.** **3. Lillesand, T. M., Kiefer, R. W., &Chipman, J.W. (2003). *Remote Sensing and Image Interpretation* (5th ed.). New York, NY: John**	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			~~Happer& Row Publisher, New York, 1980.~~ ~~**REFERENCE BOOKS**~~ ~~R1 Sabins, F.F. Jr., 'Remote Sensing Principles and Interpretation", W.H. Freeman & Co., 2002~~ ~~Edition.~~ ~~R2 Reeves, Robert G., "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA~~ ~~R3 Rampal, K.K., Handbook of Aerial Photography and Interpretation, Concept Publishing Company,~~ ~~New Delhi, 1999.~~	**Wiley & Sons.** **4. Moffitt, F. H., &Mikail, E.M. (1980). *Photogrammetry* (3rd ed.). New York, NY: Happer& Row.** **5. Rampal, K.K. (1999). *Handbook of Aerial Photography and Interpretation.* New Delhi, India: Concept Publishing Company.** **6. Sabins, F.F. (2002). *Remote Sensing-Principles and Interpretation* (3rd ed.). Long Grove, IL: Waveland press.** **Suggested e-learning materials:** **1. Introduction to Remote Sensing https://swayam.gov.in/courses/3612-introduction-to-remote-sensing** **2. Basic Concepts of Remote Sensing https://nptel.ac.in/courses/105108077/**	
6.	~~**RS 502LApplied Statistics and Research Methodology Lab**~~	**After the completion of this course, students should be able to:** • **Represent geo-statistical data in diagrammatically and graphically.** • **Describe fundamental statistical measures for geospatial analysis.**	~~Lab 1. Diagrammatic and graphical representation of data~~ ~~Lab 2. Measures of central tendency: mean, median, mode, quartiles, AM, GM, HM~~ ~~Lab 3. Measures of dispersion: range, quartile deviation, mean deviation, standard deviation~~ ~~Lab 4. Skewness, kurtosis, Moments~~ ~~Lab 5. Relative methods: coefficient of variation, coefficient of quartile deviation~~ ~~Lab 6. Karl Pearson's correlation, rank correlation~~ ~~Lab 7. Fitting of distributions: Binomial, Poisson, Normal~~ ~~Lab 8. Applications of t, F and Chi square~~ ~~Lab 9. Large sample tests: for difference of means, proportions~~		**The course content has been removed.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		• **Describe different geographical survey sample data using statistical software's.** • **Apply statistical knowledge to solve complex geospatial queries using standard software's.**			
7.	~~**RS 504L: Fundamentals of Geographic Information Sciences and Digital Cartography Lab**~~	**After the completion of this course, students should be able to:** • **Implement the knowledge about SQL in solving attribute queries.** • **Analyze errors in spatial data and their removal.** • **Digitize and geospatial data creation for various thematic overlay analysis.**	Lab 1. Analog to Digital conversion -Scanning methods Lab 2. Introduction to software Lab 3 Map Rectification, Define projection and Reprojection. Lab 4. Digital database creation -Point features, Line features, Polygon features Lab 5. Data Editing-Removal of errors -Overshoot &Undershoot, Snapping, Topology Creation Lab6: Vector Transformation – Affine and Polynomial, Co-ordinate definition. Map Bound. Lab 7. Data collection and Integration, Non-spatial data attachment working with tables Lab 8. Concept of entity and relationship Lab 9. Creation of Tables		**Thecontent has been shifted and consolidated as Remote Sensing Lab-II** **The learning outcomes and Suggested e-learning material have been reviewed.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		• **Design and produce the base map using map algebra, complex query generation.**	Lab 10. Concept of SQL Lab 11. Performing various actions over table Lab 12. Merging of tables by using primary key Lab 13. Maintaining database Lab 14. Dissolving and Merging Lab 15. Clipping, Intersection and Union Lab 16. Proximity Analysis Lab 17. Spatial and Attribute query and Analysis Lab18. Map algebra / Math in Raster data Lab 19. Layout generation and report Lab 20. Analysis of toposheet Lab 21. Base map Lab 22. Updation of toposheet from satellite imagery. Lab 23. Digital Map preparation using Dot, Isopleth and Choropleth		**Restructuring of the exercises have been done.**
8.	~~**RS 505L: GIS Programming and Scripting Lab**~~	**After the completion of this course, students should be able to:** • **Write and describe .NET and Python scripting in their specified**	Lab 1. .NET framework concepts Lab 2. Window forms application Lab 3. Python concepts Lab 4. Geo-processing with python Lab 5. Introduction to ArcGIS server		**Thecontent has been shifted and consolidated as Remote Sensing Lab-II**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		frameworks. • **Perform geo-processing using Python, and ArcGIS Server.** • **Publishing newly generated geospatial maps on web.** • **Connect the desktop based GIS operation with real-time web operations.**	Lab 6. Creating GIS Server connectivity Lab 7. Map publishing on web		**The learning outcomes and Suggested e-learning material have been reviewed.** **Restructuring of the exercises have been done.**
9.	~~**RS 506L: Microwave, Thermal and Hyperspectral Remote Sensing Lab**~~	**After the completion of this course, students should be able to:** • **Perform image fusion with different multispectral data and SAR data products.** • **Pre-process raw SAR images for monitoring of urban and environmental**	Lab 1. Risat-1 data visualization Lab 2. Reading, displaying and header extraction of SAR images Lab 3. Visual image interpretation Lab 4. SAR image fusion with optical data Lab 5. Speckle filtering techniques Lab 6. Hyperspectral data interpretation Lab 7. Spectral profile Lab 8. Hyperspectral data cube generation		**Thecontent has been shifted and consolidated as Remote Sensing Lab-I** **The learning outcomes and Suggested e-learning material have been reviewed.** **New lab exercises are**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		applications. • Visualize indigenous as well as country outside agency SAR data products. • Pre-process airborne-space borne hyperspectral imagery and their interpretation.			introduced according to the theoretical course content that would be helpful in enhancing the practical knowledge of the students from "procurement of the satellitedata" to "efficient pre-processing".
10.	~~RS 508L: Principles of Remote Sensing Lab~~	After the completion of this course, students should be able to: • Interpret satellite FCC images and aerial photographs. • Explain the different resolutions of satellite imagery.	----		The content has been shifted and consolidated as Remote Sensing Lab-I The learning outcomes and Suggested e-

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		• **Generate spectral profiles for various LULC features.** • **Perform basic image pre-processing operations on raw imaging data products**			**learning material have been reviewed.**
11.	**RS ___L Remote Sensing Lab-I**	**After the completion of this course, students should be able to:** • **Perform image fusion with different multispectral data and SAR data products.** • **Generate spectral profiles for various LULC features, pre-process raw SAR images and explain their resolution components.** • **Visualize indigenous as well as country outside agency SAR data**		1. Introduction to ERDAS IMAGINE 2011 2. Study of the marginal information given on the C.D. ROM/Digital data 3. Import / Export of files using ERDAS IMAGINE 2011 4. Mosaic and Subset of imagery 5. Stacking of different layers 6. Map rectification of Topomaps using Keyboard or GPS data. 7. Geo-reference of the Topomaps and Imageries 8. Display, analysis and interpretation of black & white images, Gary image, Pseudo image and FCC **9.** Study of the Spectral Signature of water, Built-up, Bare Soil, Vegetation, Plantation, Crop land, Snow and Cloud. **10. Overview of RS imaging online data portals and procurement of imagery (Thermal, Radar, and Hyperspectral).** **11. Familiarization to the ISSDC, and procurement of available RS data products.** **12. Familiarization to software tools for handling SAR, and Hyperspectral Datasets.** **13. SAR metadata extraction and Visualization of (SLC and GRD Products).** **14. SAR Image visual interpretation and comparative study with optical, hyperspectral and thermal imagery.** **15. Radiometric terrain correction of SAR Data.** **16.** Speckle filtering **of SAR Data.** **17.** SAR Image Fusion with Optical **and Hyperspectral images.**	**The components have been modified and consolidated. The learning outcomes and Suggested e-learning material have been reviewed. New lab exercises are introduced according to the theoretical course content that would be**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		products. • Interpret satellite FCC images and aerial photographs, pre-process airborne-space borne raw imaging data products and their interpretation.		18. Familiarization to the InSAR Data, Interferogram and their interpretation. 19. Familiarization to "Thermal data products" their visualization, and LST retrieval using thermal bands. 20. Familiarization to the Erdas Imagine "Spatial Modeler". 21. Hyperspectral data cube generation and its interpretation. 22. Hyperspectral Imagery profile and visual interpretation. **Recommended Books:** 1. Baghdadi, N., &Zribi, M. (2016). *Microwave Remote Sensing of Land Surfaces - Techniques and Methods*. London, United Kingdom: ISTC Press-Elsevier. 2. Richards, J. A. (2009). *Remote Sensing with Imaging Radar*. Heidelberg, Germany: Springer 3. Thenkabail, P. S., Lyon, J. G., &Huete, A. (2011). *Hyperspectral Remote Sensing of Vegetation*. Boca Raton, FL: CRC Press. 4. Jensen, J. R. (2007). *Remote Sensing of the Environment - An Earth Resources Perspective* (2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall. 5. Joseph, G., &Jeganathan, C. (2018). *Fundamentals of Remote Sensing* (3rd ed.). Hyderabad, India: Universities Press. 6. Lillesand, T. M., Kiefer, R. W., &Chipman, J.W. (2003). *Remote Sensing and Image Interpretation* (5th ed.). New York, NY: John Wiley & Sons. **Suggested e-learning materials:** 1. Sentinel Missions https://earth.esa.int/web/guest/missions/esa-operational-eo-missions 2. Hyperspectral Image Analysis https://www.harrisgeospatial.com/Support/SelfHelpTools/Tutorials.asp 3. Optical - Radar Fusion http://community.hexagongeospatial.com/t5/Spatial-Recipes/Optical-Radar-Fusion/ta-p/752 4. Radar Courses https://earth.esa.int / web / guest / missions / esa – operational - eo missions / ers / instruments /sar / applications / radar-courses	helpful in enhancing the practical knowledge of the students from "procurement of the satellitedata" to "efficient pre-processing".

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				5. ENVI Tutorials (Hyperspectral Image Analysis) https://www.harrisgeospatial.com/Support/SelfHelpTools/Tutorials.aspx **6. ERDAS Hexagone Geospatial Tutorials http://community.hexagongeospatial.com/t5/Spatial-Recipes/Optical-Radar-Fusion/ta-p/752** **7. Introduction to Remote Sensing** https://swayam.gov.in/courses/3612-introduction-to-remote-sensing **8. Basic Concepts of Remote Sensing https://nptel.ac.in/courses/105108077/**	
12	**RS ___L Remote Sensing Lab-II**	**After the completion of this course, students should be able to:** **• Implement the knowledge about SQL in solving attribute queries.** **• Analyze errors in spatial data and their removal.Design and produce the base map using map algebra, complex query generation.** **• Write and describe .NET and Python scripting in their specified frameworks.** **• Perform geo-processing using Python, and ArcGIS Server.** **• Connect the**		1. Analog to Digital conversion -Scanning methods **2. Introduction to GIS software** 3. Map Rectification, Define projection and Reprojection. 4. Digital database creation-Point features, Line features, Polygon features 5. Data Editing-Removal of errors -Overshoot & Undershoot, Snapping, Topology Creation 6. Vector Transformation - Affine and Polynomial, Co-ordinate definition. Map Bound. 7. Data collection and Integration, Non-spatial data attachment working with tables **8. Creation of Tables, Performing various actions over table, and Merging of tables by using primary key** 9. Concept of SQL **10. Dissolving, Merging, Clipping, Intersection, Union, and Proximity Analysis** 11. Spatial and Attribute query and Analysis 12. Map algebra / Math in Raster data 13. Layout generation and report 14. Updation of Toposheet from satellite imagery. 15. Digital Map preparation using Dot, Isopleth and Choropleth 16. .NET framework concepts. 17. Window forms application. 18. **Console Programming.** 19. Python concepts. 20. **Conditional & Looping applications.** 21. **Concept of ArcPy.** 22. Geo-processing with Python. 23. Introduction to ArcGIS server.	**The components have been modified and consolidated.** **Restructuring of the exercises have been done.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		desktop based GIS operation with real-time web operations and publishing newly generated geospatial maps on web.		24. Creating GIS Server connectivity. 25. Map publishing on web. **Recommended Books:** **1. Burrough, P. A., & McDonnell, R. (1998). *Principles of Geographical Information Systems*(3rd ed.). New York, NY: Oxford University Press.** **2. Chang, K.T. (2002). *Introduction to Geographic Information Systems*(3rd ed.). New Delhi, India: Tata McGraw Hill.** **3. Fu, P.,& Sun, J. (2011). *WebGIS principles and applications*. New Delhi, India: ESRI press.** **4. Zandbergen, P. A. (2013). *Python scripting for ArcGIS*. New Delhi, India: ESRI Press.** **5. Zhuang, V., Wrazien, D. R., Wang, M., & Huang, X. (2005). *Programming ASP.NET for ArcGIS Server*. Florence, KY: Thomson Delmar Learning.** **Suggested e-learning materials:** **1. Introduction to GIS** **https://nptel.ac.in/courses/105102015/1** **2. Spatial Analysis** **https://nptel.ac.in/courses/105102015/25** **3. Introduction to geographic information systems, overlaying operations** **https://swayam.gov.in/courses/3691-introduction-to-geographic-information-systems** **4. Digital Elevation Models and Applications** **https://swayam.gov.in/courses/4395-digital-elevation-models-and-applications** **5. Interpolation** **https://nptel.ac.in/courses/105102015/14** **6. VB.NET Programming Tutorial** **https://www.tutorialspoint.com/vb.net/index.htm** **7. VBA Tutorial** **https://www.tutorialspoint.com/vba/index.htm** **8. Algorithm and programming** https://nptel.ac.in/courses/106106145/	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				9. **Python – Tutorial https://www.tutorialspoint.com/python/index.htm**	
1.	**RS ___ Term Paper-I/Minor Project-I/Seminar-I**	**After the completion, students should be able to:** • **. Identify and formulate the statements of the research problem and objectives related to earth system sciences, and geocomputation for effective geospatial solutions.** • **Review existing literature relevant to the problem selected and explore the research gap.** • **Collect various geospatial data products, required to carry out the research and formulate the methodology to solve the identified problem.**			**New component have been introduced.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		• **Deliver an effective technical presentation on selected research problem and prepare the term paper/project/ seminar report.**			

SECOND SEMESTER

S. N.	Course List	• Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	**RS ~~501~~Applications of Remote Sensing**	**After the completion of this course, students should be able to:** • **Identify the potentials of remote sensing in allied sectors.** • **Describe trends in**	**Section A** **INTRODUCTION** Emergence of Remote Sensing technology in application areas, Understanding potentials of Remote Sensing in ~~allied sectors,~~ Indian satellite missions with focused applications, recent trends in Remote Sensing applications. **APPLICATION IN LAND AND WATER RESOURCE**	**Discipline Elective**	**This course has been shifted from core course of II semester to elective Pool** **The learning**

		remote sensing applications. • **Apply remote sensing technology in natural resource and disaster management.** • **Explain basics about Environmental Impact Assessment (EIA).**	Remote sensing in mapping Land use / land cover classification and monitoring, Crop forecasting, Forest resources management, soil taxonomy and degradation, geomorphology and surface mining on land resources, groundwater modelling, Water quality Monitoring, Reservoir sedimentation, Snow covers mapping and modelling approaches **Section B** **APPLICATION IN CLIMATE CHANGE AND DISASTER MANAGEMENT** Concept of climate and weather, Climatic classification, paleo-climate, Adaptation and vulnerability, mapping of landslide, Floods, Cyclones, Forest fire and Drought. **APPLICATION IN URBAN PLANNING** Mapping urban land use, Urban sprawl, Site selection for urban development, Urban Information System, Urban master plans, Urban green spaces, 3 D city modelling, SMART city **Section C** **APPLICATION IN GEO-TECHNICAL ENGINEERING** Digital Terrain Modelling, Geoinformatics in water harvesting site selection, Highways and Tunnel alignment studies. **APPLICATION IN ENVIRONMENTAL MANAGEMENT** Selection of disposal sites for industrial and municipal wastes, Solid waste management, Environmental Impact Assessment (EIA). ~~**TEXT BOOKS**~~ ~~T1 Schultz, G. A. and Engman, E. T., 2000, Remote Sensing in Hydrology and Water Management, Springer-Verlag, Berlin, German.~~		**outcomes and Suggested e-learning material have been reviewed.** **Essential application is added following the modified national security policies.**

			~~T2 Lillisand, T. M. and Keifer, R. W., 1994, Remote Sensing and Image interpretation, John Willey and Sons, New York, Third Edition.~~ ~~T3 Jenson, J.R., 2000, Remote Sensing of the environment-An Earth Resource Perspective, Prentice Hall Inc.~~ ~~T4 Kumar P., Rani M, Pandey P., 2012, Conservation areas to beat the heat, Lambert Publication,Germani.~~ ~~T5 P.K. Joshi, P. Pani,S. .N. Mohapartra and T.P. Singh, Ed 2010, Geoinformatics for Natural Resource Management, Nova Publishers,India~~ ~~T6 P.K. Joshi and T.P. Singh, 2011, Geoinformatics for Climate Change Studies, TERI Press, New Delhi.~~ ~~T7 P. S. Roy, 2000, Natural Disaster and their mitigation. Published by Indian Institute of~~ ~~Remote Sensing (IIRS), 2000.~~ ~~**REFERENCE BOOKS:**~~ ~~R1 Spatial Technologies for Natural Hazard Management. Proceedings of ISRS National Symposium, Nov. 21-22, 2000, IIT, Kharagpur.~~		
2.	**RS 503: Digital Image Processing**	**After the completion of this course, students should be able to:** • **Explain sources of image degradation and their rectification.** • **Describe various filtering operation and multispectral**	**SECTION A** **BASIC PRINCIPLES** System design considerations, Sources of image degradation, Radiometric and Geometric error, Types of atmospheric correction: absolute atmospheric correction and relative atmospheric correction, correction for slope and aspect effects. Interpolation methods, Spatial and Spectral interpolation	**SECTION A** **Basic Principles** System design considerations, Sources of image degradation, Radiometric errors and **corrections:**Types of atmospheric correction - absolute and relative; **atmospheric correction for hyperspectral imagery. Slope and aspect induced errors: topographic corrections - Minnaertmethod**.Geometric errors and **corrections**:Interpolation: Spatial and Spectral. **Image Enhancement techniques:** Contrast stretching: Linear and non-linear methods.	**The learning outcomes and Suggested e-learning material have been reviewed.** **Topics are reordered**

		image enhancement techniques. • **Describe geospatial data dimensionality reduction techniques for fast and effective interpretation of the image variables.** • **Describe utilization of artificial intelligence techniques for solving problems related to environmental monitoring and management**	~~IMAGE ENHANCEMENT~~ ~~Look up Tables (LUT) and Image display, Spatial profile and Spectral profile,~~ Contrast stretching: Linear and non-linear methods **SECTION B** **FILTERING AND MULTI-BAND ENHANCEMENT TECHNIQUES** Frequency component, low pass filter: Image smoothing, edge-preserving median filter, High passes filtering: Edge enhancement and Edge detection, Gradient filters, Directional and non-directional filtering, Fourier Transformation, Band ratio, Types of vegetation indices, Tassled Cap Analysis (TCA), Principal component analysis (PCA), Texture analysis, temporal data analysis and change detection. **PATTERN RECOGNITION** Concept of ~~pattern recognition,~~ Multi-spectral pattern recognition, Spectral discrimination, ~~Signature Bank,~~ Parametric and Non-Parametric classifiers, Unsupervised classification methods, Supervised classification techniques, Accuracy Assessment: ~~User and Producer accuracy, Kappa accuracy KHAT statistics.~~ **SECTION C** **ADVANCED TECHNIQUES** Artificial intelligence, Fuzzy logic, neural networks, Image Fusion, ~~Object Oriented Classification, Hyper spectral remote sensing: atmospheric correction, Data reduction techniques, texture analysis and mineral & vegetation mapping.~~ ~~**TEXT BOOKS:**~~ ~~T1 Jensen, JR., 2004, Remote Introductory Digital Image Processing~~	**SECTION B** **Multi-Band Enhancement Techniques** **Image gradient, thresholds and segmentation**. Image Filtering: LPF, HPF, Directional, non-directional, Gradient, and **Statistical filters,**Edge detection, Band Ratio/**Indices: vegetation, water, snow, and built-up indices; Factors affecting development of band indices. Principal Component Analysis, Tasseled Cap Analysis. Image**Texture analysis: **Gray-Level Co-occurrence Matrix (GLCM).** Frequency component, Fourier Transformation. **Pattern Recognition** Concept of Multi-spectral pattern recognition, **Image Classification: Concepts**, Spectral discrimination, Classifiers: Parametric and Non-Parametric; Methods: Unsupervised, Supervised, Object-oriented, and **knowledge base classification**; Accuracy Assessment: **$\hat{K}$ statistics. Multi-temporal information extraction: concepts and considerations. Change detection analysis.** **SECTION C** **Advanced Techniques** Artificial intelligence **and Machine Learning: concepts,** techniques: Fuzzy logic,**Artificial**Neural Networks **(ANN), Genetic algorithms (GA). Image Fusion. Imaging spectroscopy for vegetation, Martian and Lunar surfaces: Mineral Spectra Extraction: concepts and considerations. LiDAR: Principles, Types, LiDAR Intensity, and Processing of LiDARdata. Terrestrial Laser Scanning (TLS).** **Recommended Books:** **1. Campbell, J. B., & Wynne, R. H. (2011). *Introduction to Remote Sensing* (5th ed.). New York, NY: The Guilford Press.** **2. Cracknell, A. P., & Hayes, L. (2007). *Introduction to***	**for adequate and systematic learning of the subject.** **Some of the topics are shifted to different courses according to their technical relevance** **Unit heading is modified with adequate relevance with course content.** **Topics are reordered for adequate and systematic learning of the subject.** **Some of the advanced techniques are added to the unit content for**

			~~(3rd Edition), Prentice Hall~~ ~~T2 Thomas M. Lillesand& Kiefer, Ralph W., Remote Sensing and Image Interpretation, John Wiley & Sons, New York.~~ ~~T3 Jensen, JR., Remote Sensing of the Environment An Earth Resources Perspective, Prentice Hall Inc.~~ ~~T4 Sabins, Floyd F., Remote Sensing: Principles and Interpretation, H. Freeman and C., New York.~~ ~~**REFERENCE BOOKS:**~~ ~~R1 Rencz, Andrew N. (Ed), Remote Sensing for the Earth Sciences: Manual of Remote Sensing, 3rd ed., John Wiley & Sons, Inc., New York.~~ ~~R2 Curran, P., Principles of Remote Sensing, Longman, London.~~ ~~R3 Campbell, James B., Introductory Remote Sensing: Principles and Concepts, Routledge.~~ ~~R4 Gibson, P.J., Introduction to Remote Sensing, 2nd ed., Taylor & Francis, London.~~ ~~R5 Cracknell, A.P. & Hayes, L.W B., Introduction to Remote Sensing, Taylor & Francis, London.~~	***remote sensing*** **(2nd ed.). Boca Raton, FL: CRC Press.** 3. **Dong, P., & Chen, Q. (2018).** ***LiDAR Remote Sensing and Applications*****. Boca Raton, FL: CRC Press.** 4. **Jensen, J. R. (2007).** ***Remote Sensing of the Environment- An Earth Resources Perspective*** **(2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall.** 5. **Jensen, J. R., (2004).** ***Introductory Digital Image Processing: A Remote Sensing Perspective*** **(4th ed.), Glenview, IL: Pearson Education.** 6. **Lillesand, T., Kiefer, R. W., &Chipman, J. (2015).** ***Remote Sensing and Image Interpretation*** **(7thed.). New York, NY: John Wiley & Sons.** 7. **Rencz, A. N., & Ryerson, R. A. (Eds.). (1999).** ***Manual of Remote Sensing: Remote Sensing for the Earth Sciences*** **(3rd ed. vol. 3). New York, NY: John Wiley & Sons.** 8. **Sabins, F. F. (2007).** ***Remote Sensing: Principles and Interpretation*** **(3rded.). Long Grove, IL: Waveland Press.** 9. **Shan, J., &Toth, C. K. (2018).** ***Topographic Laser Ranging and Scanning- Principles and Processing*** **(2nded.). Boca Raton, FL: CRC Press.** 10. **Tso, B., & Mather, P. M. (2009).** ***Classification methods for Remotely Sensed Data*** **(2nded.). Boca Raton, FL: CRC Press.** **Suggested e-learning materials:** 1. **Image Processing** **http://geoinfo.amu.edu.pl/wpk/rst/rst/AppB/B4.html** 2. **Fundamentals of Satellite Remote Sensing** **https://arset.gsfc.nasa.gov** 3. **Digital Image Processing: Introduction to Object Recognition** **https://nptel.ac.in/courses/117105079/4**	**strengthening the high level research in digital image processing domain.**

3.	**RS 507: Photogrammetry, Global Positioning Systems and Mobile Mapping**	**After the completion of this course, students should be able to:** • **Explain concepts related to aerial photography, planning and execution of photographic flights.** • **Describe standard digital photogrammetric operations i.e., Ortho-rectification.** • **Describe concepts related to aerial camera lenses, and digital terrain modeling.** • **Integrate the knowledge about GPS.**	**Section A** **AERIALPHOTOGRAPHY** Fundamentals of aerial photography, geometry of aerial photograph, Basics concepts of Perspective projection and Orthographic projection, Types of aerial photographs: Vertical and Oblique/High Oblique aerial photography Scale of photograph, Concept of stereoscope, Relief displacement and applications, tilt displacement, stereoscopic parallax, measurement of height difference from aerial photograph. Planning and execution of photographic flight, Computation of flight plan. **AERIAL FILM AND FILTERS AND DIGITAL PHOTOGRAMMETRY** Basics of photography, Aerial cameras lenses, Filters and Films, Photographic scale: Object height and Length, Basic of Optics: Reflection & refraction and lens distortion; Photo mosaic, Ortho photo, Photograph co-ordinate and ground coordinate of Vertical and tilted photographs, Block adjustment, orthorectification, Digital Terrain Model, Terrain editing, Digital orthophotos. **Section B** **FUNDAMENTALS OF GPS AND ITS COMPONENTS** Introduction of Global Positioning System, Control Segment, Space Segments, User Segment, GPS signals and data, Geopositioning – Basic concepts; NAVSTAR, GLONASS and GAGAN, ~~GPS Positioning Types Absolute Positioning, Differential positioning.~~ **GEODESY** Basics geodesy, Geoid/ datum/Ellipsoid-definition and basic concepts, Application of Geodesy, Coordinate system: Cartesian 3-D coordinate systems, Earth Centred, Earth Fixed X, Y and Z, Geographic Coordinate System Transformation, Geocentric Translation **Section C** **SURVEYING METHODS AND FACTORS AFFECTING ACCURACY**	**Section A** **Aerial Photography** Fundamentals of aerial photography, geometry of aerial photograph, Basics concepts of Perspective projection and Orthographic projection, Types of aerial photographs: Vertical and Oblique/High Oblique aerial photography Scale of photograph, Concept of stereoscope, Relief displacement and applications, tilt displacement, stereoscopic parallax, measurement of height difference from aerial photograph. Planning and execution of photographic flight, Computation of flight plan. **Aerial Film and Filters and Digital Photogrammetry** Basics of photography, Aerial cameras lenses, Filters and Films, Photographic scale: Object height and Length, Basic of Optics: Reflection & refraction and lens distortion; Photo mosaic, Ortho photo, Photograph co-ordinate and ground coordinate of Vertical and tilted photographs, **Types of Photogrammetry** Block adjustment, orthorectification, Digital Terrain Model, Terrain editing, Digital orthophotos. **Section B** **Fundamentalsof GPS And Its Components** Introduction of Global Positioning System, Control Segment, Space Segments, User Segment, GPS signals and data, Geopositioning – Basic concepts; NAVSTAR, GLONASS and GAGAN, GPS Positioning, **Satellite-based Augmentation System**. **Geodesy** Basics geodesy, Geoid/ datum/Ellipsoid-definition and basic concepts, Application of Geodesy, Coordinate system: Cartesian 3-D coordinate systems, Earth Centred, Earth Fixed X, Y and Z, Geographic Coordinate	**The learning outcomes and Suggested e-learning material have been reviewed.** **Broader coverage of types is added to cover the various available recent technologies** **Content is added to remove the gaps**

			Satellite Geometry, Satellite signals and its strength, Number of satellites, Effects of Multi path, Ionosphere, Troposphere, Methods-Static & Rapid static, Kinematic-Real time kinematic, Survey: DGPS data processing. **REFERENCE STATION AND MOBILE MAPPING** Selection of reference station, Reference station equipment- GPS receiver & GPS antenna. Mobile mapping basic concepts and applications, GPS application in surveying and mapping: Navigation military, Location based services, Vehicle tracking, Seismic Applications-Crustal deformation and tectonic movements. New Cellular mapping – GSM and CDMA technology. ~~**TEXT BOOK**~~ ~~T1 Moffitt F. H. and Mikail E.M "Photogrammetry", 3rd edition, Happer& Row Publisher, New York, 1980~~ ~~T2 Lillesand, Thomas M. and Kiefer, Ralph, W., "Remote Sensing and Image Interpretation", 4th Edition, John Wiley and Sons, New York, 2000~~ ~~T3 N.K. Agrawal Essentials of GPS, Spatial Network Pvt Ltd 2004~~ ~~T4 SathishGopi , GPS and Surveying using GPS~~ ~~T5 Drummond. J., Billen. R., Joao. E., and Forrest. D., Ed 2007, "Dynamic and Mobile GIS" CRC Press, New York.~~ ~~T6 Terry Karen Steede, 2002, Integrating GIS and the Global Positioning System, ESRI Press.~~ ~~**REFERENCE BOOKS**~~	System Transformation, Geocentric Translation **Section C** **SurveyingMethodsand Factors Affecting Accuracy** Satellite Geometry, Satellite signals and its strength, Number of satellites, Effects of Multi path, Ionosphere, Troposphere, Methods-Static & Rapid static, Kinematic-Real time kinematic, Survey: DGPS data processing. **Reference Station and Mobile Mapping** Selection of reference station, Reference station equipment- GPS receiver & GPS antenna. Mobile mapping basic concepts and applications, GPS application in surveying and mapping: Navigation military, Location based services, Vehicle tracking, Seismic Applications-Crustal deformation and tectonic movements. New Cellular mapping – Global System for Mobile Communication (GSM) and Code Division Multiple Access (CDMA) technology. **Recommended Books:** 1. **Drummond, J., Billen, R., Joao, E.,& Forrest, D. (Eds.). (2006). *Dynamic and Mobile GIS*. New York, NY: CRC Press.** 2. **Gopi, S. (2005). *GPS and Surveying using GPS*.NewDelhi, India:Tata McGraw-Hill.** 3. **Leick, A. (2004). *GPS Satellite Surveying*(3rd ed.). New York, NY: John Wiley & Sons.** 4. **Lillesand, T., Kiefer, R. W., &Chipman, J. (2015). *Remote Sensing and Image Interpretation* (7th ed.). New York, NY: John Wiley & Sons.** 5. **Moffitt F. H., &Mikail, E.M. (1980).*Photogrammetry***	

			~~R1 Sabins, F.F. Jr., 'Remote Sensing Principles and Interpretation', W.H. Freeman & Co., 2002 Edition.~~ ~~R2 Reeves, Robert G., "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA~~ ~~R3 Rampal, K.K., Handbook of Aerial Photography and Interpretation, Concept Publishing Company, New Delhi, 1999~~ ~~R4 Leica. A.: GPS Satellite Surveying, John Wiley & Sons, use. New York~~	**(3rd ed.).New York, NY:Happer& Row.** **6. Rampal, K.K. (1999). *Handbook of Aerial Photography and Interpretation*. New Delhi, India: Concept.** **7. Colwell, R. N. (1983). *Manual of Remote Sensing*(2nd ed. vol.1).Falls Church, VA: ASPRS** **8. Sabins, F. F. (2007). *Remote Sensing: Principles and Interpretation* (3rd ed.). Long Grove, IL: Waveland Press.** **9. Terry, K. S. (2000).*Integrating GIS and the Global Positioning System*. New Delhi, India: ESRI Press.** **Suggested e-learning materials:** **1. Aerial Photography https://nptel.ac.in/courses/105104167/4** **2. Photogrammetry https://nptel.ac.in/courses/105104100/18** **3. Drone https://www.dronethusiast.com/tutorials**	
4.	**RS ~~509:~~ Spatial Database Systems, Analysis and Modeling**	**After the completion of this course, students should be able to:** • **Statistically evaluate the spatial entities their topological, geometric, or geographic properties.** • **Learn different analytic approaches.** • **Describe and design the concept of spatial databases its components,**	**SECTION A** **ADVANCE ATTRIBUTE ANALYSIS** Basics Matrix: Addition, subtraction, multiplication, Identity, Determinant and Inverse, **SPATIAL MODELING** Spatial analysis concept: Distance, Adjacency, Interaction and neighbourhood Geospatial models- types and Modeling: Descriptive, prescriptive and predictive; Normalization, level of measurement, Introduction to modeling& flowcharting, Map algebra-operators & operations, Functional operations, Modeling essentials, Spatial interaction models Conceptualizing the model, Model formulation, Conflict resolution and Prescriptive modeling, Model verification	**Discipline Elective**	**This course has been shifted from core course of II semester to elective Pool** **The learning outcomes and Suggested e-learning material have been reviewed.** **An application component**

		models, mining, analysis and visualization. • **Apply the strength and applications of Arc model builder.**	**SECTION B** **SPATIAL ANALYSIS** Point Analysis: Coordinate, Distance – Nearest Neighbour Distance, Density – Quadrant and other methods **GEO-STATISTICS** Spatial Interpolation and Geostatistics: Local and global methods, Gravity model, Regression model, Pattern analysis, Moran's Index, Cluster analysis, Trend surface Analysis Thiessen polygon, Density estimation, Inverse Distance Weight (IDW), Thin – plate Spline, Kriging – ordinary and Universal, Semivariogram; Spatial Autocorrelation **Section C** **GEOCODING AND NETWORK ANALYSIS** Address Geocoding, Optimum Routing, Closest facilities, Resource Allocation, Network Analysis, Dynamic Segmentation: Route, Section, Events and its application. **DIGITAL TERRAIN** Terrain mapping: Source of existing elevation data, quality and standard of DEM data, Counting, Vertical profile, Hill shading, Slope, Aspect, Surface Curvature, Digital terrain visualization 2D and 3D; Application of Digital terrain models **ARC GIS MODEL BUILDER** Concepts of Model Builder, Model elements: Tools, Variables, Connectors, setting up Models, Executing Model, Model Validation, Model builder to create Tools – Advance techniques in Model Builder,		**based on matrix is introduced.**

			Geoprocessing Techniques in Model Builder **~~TEXT BOOKS~~** ~~T1 David L. Verbyla, 2002, "Practical GIS Analysis", Taylor &Francis~~ ~~T2 David O' Sullivan and David Unwin, 2003 "Geographic Information analysis, John Wiley and Sons, Hoboken, USA~~ ~~T3 Burrough, Peter A. and Rachael McDonnell. 1998. Principles of Geographical Information Systems. Oxford University Press, New York~~ ~~T4 Kang tsung Chang, 2002, 'Introduction to Geographic Information Systems' Tata McGraw Hill, New Delhi.~~ ~~T5 C.P.Lo and Albert K.W.Yeung, 2005, "Concepts and Techniques of Geographic Information Systems" Prentice Hall of India, New Delhi~~ ~~T6 Laurini, Robert, and Derek Thompson "Fundamentals of Spatial Information Systems", Academic Pr. London~~ ~~T7 Kluwer FotheringhamA S, O'Kelly M E, "Spatial Interaction Models: Formulations and Applications".~~ ~~T8 Goodchild, M.F. (1978) Statistical Aspects of the Polygon Overlay Problems, in Harvard papers on GIS, Ed. G. Dulton, Vol. 6, Addison Wesley, Reading Press.~~ ~~T9 Mac Donald, A. 1999, Building a Geodatabase, Redlands CA: ESRI Press.~~ **~~REFERENCE BOOKS~~** ~~R1 Geographical Information Systems. Principles, Techniques, Applications and Management. John Wiley & Sons, Paul Longley,~~		

			~~Michael Goodchild, David Maguire and David Rhind: (Editors).~~ ~~R2 Sanghavi, Hitesh (1998) Oracle Miracles, Express computers methods, 1998.~~ ~~R3 Samet, H., 1990, The Design and Analysis of Spatial Data Structures, Addison Wesley.~~ ~~R4 A. Silberschats, Henry F. Korth, 1998, "Database System Concepts", 3rd Edition, TMH,~~ ~~R5 Bonham Carter G.F., 1994, GIS for Geoscientists: Modeling with GIS Pergamon Publications.~~		
5.	**RS ~~510:~~ Spatial decision support system**	• **After the completion of this course, students should be able to:** • **Study the spatial information systems developed for a specific problem or decision-making situation.** • **Observe key concepts and theories underlying spatial information systems and technology trends.** • **Explore and reform the solutions to spatial problems by**	**Section A** **INTRODUCTION** GIS and decision support systems, SDSS definition and characteristics, Introduction to decision making process and decision support systems, Introduction of a frame work for planning and decision making, Spatial Decision Making, SDSS architecture. **DATABASE MANAGEMENT** Data base management system, Model based management system, Graphical and tabular report generator, User interface. **Section B** **ANALYSIS AND DECISION MAKING** Principles and ~~components~~ of multiple-criteria decision ~~making~~, Main multiple-criteria evaluation methods/techniques, Spatial multiple criteria decision making, ~~Multiple-criteria decision making in spatial data analysis,~~ Spatial multiple criteria evaluation in planning and decision making	**Discipline Elective**	**This course has been shifted from semester II to elective pool .**

		generating a set of alternatives and selecting from among those that appear to be viable through multi criteria analytics. • **Illustrate and assess the emerging concepts that may impact spatial information system development and applications.**	**TECHNOLOGY AND DEVELOPMENT** Development of DSS, Technology levels, Functions and roles, Status of SDSS, Open source tools. **Section C** **SDSS SOFTWARES AND ITS APPLICATIONS** Classification of DSS software, Problem specific SDSS, Generic SDSS, Domain level SDSS, Desktop SDSS, Web-Based SDSS, SDSS applications in: natural resource management, environmental, urban, agriculture, utilities and business ~~**Text Books:**~~ ~~T1 Silberschatz, A., Korth, H. F., &Sudarshan, S. (2011). Database System Concepts. McGraw Hill.~~ ~~T2 Sugumaran, R., &Degroote, J. (2011). Spatial Decision Support System (Principles and Practices). Newyork: CRC Press.~~ ~~T3 Scholl, R. P., &Voisard, M. (2002). Spatial Applications with Applications to GIS. Morgan Kaufmann.~~ ~~**Reference Books:**~~ ~~R1 Bonczek, R. H., Holsapple, C. W., &Whinston, A. B. (1981). Foundadation of Decision Support System. New York: Academic Press.~~ ~~R2 House, W. C. (1983). Decision Support Systems. New York: Petrocelli.~~ ~~R3 Sprague, R. H., & Carlson, E. D. (1982). Building Effective Decision Support Systems. NJ: Prentice Hall.~~		

6.	**~~RS 501L: Applications of Remote Sensing Lab~~**	**After the completion of this course, students should be able to:** • **Perform Land Use/ Land Cover Mapping for natural resource monitoring.** • **Develop the Forecasting models for the crop production, flood hazards.** • **Identify the suitable waste disposal sites.** • **Mapping the landslide hazard zonation maps.**	Lab 1. Land use \ land cover mapping Lab 2 Mapping flood hazards in a region using satellite images Lab 3. Urban sprawl mapping of a township using satellite images Lab 4. Crop forecasting using multi-dates satellite images Lab 5. Application of remote sensing for identification of waste disposal sites Lab 6. Forest cover and density mapping using geospatial techniques Lab 7. Mapping landslide hazards in a region using satellite images		**Theconte nt has been shifted and consolidat ed as Remote Sensing Lab-III** **The learning outcomes and Suggested e-learning material have been reviewed.** **Recent trend based applicatio ns have been added**
7.	**~~RS 503L: Digital Image Processing Lab~~**	**After the completion of this course, students should be able to:** • **Perform standard radiometric**	Lab 1. Haze and noise reduction/ Lab 2. Absolute radiometric correction Lab 3. Relative radiometric correction Lab 4. Perform the various band ratio calculations		**Theconte nt has been shifted and consolidat ed as Remote Sensing**

		corrections on satellite imagery. • **Classify the imagery using knowledge base for advanced mapping of LULC.** • **Perform band indices calculations for enhancement of the natural features on imagery.** • **Perform the accuracy assessment of the classified remote sensing imagery.**	Lab 5. Image enhancement and filtering: Lab 6. Data compression techniques (PCA, TCA) Lab 7. Resolution merging and its assessment Lab 8. Unsupervised classification Lab 9. Supervised classification Lab 10. Object oriented classification Lab 11 Knowledge base classification ~~Lab 12. Accuracy assessment~~ Lab 13. Visualisation and presentation Lab 14. Hyperspectral pre-processing Lab 15 Atmospheric correction of hyperspectral data Lab 16. Classification of hyperspectral data		**Lab-III** **The learning outcomes and Suggested e-learning material have been reviewed.** **New lab exercises are introduced according to the theoretical course content that would be helpful in enhancing the practical knowledge of the students from "efficient pre-processing of the data" to "advanced pattern recognitio**

					n exercises” .
8.	~~**RS 507L Photogrammetry, Global Positioning System and Mobile Mapping Lab**~~	**After the completion of this course, students should be able to:** • **Prepare the Ortho- images using Photogrammetry software’s** • **Rectify the geographic co-ordinates using GPS** • **Collect geographic co-ordinates using DGPS and post-processing of the attributes using standard software’s.** • **Generate contour maps for the DEM generation.**	Lab1: Stereovision exercise Lab 2. Preparation of ortho image using Leica Photogrammetry Suite Lab 3. Contour generation using orthophoto or Images Lab 4. Introduction to GPS and initial setting Lab 5. Creating codes and attribute table in receiver Lab 6. Point data collection using GPS with different datum Lab 7. Line data collection using GPS and measurements Lab 8.GPS data collection for area calculation Lab 9. Post processing of the DGPS data Lab 10.GPS and GIS integrations output preparation Lab 11. Contour generation using GPS point data Lab 12. Image rectification using GPS coordinate data		**Thecontent has been shifted and consolidated as Remote Sensing Lab-IV** **The learning outcomes and Suggested e-learning material have been reviewed.**

9.	**~~RS 509L: Spatial Database Systems, Analysis and Modeling Lab~~**	**After the completion of this course, students should be able to:** • **Statistically evaluate the spatial entities their topological, geometric, or geographic properties.** • **Learn different analytic approaches.** • **Describe and design the concept of spatial databases its components, models, mining, analysis and visualization.** • **Acquire and apply the strength and applications of Arc model builder.**	**----**		**Thecontent has been shifted and consolidated as Remote Sensing Lab-IV** **The learning outcomes and Suggested e-learning material have been reviewed.**
12	**RS ___L Remote Sensing Lab-III**	**After the completion of this course, students should be able to:** • **Perform standard radiometric corrections on**		**Course Content:** 1. **De-hazing and noise reduction in RS imagery.** 2. **DN-Radiance-at sensor reflectance conversion of satellite imagery.** 3. **Retrieval of true planetary surface reflectance (i.e., atmospheric correction).**	**The components have been modified and consolidated.**

		satellite imagery andcalculateband indices for enhancement of the natural features on imagery. • **Classify the imagery using knowledge base for advanced mapping of LULC.** • **Develop the Forecasting models for the crop production, flood hazards.** • **Identify the suitable waste disposal sites, and Mapping the landslide hazard zonation maps.**		**4. Derive band ratios/indices for multispectral and hyperspectral imagery.** 5. Image Enhancement and filtering. 6. Data **dimensionality reduction** techniques (PCA, TCT). **7. RGB-to-HSV Transformation and interpretation.** 8. Resolution merging and its assessment. 9. Unsupervised classification **and accuracy assessment**. 10. Supervised classification **and accuracy assessment.** 11. Object-Oriented classification. 12. Knowledge base classification. **13. Pre-processing of Hyperspectral data.** 14. Atmospheric correction of hyperspectral data. **15. Spectral Mixture Analysis for Hyperspectral Data.** **16.** Land use \ land cover mapping. **17. Monitoring flood risk zones using satellite images.** **18.** Urban sprawl mapping of a township using satellite images. **19.** Crop forecasting using multi-dates satellite images. **20.** Application of remote sensing for identification of waste disposal sites. **21.** Forest cover and density mapping using geospatial techniques. **22.** Mapping landslide hazards in a region using satellite images. **23. Mapping of Forest Fire using Remote Sensing and GIS.** **24. Identify Ground water potential zones using Geo spatial techniques.** **25. Draught Zone identification using Remote Sensing and GIS.** **26. Estimation of Land Surface Temperature using QGIS.** **Recommended Books:** **1. Dong, P., & Chen, Q. (2018). *LiDAR Remote Sensing and Applications*. Boca Raton, FL: CRC Press.** **2. Jensen, J. R. (2007). *Remote Sensing of the Environment-An Earth Resources Perspective* (2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall.** **3. Jensen, J. R., (2004). *Introductory Digital Image Processing: A Remote Sensing Perspective* (4th ed.), Glenview, IL: Pearson Education.** **4. Sabins, F. F. (2007). *Remote Sensing: Principles and Interpretation* (3rd ed.). Long Grove, IL: Waveland Press.** **5. Joshi, P.K., & Singh, T.P. (2011). *Geoinformatics for Climate Change Studies.* New Delhi, India: TERI Press.** **6. Joshi, P.K., Pani, P., Mohapartra, S. N., & Singh, T.P.**	**The learning outcomes and Suggested e-learning material have been reviewed.** **The learning outcomes and Suggested e-learning material have been reviewed.** **New lab exercises are introduced according to the theoretical course content that would be helpful in enhancing the practical knowledge of the students from "efficient pre-processing of**

				(2010). *Geoinformatics for Natural Resource Management*. New Delhi, India: Nova. 7. Lillesand, T. M., Kiefer, R. W., &Chipman, J. (2015). *Remote Sensing and Image interpretation* (7th ed.). New York, NY: John Willey & Sons. 8. Roy, P. S., Westen, C. J. V., Jha, V. K., Lakhera, R. C., & Ray, P. K. C. (Eds.). (2000). *Natural disasters and their mitigation: a remote sensing perspective*. Dehradun, India: IIRS. 9. Schultz, G. A., &Engman, E. T. (2000).*Remote sensing in Hydrology and Water Management.* Berlin, Germany: Springer **Suggested e-learning materials:** 1. ENVI Tutorials : (Hyperspectral Image Analysis) https://www.harrisgeospatial.com/Support/SelfHelpTools/Tutorials.asp 2. Erdas Imaging Exercises with Sample Data Sets https://download.hexagongeospatial.com/en/downloads/imagine/erdas-imagine-remote-sensing-example-data 3. Applications Guide https://www.itc.nl/ilwis/applications-guide/ 4. Data & Products http://glcf.umd.edu/data/ 5. Bhuvan Portal http://ww12.bhuvan.com 6. Data & Products https://earthexplorer.usgs.gov/ 7. Meteorological and Oceanographic Satellite Data Archival Centre https://www.mosdac.gov.in/ 8. National Information System for Climate and Environment Studies https://nrsc.gov.in/nices 9. Agriculture Practices https://nptel.ac.in/courses/126104002/ 10. Water Resources Information System http://www.india-wris.nrsc.gov.in/wrpinfo/index.php?title=Main_Page	the data" to "advanced pattern recognition exercises". Recent trend based applications have been added

12	**RS ___L Remote Sensing Lab-IV**	**After the completion of this course, students should be able to:** • **Prepare the Ortho-images using Photogrammetry software's** • **Collect geographic co-ordinates using DGPS and post-processing of the attributes using standard software's.** • **Generate contour maps for the DEM generation.** • **Describe and design the concept of spatial databases its components, models, mining, analysis and visualization.** • **Acquire and apply the strength and applications of Arc model builder.**		**Course Content:** 1. Stereovision exercise. 2. Preparation of ortho image using Leica Photogrammetry Suite 3. Contour generation using orthophoto or Images. 4. Introduction to GPS and initial setting. 5. Creating codes and attribute table in receiver. 6. Point data collection using GPS with different datum. 7. Line data collection using GPS and measurements. 8. GPS data collection for area calculation. 9. Post processing of the DGPS data. 10. GPS and GIS integrations output preparation. 11. Contour generation using GPS point data. 12. Image rectification using GPS coordinate data. **13. DEM generation using Interferometry.** **14. Construction of 3D model.** 15. Point pattern analysis. 16. Cluster analysis. 17. Geostatistics (Surface generation). 18. Network analysis. 19. Dynamic segmentation. 20. Terrain analysis. 21. Hydrological modelling. 22. Introduction to model builder. 23. Interactive model. **Recommended Books:** **1. Gopi, S. (2005). *GPS and Surveying using GPS*.New Delhi, India: Tata McGraw-Hill.** **2. Leick, A. (2004). *GPS Satellite Surveying*(3rd ed.). New York, NY: John Wiley & Sons.** **3. Rampal, K.K. (1999). *Handbook of Aerial Photography and Interpretation*. New Delhi, India: Concept.** **4. Colwell, R. N. (1983). *Manual of Remote Sensing*(2nd ed. vol.1).Falls Church, VA: ASPRS.** **5. Terry, K. S. (2000).*Integrating GIS and the Global Positioning System*. New Delhi, India: ESRI Press.** **6. Allen, D.W. (2011). *Getting to know ArcGIS Model builder*. New Delhi, India: ESRI Press.** **7. Carter, G. B. (1994). *GIS for Geoscientists: Modeling with GIS*. Amsterdam, Netherlands: Elsevier.**	**The components have been modified and consolidated.** **The learning outcomes and Suggested e-learning material have been reviewed.** **Restructuring of the exercises have been done.**

				8. Burrough, P. A., & McDonnell, R. (1998). *Principles of Geographical Information Systems*(3rd ed.). New York, NY: Oxford University Press. **9. Chang, K.T. (2002). *Introduction to Geographic Information Systems*(3rd ed.). New Delhi, India: Tata McGraw Hill.** **Suggested e-learning materials:** **1. Aerial Photography https://nptel.ac.in/courses/105104167/4** **2. Photogrammetry https://nptel.ac.in/courses/105104100/18** **3. Drone https://www.dronethusiast.com/tutorials** **4. Digital Elevation Model and applications** https://swayam.gov.in/courses/4395-digital-elevation-models-and-applications **5. Digital Elevation Model http://gazebosim.org/tutorials?tut=dem** **6. Hydrologic Simulation Models https://nptel.ac.in/courses/105101002/36**	
13.	**RS ___ Term Paper-II/Minor Project-II/Seminar-II**	**After the completion, students should be able to:** • **Identify research problems related to the study domain.** • **Apply the principles, tools and techniques to solve the selected complex geospatial problem.** • **Analyze the research outcomes and suggest feasible/ practical solutions.** • **Deliver an effective technical**			**New component have been introduced.**

		presentation on selected research problem and prepare the term paper/project/ seminar report.			

THIRD SEMESTER

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	~~**RS 601R: Geo-informatics in Human Settlement Analysis**~~	~~**After the completion of this course, students should be able to:**~~ ~~• **Study role of geoinformatics in human settlement analysis and planning.**~~ ~~• **Identify the factors for urban development and plans.**~~ ~~• **Describe the urban landuse classification.**~~ ~~• **Apply spatial planning in effective urban management.**~~	~~**Introduction**~~ ~~Geo informatics for human settlement analysis; Planning definition; Scope and evaluation of human settlement, Economic planning, Data requirement of Urban and Regional planning~~ ~~**Interpretation of rural settlement**~~ ~~Type of rural settlement, existing rural land use, Interpretation of rural land use / land cover classification, rural development plan in India, rural poverty programme in India, Geo informatics for soil type, water, drainage system and transportation system in rural area.~~ ~~**Interpretation of urban settlements**~~ ~~Urban Master plan, city development plan and guidelines, urban land use classification; environmental and socioeconomic factors for urban development~~ ~~**Details development plans**~~ ~~Population projection, exiting urban land use, housing problems and development, urban information system~~ ~~**TEXT BOOKS:**~~ ~~T1 Jean Paul Donnay, Michael J.Barnsley and Paul A.Longley,2001, "Remote Sensing and Urban, Taylor & Francis, London~~ ~~T2 TarekRashed and CarstenJurgen, 2010, " Remote Sensing for Urban and Suburban Areas" Springer, London~~ ~~T3 Peter Hall and Mark Tewder Jones, 2011, "Urban and Regional planning", Taylor & Francis, London~~		**The course has been replaced by new course**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
2.	**RS 602R: Pattern Recognition and Processing**	**After the completion of this course, students should be able to:** • **Define techniques of Radiometric, Atmosphericand Geometric correction.** • **Explain spatial and spectral interpolation techniques.** • **Describe PCA and TCA techniques.** • **Applyadvanced pattern recognition, information extraction and image fusion techniques.**	**Fundamental** Radiometric and Geometric correction technique for various sensors, gains and bias value of different sensor, Atmospheric correction types and methods, Interpolation methods – linear and nor linear transformation for geometric corrections. **Advance Research** Advance research in Spatial and Spectral interpolation, spatial enhancement techniques, Contrast stretching: Linear and non linear methods. Principal component analyses, TCA, Texture Analysis and its types, conversion of radiance to temperature. **Pattern Recognition and Information Extraction** Concept of pattern recognition, Multi-spectral pattern recognition, Spectral discrimination Artificial intelligence, Fuzzy algebra, Artificial Neural networks, Expert systems, analysis of hyper spectral data, Image compression technique and types. Image fusion techniques and application **TEXT BOOKS:** T1 Jensen, JR., Remote Introductory Digital Image Processing (3rd Edition), Prentice Hall, 2004 T2 Jensen, JR., Remote Sensing of the Environment An Earth Resources Perspective, Prentice Hall Inc. T3 Sabins, Floyd F., Remote Sensing: Principles and Interpretation, H. Freeman and C., New York. **REFERENCE BOOKS:** R1 Gibson, P.J., Introduction to Remote Sensing, 2nd ed., Taylor & Francis, London		**The course has been replaced by new course**
3.	**RS 605R: Remote Sensing in Environment Studies**	**After the completion of this course, students should be able to:** • **Describe principles of environmental modeling.** • **Explain Remote Sensing applications in water, land and air quality management.** • **Integrate remote**	**Principles** Ecological and biological aspects of environment, atmosphere, hydrosphere, lithosphere, biosphere **Pollution** Types of pollution, chemistry of pollution, concentration of pollution, Remote sensing application for air, water and land and soil pollution **Environmental management** Water, land and air quality management, solid waste management, Application of remote sensing in solid waste management, pollution monitoring **Impact Assessment** Basic concept, Environmental Impact Assessment (EIA), Method of EIA, Benefit of EIA, impact of man on biosphere, Natural Disaster. **TEXT BOOKS:** T1 Jenson, J.R. 2000.Remote Sensing of the environment An Earth		**The course has been replaced by new course**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		~~**sensing in solid waste management.**~~ • ~~**Explain methods and benefits of Environmental Impact Assessment (EIA).**~~	~~Resource Perspective, Prentice Hall Inc~~ ~~T2 P.K. Joshi, P. Pani,S. .N. Mohapartra and T.P. Singh, Ed 2010 "Geoinformatics for Natural Resource Management", Nova Publishers,India~~ ~~T3 P.K. Joshi and T.P. Singh (2011). Geoinformatics for Climate Change Studies, TERI Press, New Delhi~~ ~~T4 P. S. Roy (2000).Natural Disaster and their mitigation. Published by Indian Institute of Remote Sensing (IIRS), 2000.~~		

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	**RS 603P Project** **(Part I)**	**After the completion, students should be able to:** • **Select a relevant research topic related to social and engineering problems, natural disaster, decision support system etc. with integration of geospatial technologies.** • **Evaluate and review significant existing literature of the topic selected.** • **Collect various geospatial data products, required to carry out the research and formulate the methodology to solve the identified problem** • **Deliver well-organized technical presentations and prepare the mid-term report.**			**The learning outcomes have beenreviewed.**

FOURTH SEMESTER

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
2.	~~RS 606R: Remote sensing in Hydrology and Water Resources~~	**After the completion of this course, students should be able to:** • **Describe fundamentals related to satellite imaging based hydrological investigation.** • **Apply hydro geomorphology based interpretation knowledge for the identification of potential ground water resources.** • **Explain concepts of watersheds leading to its inventory and effective management.** • **Explain methods of snow cover mapping based on hydrological and GIS based models.**	**Basic Concept** Hydrological cycle~~, hydrological parameter~~, Darcy,s Law, ~~porosity, permeability, Transmissibility, specific yield, specific capacity~~, ~~field capacity and depressionstorage; role of remote sensing in evaluation hydrological investigations.~~ **Ground Water Exploration** Surface and ground water, classification of stream and rivers, type of aquifer, ~~aquiclude, aquitard, aquifuge~~, ground water regimes, application of remote sensing for the hydro geomorphological interpretation. **Watershed Management** ~~Drainage network and drainage pattern,~~ watershed definition and scope, morphometric parameter, watershed inventory and management. **Remote sensing in water resource Evaluation** Estimation of precipitation, interception, soil moisture, evaporation run off and discharge, hydrological models in GIS and snow cover mapping. ~~**TEXT BOOKS:**~~ ~~T1 Karanth, K.A, 2008, "Ground water assessment Development and management Tata McGraw Hill~~ ~~T2 JVS Murty, 2004, "Watershed management" New Age International Pvt Ltd, New Delhi~~ ~~T3 Jenson, J.R. 2000.Remote Sensing of the environment An Earth Resource Perspective, Prentice Hall Inc.~~		**This course has been shifted to reading elective pool with significant pool.** **The learning outcomes and Suggested e-learning material have been reviewed.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
3.	**RS 607R: Remote sensing in Resource management.**	**After the completion of this course, students should be able to:** • **Define resource classification systems.** • **Identify parameters of natural resource inventory and mapping.** • **Explain desertification monitoring.** • **Describe the potentials of wildlife habitat and biodiversity conservation.**	**RS 607R: Remote Sensing in Resource Management** **Concept of Resources** Resources classification systems, criteria of classification, natural and cultural resources **Resources Inventories** Identification, resources survey, base map preparation, problem identification, thematic mapping and resources monitoring **Desertification Monitoring and habitat assessment** Desertification Assessment and monitoring,wildlife habitat assessment, animal population **Resources regions** Demarcation of resource potential, resource conservation and planning for development, resource and geographical information system. **TEXT BOOKS:** T1 Lillisand, T. M. and Keifer, R. W. 1994. Remote Sensing and Image interpretation', John Willey and Sons, New York, Third Edition. T2 Jenson, J.R. 2000.Remote Sensing of the environment-An Earth Resource Perspective, Prentice Hall Inc. T3 Skidmore, Andrew, 2002,"Environmental Modelling With GIS and Remote Sensing", Taylor & Francis Routledge		**The course has been replaced by new course**
3.	**RS 608R: Spatial Modeling and Resource Model**	**After the completion of this course, students should be able to:** • **Define methods and applications of clustering.** • **Describe raster based modeling methods and mapping.** • **Explain the concepts of autocorrelation and its applications.** • **Apply Geo statistics using various approaches.**	**Vector Base Modeling** Clustering methods and application; Network analysis and its process: shortest path model, Smeed's Index; address Geocoding, Optimum Routing Dynamic Segmentation: Route, Section, Events; application of network and dynamic segmentation. **Raster Base Modeling** Process and derivation of local neighbourhood operation: Reclassification, filter, slope, Aspect; Method of optimum path and cost allocation; environmental modeling on cost analysis, corridor mapping. **Geo Statistics** Spatial Interpolation and Geostatistics with equation: Local and global methods, Gravity model, Regression model, Pattern analysis, Moran's I, Cluster analysis, Trend surface Analysis. **Spatial Interpolation** Equation and derivation: Thiessen polygon, Density estimation, Inverse Distance Weight (IDW), Thin plate Spline, Kriging ordinary and Universal, Semivariogram; Spatial Autocorrelation and its procedure,		**The course has been replaced by new course**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			~~Application of spatial statistics in natural resources.~~ ~~**TEXT BOOKS:**~~ ~~T1 David L. Verbyla, 2002, "Practical GIS Analysis", Taylor &Francis~~ ~~T2 David O' Sullivan and David Unwin, 2003 " Geographic Information analysis, John Wiley and Sons, Hoboken, USA~~ ~~T3 Principles of Geographical Information Systems. Oxford University Press, New York Burrough, Peter A. and Rachael McDonnell. 1998.~~ ~~T4 Kang tsung Chang 2002, 'Introduction to Geographic Information Systems' Tata McGraw Hill, New Delhi.~~ ~~T5 C.P.Lo and Albert K.W.Yeung 2005 "Concepts and Techniques of Geographic Information Systems" Prentice Hall of India, New Delhi~~		

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	**RS 604P Project (Part II)**	**After the completion, students should be able to:** • **Select a relevant research topic related to social and engineering problems, natural disaster, decision support system etc. with integration of geospatial technologies.** • **Apply the principles, tools and techniques to solve the problem.** • **Process independent research to compute and resolve the chosen issue.** **At the end the student should be able to design and carry out an experiment on her own and prepare the final**			**The learning outcomes have been reviewed.**

		technical report.			

List of Discipline Electives

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	**RS ---- Applications of Remote Sensing**	**After the completion of this course, students should be able to:** • **Identify the potentials of remote sensing in allied sectors.** • **Describe trends in remote sensing applications.** • **Apply remote sensing technology in natural resource**		**Section A** **Introduction** Emergence of Remote Sensing technology in application areas, Understanding potentials of Remote Sensing in **Defence Applications,** Indian satellite missions with focused applications, recent trends in Remote Sensing applications. **Applicationin Land And Water Resource** Remote sensing in mapping Land use / land cover classification and monitoring, Crop forecasting, Forest resources management, soil taxonomy and degradation, geomorphology and surface mining on land resources, groundwater modelling, Water quality Monitoring, Reservoir sedimentation, Snow covers mapping and modelling approaches.	**This Course has been shifted from semester II to elective pool.** **The learning outcomes and Suggested e-learning material have been**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		and disaster management. • **Explain basics about Environmental Impact Assessment (EIA).**		**Section B** **Application in Climate Change and Disaster Management** Concept of climate and weather, Climatic classification, paleo-climate, Adaptation and vulnerability, mapping of landslide, Floods, Cyclones, Forest fire and Drought. **Application in Urban Planning** Mapping urban land use, Urban sprawl, Site selection for urban development, Urban Information System, Urban master plans, Urban green spaces, 3 D city modelling, SMART city **Section C** **Application in Geo-Technical Engineering** Digital Terrain Modelling, Geoinformatics in water harvesting site selection, Highways and Tunnel alignment studies. **Application in Environmental Management** Selection of disposal sites for industrial and municipal wastes, Solid waste management, Environmental Impact Assessment (EIA). **Recommended Books:** **1. Jenson, J.R. (2000). *Remote Sensing of the environment-An Earth Resource Perspective*(2nded.). Upper Saddle River, NJ: Pearson Prentice Hall.** **2. Joshi, P.K., & Singh, T.P. (2011). *Geoinformatics for Climate Change Studies.* New Delhi, India: TERI Press.** **3. Joshi, P.K., Pani, P., Mohapartra, S. N., & Singh, T.P. (2010). *Geoinformatics for Natural Resource Management*. New Delhi, India: Nova.** **4. Lillesand, T. M., Kiefer, R. W., &Chipman, J. (2015). *Remote Sensing and Image interpretation* (7th ed.). New York, NY: John**	**reviewed.** **Essential application is added following the modified national security policies.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				Wiley & Sons. **5. Roy, P. S., Westen, C. J. V., Jha, V. K., Lakhera, R. C., & Ray, P. K. C. (Eds.). (2000). *Natural disasters and their mitigation: a remote sensing perspective*. Dehradun, India: IIRS.** **6. Schultz, G. A., &Engman, E. T. (2000).*Remote Sensing in Hydrology and Water Management.* Berlin, Germany: Springer.** **Suggested e-learning materials:** **1. Applications Guide** **https://www.itc.nl/ilwis/applications-guide/** **2. Data & Products** **http://glcf.umd.edu/data/** **3. Bhuvan Portal** **http://ww12.bhuvan.com** **4. Data & Products** **https://earthexplorer.usgs.gov/** **5. Meteorological and Oceanographic Satellite Data ArchivalCentre** **https://www.mosdac.gov.in/** **6. National Information System for Climate and Environment Studies** **https://nrsc.gov.in/nices** **7. Agriculture Practices** **https://nptel.ac.in/courses/126104002/** **8. Water Resources Information System** **http://www.indiawris.nrsc.gov.in/wrpinfo/index.php?title=Main_Page**	
2.	**RS ____: Applied Statistics and Research Methodology**	**After the completion of this course, students should be able to:** • **Formulate research problems using geo-statistical methods.** • **Apply statistical knowledge to the geospatial**		**Section A** **Data Distribution and Basic Statistics** Scope and importance of statistics, Source of data-primary and secondary, Collection of data-sampling methods; Random and systematic method; Organization of data-array, Frequency, Class intervals, Histograms, and distribution, Presentation of data-Tables, Diagrams; Geometric form (Bar diagrams, Pie-diagrams), Frequency diagrams (histogram, polygon), Arithmetic line graphs (time series graph); Data grouping, Geographical data- Discrete and continuous series, Scales of measurement, Measures of central tendency-Mean, Median, Mode, Quartiles, Arithmetic mean, Geometric mean, Harmonic mean, Quadratic mean and their interrelated relations; Measures of dispersion-Absolute dispersion (range, quartile deviation, mean deviation, standard deviation); Relative dispersion (Coefficient of	**This Course has been shifted from semester I to elective pool.** **The learning outcomes and**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		variability. • **Define research problems and selection of survey methods.** • **Writing project proposal for various funding**		quartile deviation, Coefficient of variation), Moments, Skewness, Kurtosis **Section B** **Correlation, Probability and Hypothesis Testing** Correlation-meaning, Scatter diagram, standard deviation, Variance, Measures of Correlation-Karl Pearson's method (Two variables ungrouped data) Spearman's rank correlation methods. Probability-Binomial, Normal, and Poisson distribution; Theory of Sampling - Sampling distributions of means and proportions, Standard errors, Confidence interval estimation for population means, Standard deviations, Testing of Hypothesis – Large and small sample test. **Basic Conceptof Research Methodology** Definition of Research Problem, Identification of problems of regional and Local level, Considerations in selection of problem, Research process, Review of literature, Research objectives and research questions, Research scheme/design. **Section C** **Data Collection, Analysis and Reports** Methods of data collection, Survey methods, Samples-Type and methods, Data processes and analysis, Reporting of results, References, Future scope of work. **Preparationof Research Projects** Writing of proposals, Objectives of project, Research hypothesis and design, Research Questions, Scope of project, Brain storming sessions, Finalization of methodology, Review of similar studies and present level of research, Time scheduling (PERT), Financial estimates, Submission of Proposal. Project planning, Project activities/tasks, Feasibility, Resource requirements and allocation, Project management software, Project review, Project Completion-Quality assurance, Evaluation of individual tasks, Financial auditing, Problems and opportunities in Projects. **Recommended Books:** **1. Gupta, S. C., &Kapoor, V. K. (2000). *Fundamental of Mathematical Statistics* (10th ed.). New Delhi, India: S. Chand.** **2. Gupta, S. L., & Gupta, H. (2011). *Research Methodology Text and Cases with SPSS Applications.* New Delhi, India:**	**Suggested e-learning material have been reviewed.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				International book House. **3. Kothari, C. R. (2004). *Research Methodology Methods and Technique* (2nd ed.). New Delhi, India: New Age International.** **4. Meyer, P. L. (1970). *Introductory Probability and Statistical Applications* (2nd ed.). Washington, WA: Addison-Wesley.** **5. Spiegel, M. R. (2011). *Theory and Problems of Statistics* (4th ed.). New York, NY: McGraw Hills.** **Suggested e-learning materials:** **1. Sampling distribution** **https://nptel.ac.in/courses/111105041/23**	
3.	**RS ___: GeospatialEntrepreneurship**	**After the completion of this course, students should be able to:** • **identify the elements of success of entrepreneurial ventures,** • **evaluate the effectiveness of different entrepreneurial strategies** • **Interpret importance of the entrepreneurial infrastructure** • **recogniseGeo**		**Section A** **Concepts and theory of Entrepreneurship** Entrepreneurship- definition, Need and Significance of Entrepreneurship Development in Global contexts. Entrepreneurship Development – concepts, Process, Experience and strategies. Dynamics of Entrepreneurship Development,Entrepreneurs Skills and Competencies **Section B** **Entrepreneurship Development** Characteristics and role demanded of an Entrepreneur, Process of Developing Entrepreneur Qualities Enterprise Launching & Resources: Government Programmes, Policies, Incentive and Institutional Networking for Enterprise setting, Steps of setting new Enterprise, Scanning Business Environment, Sensing Business opportunity & Identifying Product.Challenges of new startup. **Section C** **Geospatial innovation and Entrepreneurship** Geospatial sciences for harnessing technological Innovation. Enterprise GIS Role of various national and state agencies, .Remote sensing and GIS component in Government of India PSU and in MNC. Case study of successful geospatial Entrepreneurs in India.	**New course introduced based on professional skills**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		spatial technology for harnessing Innovation and Entrepreneurship		**Recommended Books:** 1. Sethi, A. (2016). *From Science to Startup: The Inside Track of Technology. Entrepreneurship*.Göttingen, Germany: Copernicus & Springer. 2. Westhead, P.,& Wright, M.(2013). *Entrepreneurship. A very short introduction*. Oxford, UK: Oxford University Press. 3. Roger Tomlinson (2013) *Thinking About GIS: Geographic Information System Planning for Managers, Fifth Edition*, New York, NY:ESRI Press. **Suggested e-learning materials:** 1. **Entrepreneurship Development** https://www.tutorialspoint.com/entrepreneurship_development/ 2. **Enterprise GIS** https://www.esri.com/library/bestpractices/enterprise-gis.pdf	
4	RS___: Geospatial Intelligence	After the completion of this course, students should be able to: • Explain concepts and components of Geospatial Intelligence. • Explain different aspects of spatial cognition and their characteristics. • Describe multiple intelligence and		**Section A** **Geospatial Intelligence: Introduction and Background** Geospatial intelligence (GEOINT): Definition, Introduction: perceptality and convergence of digital and physical worlds. Spatial Intelligence to Spatial Competence; Components of Spatial Intelligence: Identifying components of spatial thinking- spatial ability measures, examination of spatial expertise. Intelligence, Surveillance, and Reconnaissance (ISR); GEOINT Trends; GEOINT: Collection and platforms; Intelligence Tasking and Collection: TCPED approach; Automatic Target	New course introduced based on AI technology is spatial domain.

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		discuss applications of geospatial technology in strategic planning and operations. • **Rationalize outlook of basic architecture of GEOINT.**		Recognition (ATR) and Remote Sensing: Introduction and basic architecture; GEOINT: Challenges /Hard problems; Uses of GEOINT. **Section B** **Concepts of Spatial Cognition and Ontology** Spatial Cognition in Geographic Environment: Definition, Cognitive processing – Cognition, Perception, Moist Map, Images, Schemata, Conceptual-Propositions, Dual Coding Behaviour, Cognitive Maps, Neural Networks. Spatial Search Processes - Introduction, Cognitive theories of search- Feature Integration Theory (FIT), Attention Engagement Theory (AET), Guided Search Theory (GST). Similarity Judgment of Places. Spatial Cognition: as an Artificial Intelligence (AI) Perspective. Spatial Ontology: Introduction and Utility. **Section C** **Multiple Intelligence: Concepts and Applications** Multiple intelligence (Multi - INT): Imagery Intelligence (IMINT), Signals Intelligence (SIGINT), Human Intelligence / Intelligence Gathering (HUMINT), Measurement and Signature Intelligence (MASINT), Open Source Intelligence (OSINT): Concept, value and application. Human Geography and GEOINT; Terrain Analysis and Aerial Photography in GEOINT; Distributed Geospatial Intelligence Network (DGInet); Command, Control, Communications, Computers, Information/Intelligence, Surveillance, Targeting Acquisition and Reconnaissance (C4ISTAR): Concept and Utility. **Recommended Books:** 1. **Waller, D., &Nadel, L. (Eds.). (2013). *Handbook of Spatial Cognition*. Washington, DC: American Psychological Association** 2. **Vecchi, T., &Bottini, G. (Eds.). (2006). *Imagery and Spatial Cognition*. Amsterdam, Pennsylvania: PA: John Benjamin's.** 3. **Lloyd, R. (1997). *Spatial Cognition Geographic Environments*. NewYork, NY: Springer.** **Suggested e-learning materials:** 1. **Distributed Geospatial Intelligence Network (DGInet):** https://www.esri.com/~/media/Files/Pdfs/industries/defense/pdfs/dgin.pdf	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				2. Multi-INT: https://www.geospatialworld.net/article/multi-int-intelligence-effective-multi-sensor-data-fusion/ **3. Human Geography and GEOINT:** https://info.publicintelligence.net/NGIA-HumanGeography.pdf **4. GEOINT Basic Doctrine:** https://geog.utah.edu/pdf/certificates/NGA-doctrine-GEOINT.pdf **5. Geospatial Intelligence and National Security:** https://gistbok.ucgis.org/bok-topics/geospatial-intelligence-and-national-security	
5.	**RS ___: GIS Programming and Scripting**	**After the completion of this course, students should be able to:** • **Describe object-oriented models and functional modeling in GIS Framework.** • **Explain concepts of common language infrastructure and class library.** • **Explain .NET and Python programming languages for geospatial tool development.** • **Rationalize the concepts of**		**Section A** **Introduction to Object Oriented** Introduction to Object Oriented modelling and Design**;** Definitionobjectoriented (OO), Object modelling Concepts, OO methodology, OO themes, Introduction to OO modelling techniques: Modelling, modelling techniques, object model, Dynamic Model and Functional Model, relationship among models. Object Modelling:Object and Classes: Object modelling concepts in details: links, association, generalization, inheritance, metadata, etc. A sample Object Model**.** Dynamic Modelling:Dynamic modelling concepts. A sample dynamic model, Relation of object and dynamic model with example. Functional Modelling:Functional Modelling Concepts, A sample functional model. **Section B** **. NET Framework** Concept of .NET framework, Common Language Infrastructure, Base Class Library and Framework Class Library. **Visual Studio.NET – IDE, Languages Supported, Components. Visual Programming, VB.NET- Features, IDE- Menu System,**	**This Course has been shifted from semester I to elective pool.** **the content is reframed to enforce the in-depth extends must for learning object-oriented programming skills** **The repeated content is removed to maintain**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		WebGIS, Server, and geo-processing functionalities.		**Toolbars, Code Designer, Solution Explorer, Object Browser, Toolbox, Class View Window, Properties Window, Server Explorer, Task List, Output Window, Command Window.** **Elements of Visual Basic .NET** **Properties, Events and Methods of Form, Label, TextBox, ListBox, Combo Box, Radio Button, Button, CheckBox, Progress Bar, Date Time Picker, Calendar, PictureBox, HScrollbar, VScrollBar, Group Box, ToolTip, Timer.** **Data Types, Keywords, Variables and Constants, Operators, Scope and accessibility of variables, Conditional Statements, Looping Statement, Arrays- Static and Dynamic.** **Menus and toolbars, Built-In Dialog Boxes, InputBox, MsgBox Functions and Procedures- Built-In Functions/ User Defined Functions and Procedures.** **Creating Classes, Objects, Fields, Properties, Methods, Events,Inheritance, Polymorphism. Constructors and Destructors, Exception handling.** **Section C** **Python Programming** Introduction to Python, variables, built- in data types, statements and expressions, strings, lists, python objects. Conditional Statements, **Looping Statement** commenting scripts, Modules and packages, functions, classes. Geoprocessing Python Scripts: Importing ArcPy, accessing data, accessing toolboxes, intersection, union and buffering, querying. **WebGIS Development** Introduction to WebGIS, Principles, Architecture - Web Server, Map	**the level of detailing and an essential component for programing logic is introduced.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				Server and Data Server, Technologies for WebGIS applications, Scripting for serving maps, map editing and geo-processing functionalities for GIS server. **Recommended Books:** **1. Fu, P.,& Sun, J. (2011). *WebGIS principles and applications*. New Delhi, India: ESRI press.** **2. Pimpler, E. (2013). *Programming ArcGIS 10.1 with python cookbook*. Birmingham, England: Packt.** **3. Zandbergen, P. A. (2013). *Python scripting for ArcGIS*. New Delhi, India: ESRI Press.** **4. Zhuang, V., Wrazien, D. R., Wang, M., & Huang, X. (2005). *Programming ASP.NET for ArcGIS Server*. Florence, KY: Thomson Delmar Learning.** **Suggested e-learning materials:** **1. VB.Net Programming Tutorial** **https://www.tutorialspoint.com/vb.net/index.htm** **2. VBA Tutorial** **https://www.tutorialspoint.com/vba/index.htm** **3. Algorithm and programming** **https://nptel.ac.in/courses/106106145/** **4. Python – Tutorial** **https://www.tutorialspoint.com/python/index.htm**	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
6.	**RS ___: Microwave, Thermal and Hyperspectral Remote Sensing**	**After the completion of this course, students should be able to:** • **Explain concepts and components of satellite radar imaging.** • **Explain different microwave sensors data (SLC and GRD) and their characteristics.** • **Describe pre-processing requirements and discuss SAR image processing techniques.** • **Rationalize outlook of SAR, thermal, and hyperspectral images.**		**Section A** **Concepts of Imaging RADAR** Concept of Microwave **RS**and its components: - Wavelength, Frequency, Pulse and **Chirping of SAR Signals, Coherence, Scattering matrix, Looks,**polarization. RAR/SAR Imaging Geometry and Concepts: - Directions: Azimuth and Range; Angles: Look, Depression, and Incident; Ranges: Slant and Ground; Resolutions: Range and Azimuth; Penetration of radar signals: Skin depth. Radar Relief Displacement: Layover, Foreshortening, Shadows. **Antenna induced radiometric distortions**. Radar Equation. Radar Image interpretation variables: Surface roughness, Dielectric properties, Backscattering, Speckles. **Concepts of Radar Polarimetry, Interferometry, and Altimetry. GPR: Principals, scope, and interpretation of Radargrams.** **Section B** **Thermal Infrared Remote Sensing** Introduction to Thermal IR radiation Laws, Thermal properties of terrain: Thermal capacity, Thermal conductivity, Thermal Inertia. Thermal IR scanners and bands**. Retrieval of LSE from RS Data: Definition of LSE, *r*, *e* and Apparent Emissivity, Characteristics of emissivity: Angular and Spectral variation of Emissivity. LST retrieval from TIRS data: Definition of LST, Definition of temperature for flat and rough surfaces, Single-Channel method of LST Retrieval, Difficulties in the estimation of LST from Space Measurement.** Thermal Image Interpretation: **Considerations.** **Section C** **Hyperspectral Remote Sensing** Spectral Radiometry – Principle, solid angle, Radiance Vs. Reflectance,**Imaging** Spectroscopy - Introduction, absorption processes	**This Course has been shifted from semester I to elective pool.** **Unit heading is modified with adequate relevance with course content** **Content is reordered by adding significant inescapable fundamentals and introductory part of advanced technical headings associated with GPR and Radar Imaging.** **Newly**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				– charge transfer, electronic and vibrational, Spectral library **and Bank-** concept, development, parameters controlling the spectra- spectral range, bandwidth, Full Width Half Maximum (FWHM), spectral sampling, S/N ratio, Bidirectional Reflectance Distribution Function (BRDF), Continuum **removal,** Imaging Spectrometers **Recommended Books:** **1. Baghdadi, N., &Zribi, M. (2016). *Microwave Remote Sensing of Land Surfaces - Techniques and Methods*. London, United Kingdom: ISTC Press-Elsevier.** **2. Borengasser, M., Hungate, W. S., & Watkins, R. (2007). *Hyperspectral Remote Sensing: Principles and Applications*. Boca Raton, FL: CRC Press.** **3. Campbell, J. B., & Wynne, R. H. (2011). *Introduction to Remote Sensing* (5th ed.). New York, NY: The Guilford Press.** **4. Henderson, F. M., & Lewis, A. J. (1998). *Principles & Applications of Imaging Radar - Manual of Remote Sensing* (3rd ed. vol. 2). Hoboken, NJ: John Wiley & Sons.** **5. Jensen, J. R. (2007). *Remote Sensing of the Environment - An Earth Resources Perspective* (2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall.** **6. Joseph, G., &Jeganathan, C. (2018). *Fundamentals of Remote Sensing* (3rd ed.). Hyderabad, India: Universities Press.** **7. Richards, J. A. (2009). *Remote Sensing with Imaging Radar*. Heidelberg, Germany: Springer** **8. Thenkabail, P. S., Lyon, J. G., &Huete, A. (2011). *Hyperspectral Remote Sensing of Vegetation*. Boca Raton, FL: CRC Press.** **9. Woodhouse, I. H. (2006). *Introduction to Microwave Remote Sensing*. Boca Raton, FL: CRC Press.** **Suggested e-learning materials:** **1. How Does SAR Works** **www.radartutorial.eu/20.airborne/ab07.en.html** **2. History of Radar Imaging** **https://www.geos.ed.ac.uk/homes/ihw/timeline.html**	**added content/topics are required for underpinning the essential component for further research** **work in microwave imaging based earth observations.** **Necessary technical contents are added that strengthen the fundamental as well as methodological approach for temperature retrieval using**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				3. Visual Introduction to radar imaging **https://www.geos.ed.ac.uk/~ihw/hype/radar/intro2radar.html** **4. Hyperspectral Image Analysis** **https://www.harrisgeospatial.com/Support/SelfHelpTools/Tutorials.aspx**	**satellite imaging.** **The LiDAR related topics are shifted to the DIP course of the second semester of M.Tech. RS, accordingly .** **Topics are reorganized accordingly.**
7.	**RS ___: Spatial decision support system**	**After the completion of this course, students should be able to:** • **Study the spatial information systems developed for a specific problem or decision-making situation.** • **Observe key concepts and**		**Section A** **Introduction** GIS and decision support systems, SDSS definition and characteristics, Introduction to decision making process and decision support systems, Introduction of a frame work for planning and decision making, Spatial Decision Making, SDSS architecture. **Database Management** Data base management system, Model based management system, Graphical and tabular report generator, User interface. **Section B**	**This Course has been shifted from semester II to elective pool.** **The learning outcomes and Suggested e-learning material**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		theories underlying spatial information systems and technology trends. • **Explore and reform the solutions to spatial problems by generating a set of alternatives and selecting from among those that appear to be viable through multi criteria analytics.** • **Illustrate and assess the emerging concepts that may impact spatial information system development and applications.**		**Analysis and Decision Making** Principles and elements of multiple-criteria decision analysis, Spatial multiple criteria decision analysis, Main multiple-criteria evaluation methods/techniques, **criteria, alternatives, weights, decision rules and sensitivity analysis**. Spatial multiple criteria evaluation in planning and decision making. **Technology and Development** Development of DSS, Technology levels, Functions and roles, Status of SDSS, Open source tools. **Section C** **SDSS Software And Its Applications** Classification of DSS software, Problem specific SDSS, Generic SDSS, Domain level SDSS, Desktop SDSS, Web-Based SDSS, SDSS applications in: natural resource management, environmental, urban, agriculture, utilities and business. **Recommended Books:** **1. House, W.C. (1983). *Decision Support Systems.* New York, NY: Petrocelli.** **2. Silberschatz, A., Korth, H. F.,&Sudarshan, S. (2011). *Database System Concepts* (6th ed.). New York, NY: McGraw Hill.** **3. Malczewski, J. (1999). *GIS and Multicriteria Decision Analysis*. New York, NY: John Wiley & Sons.** **4. Ramanathan, S. (2011). *Spatial Decision Support Systems: Principles and Practices.* Boca Raton, FL: CRC Press.** **5. Sprague, R.H., & Carlson, E.D. (1982). *Building Effective Decision Support Systems.* Englewood Cliffs, NJ: Prentice-Hall.** **Suggested e-learning materials:**	**have been reviewed.** **The repetition has been removed and gaps have been filled to maintain the continuity .**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				1. Database Management Systems (DBMS) **https://onlinecourses.nptel.ac.in/noc18_cs15/preview** **2. Geographic Information and Analysis** **http://www.ncgia.ucsb.edu/**	
8.	**RS ___: Spatial Database Systems, Analysis and Modeling**	**After the completion of this course, students should be able to:** • **Statistically evaluate the spatial entities their topological, geometric, or geographic properties.** • **Learn different analytic approaches.** • **Describe and design the concept of spatial databases its components, models, mining, analysis and visualization.** • **Apply the strength**		**SECTION A** **Advance Attribute Analysis** Basics Matrix: Addition, subtraction, multiplication, Identity, Determinant and Inverse, **Linear equation solutions using matrix** **Spatial Modeling** Spatial analysis concept: Distance, Adjacency, Interaction and neighbourhood Geospatial models- types and Modeling: Descriptive, prescriptive and predictive; Normalization, level of measurement, Introduction to modeling& flowcharting, Map algebra-operators & operations, Functional operations, Modeling essentials, Spatial interaction models. Conceptualizing the model, Model formulation, Conflict resolution and Prescriptive modeling, Model verification. **SECTION B** **Spatial Analysis** Point Analysis: Coordinate, Distance – Nearest Neighbour Distance, Density – Quadrant and other methods	**This Course has been shifted from semester II to elective pool.** **The learning outcomes and Suggested e-learning material have been reviewed.** **An application component based on**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		and applications of Arc model builder.		**Geo-Statistics** Spatial Interpolation and Geostatistics: Local and global methods, Gravity model, Regression model, Pattern analysis, Moran's Index, Cluster analysis, Trend surface Analysis Thiessen polygon, Density estimation, Inverse Distance Weight (IDW), Thin – plate Spline, Kriging – ordinary and Universal, Semivariogram; Spatial Autocorrelation **Section C** **Geocoding and Network Analysis** Address Geocoding, Optimum Routing, Closest facilities, Resource Allocation, Network Analysis, Dynamic Segmentation: Route, Section, Events and its application. **Digital Terrain** Terrain mapping: Source of existing elevation data, quality and standard of DEM data, Counting, Vertical profile, Hill shading, Slope, Aspect, Surface Curvature, Digital terrain visualization 2D and 3D; Application of Digital terrain models **Arc GIS Model Builder** Concepts of Model Builder, Model elements: Tools, Variables, Connectors, setting up Models, Executing Model, Model Validation, Model builder to create Tools – Advance techniques in Model Builder, Geoprocessing Techniques in Model Builder **Recommended Books:**	**matrix is introduced.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				1. Allen, D.W. (2011). *Getting to know ArcGIS Model builder*. New Delhi, India: ESRI Press. 2. Carter, G. B. (1994). *GIS for Geoscientists: Modeling with GIS*. Amsterdam, Netherlands: Elsevier. 3. Burrough, P. A., & McDonnell, R. (1998). *Principles of Geographical Information Systems*(3rd ed.). New York, NY: Oxford University Press. 4. Chang, K.T. (2002). *Introduction to Geographic Information Systems*(3rd ed.). New Delhi, India: Tata McGraw Hill. 5. Fotheringham, A. (1988). *Spatial Interaction Models: Formulations and Applications.* Dordrecht, Netherlands: Springer. 6. Laurini, R., & Thompson, D. (1998). *Fundamentals of Spatial Information Systems*. London, England: Academic Press. 7. Lo, C.P., &Yeung, A. K.W. (2005). *Concepts and Techniques of Geographic Information Systems*(2nd ed.). New Delhi, India: Prentice Hall of India. 8. MacDonald, A. (1999). *Building a Geodatabase.* Redlands, CA: ESRI Press. 9. Samet, H. (1990). *The Design and Analysis of Spatial Data Structures*. Washington, WA: Addison–Wesley. 10. Silberschats, A.,&Korth, H.F. (1998). *Database System Concepts*(3rd ed.).New York, NY:McGraw-Hill. 11. Sullivan, D. O., &Unwin, D. (2010). *Geographic Information analysis* (2nd ed.). Hoboken, NJ: John Wiley & Sons. 12. Verbyla, D. L. (2002). *Practical GIS Analysis*. London, England: Taylor &Francis. **Suggested e-learning materials:** 1. Digital Elevation Model and applications https://swayam.gov.in/courses/4395-digital-elevation-models-and applications 2. Digital Elevation Model http://gazebosim.org/tutorials?tut=dem	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				3. **Hydrologic Simulation Models** https://nptel.ac.in/courses/105101002/36 4. **Model Builder** http://desktop.arcgis.com/en/arcmap/10.3/analyze/modelbuilder/what-is-modelbuilder.htm	

List OfReading Electives

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	**RS ___R: Environmental Remote Sensing and Modeling**	**After the completion of this course, students should be able to:** • **Describe principles of environmental modeling and taxonomy of environmental models in the spatial sciences.** • **Explain Remote Sensing applications to monitoring wetland dynamics and**		**Principles of environmental modeling. Taxonomy of environmental models in the spatial sciences**.Basic concept, Environmental Impact Assessment (EIA): Basic concepts, method, and Benefit. **Integrated Environmental Modeling (IEM): A vision and roadmap for the future. Sensitivity Analysis: Importance in environmental modeling. Spatial multi-criteria evaluation and environmentalmodeling**. Application of remote sensing in solid waste management, **waterpollution monitoring and air pollution monitoring. Remote Sensing of urban biophysical environment: components and "urban heat islands" monitoring. Remote Sensing applications to monitoring wetland dynamics: Functions and values of Ramsar Sites (India). Aboveground terrestrial biomass and carbon stock estimations from Multi-sensor remote sensing: Global carbon budgets and remote sensing. Ecological characterization of vegetation using multi-sensor**	**New course introduced based on emerging technologies.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		management of Ramsar sites. • **Apply concepts of remote sensing in urban biophysical environmental modeling and management.** • **Explain methods and benefits of Environmental Impact Assessment (EIA).**		**remote sensing in the solar reflective spectrum. Principles and Practices of data fusion in multi-sensor remote sensing for environmental monitoring.** **Recommended Books:** **1. Brimicombe, A. (2009). *GIS, Environmental Modeling and Engineering* (2nd ed.). Boca Raton, FL: CRC Press.** **2. Chang, N. B., &Bai, K. (2018). *Multisensor Data Fusion and Machine Learning for Environmental Remote Sensing*. Boca Raton, FL: CRC Press.** 3. Joshi, P. K., & Singh, T. P. (2011). *Geoinformatics for Climate Change Studies*. New Delhi, India: TERI Press. 4. Joshi, P. K., Pani, P., Mohapartra, S. N., & Singh, T. P. (Eds.). (2010). *Geoinformatics for Natural Resource Management*. Punjab, India: Nova. **5. Reddy, G. P. O., & Singh, S. K. (Eds.). (2018). *Geospatial Technologies in land resource mapping, monitoring and management.* New York, NY: Springer-nature.** **6. Skidmore, A. (2002). *Environmental Modelling with GIS and Remote Sensing.* London, United Kingdom: CRC Press.** **7. Thenkabail, P. S. (2015). *Land Resources Monitoring, Modeling, and Mapping with Remote Sensing*. Boca Raton, FL: CRC Press.** **8. Weng, Q. (2011). *Advances in Environmental Remote Sensing: Sensors, Algorithms, and Applications.* Boca Raton, FL: CRC Press.** **Suggested e-learning materials:** **1. Taxonomy of environmental models in the spatial sciences** https://research.utwente.nl/en/publications/taxonomy-of-environmental-models-in-the-spatial-sciences **2. Ramsar Convention** https://www.ramsar.org/about-the-ramsar-convention	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
2.	**RS ___R: Geo-informatics for resource management**	**After the completion of this course, students should be able to:** • **Define resource classification systems for different natural and cultural resources.** • **Explain methods related to natural resource inventory and mapping.** • **Apply concepts of multiresolution approach for wildlife habitat assessment and corridor mapping.** • **Explain the principles of biodiversity conservation, and essential ecosystem services for sustainable development.**		**Concepts of resources management in realms of environmental sustainability:** criteria and classification systems, **natural resources,** Natural **resources inventory and planning system in India:identification of local and regional problems**, base map preparation, thematic mapping and resources monitoring; Geospatial techniques in desertification assessment **and control; Multi-resolution approach for wildlife habitat modeling: Major causes-outcomes of Human-wildlife conflicts, concept of habitat connectivity, corridor, or GIS based habitat modelling, Habitat Suitability Index; The Illegal wildlife trade: issues and challenges, monitoring organizations (i.e., TRAFFIC: The wildlife trade monitoring network, WCCB-Wildlife Crime Control Bureau, India: Structure and function); Geoinformatics based identification of potential natural resources, their conservation and planning for Sustainable development;Biodiversity conservation: potential, benefits and essential ecosystem service; Application of GIS to biodiversity monitoring; United Nations Decade on Biodiversity (2011-2020)** **Recommended Books:** 1. **Adams, C. E. (2016). *Urban Wildlife Management* (3rd ed.). Boca Raton, FL: CRC Press.** 2. **Conover, M. R. (2001). *Resolving Human-Wildlife Conflicts: The Science of Wildlife Damage Management.* Boca Raton, FL: CRC Press.** 3. **Fulbright, T. E., & Hewitt, D. G. (Eds.). (2007). *Wildlife Science: Linking Ecological Theory and Management Applications*. Boca Raton, FL: CRC Press.** 4. **Jenson, J. R. (2000). *Remote Sensing of the environment - An Earth Resource Perspective* (3rd ed.). Upper Saddle River, NJ: Pearson's Prentice Hall.** 5. **Singh, C. K. (2018). *Geospatial Applications for Natural Resources Management*. Boca Raton, FL: CRC Press.** 6. Skidmore, A. (2002). *Environmental Modelling With GIS and Remote Sensing*. London, United Kingdom: **CRC Press.** 7. **Thenkabail, P. S. (2015). *Land Resources Monitoring, Modeling, and Mapping with Remote Sensing*. Boca Raton, FL: CRC Press.** **Suggested e-learning materials:**	**New course introduced based on emerging technologies.**

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				1. The Potential, Realized and Essential Ecosystem Service Benefits of Biodiversity Conservation http://www.gibbs-lab.com/wp-content/uploads/2015/09/ 2. TRAFFIC https://www.worldwildlife.org/initiatives/traffic-the-wildlife-trade-monitoring-network 3. 2011-2020 Decade on Biodiversity https://www.cbd.int/2011-2020/ 4. Habitat Connectivity Analysis https://waconnected.org/habitat-connectivity-analyses/ 5. GIS based Corridor modeling http://corridordesign.org/designing_corridors/resources/gistools	
3.	RS ___R: Geospatial BigData: Challenges and Opportunities	After the completion of this course, students should be able to: • Describe trinity of understanding BigData. • Describe geocomputation and massive remote sensing data handling and associated challenges. • Apply concepts of parallel computing and internet of Things (IoT) in Geospatial BigData handling. • Explain recent technology trends in public dissemination of the real-time geospatial data		Geospatial BigData: Introduction, Definition, trinity of understanding BigData, common and individual challenges. Geospatial data and virtual reality (VR) development: Augmented Reality, Mixed Reality, and Virtual Reality GIS (VR-GIS). Geospatial data, 4V's properties, and 3C's. Voxels: concepts and application in 3-D urban scene modeling. Internet of Things (IoT): Concept, real-time monitoring and ArcGIS GeoEvent Server. Spatial Online Analytical Processing (SOLAP): Introduction and applications in Geomatics. Geocomputation and Earth Observations: Introduction and concept of "Context-awareness" and "Geo-smart dust". Parallel computing and massive remote sensing data handling: concepts and terminology. Open Geospatial Data Consortium (OGC): Structure, initiatives and technology trends. United Nations - Global Geospatial Information Management (UN-GGIM): Genesis, Objectives, and Initiatives. Recommended Books: 1. Nilanjan, D., Chintan, B., &Ashour, A. S. (Eds.). (2019). *Big Data for Remote Sensing: Visualization, Analysis and Interpretation.* New York, NY: Springer. 2. Plaza, A. J., & Chang, C. I. (Eds.). (2007). *High Performance Computing in Remote Sensing.* New York, NY: Chapman and Hall/CRC Press. 3. Swarnalatha, P., &Sevugan, P. (2018). *Big Data Analytics for Satellite Image Processing and Remote Sensing (Advances in*	New course introduced based on emerging technologies.

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		and analysis.		***Computer and Electrical Engineering).*** **New Delhi,India: IGI Global Press.** **Suggested e-learning materials:** 1. **OGC A to Z** http://www.opengeospatial.org/ 2. **OGC Tech Trends** http://www.opengeospatial.org/OGCTechTrends 3. **Virtual Reality Landscape** https://www.intel.com/content/www/us/en/tech-tips-and-tricks/virtual-reality-vs-augmented-reality.html 4. **The Changing Face of Geospatial Analytics** https://tdwi.org/Articles/2015/11/17/Changing-Face-of-Geospatial-Analytics.aspx?Page=2 5. **UN-GGIM** http://ggim.un.org/about/ **6. GeoEvent Server** https://www.esri.com/en-us/arcgis/products/arcgis-geoevent-server **7. Parallel computing, concepts and terminology** https://computing.llnl.gov/tutorials/parallel_comp/	
4.	**RS ___R: Open source software, services and utility application**	**After the completion of this course, students should be able to:** • **Describe current trends in remote sensing and GIS based open source software's.** • **Understand role of Geospatial technologies in government projects.** • **Familiarise with geo-statistical analysis in utility applications such**		**Open source software in remote sensing and GIS (e. g., QGIS, SAGA, Grass, ILWIS), Mobile GIS, Mobile GIS software, Location based services using mobile devices. National Centre of Geo-Informatics (NCoG), Indian National GIS Organization (INGO), geospatial technologies in Government projects such as Re-structured Accelerated Power Development and Reform Programme (R-APDRP), AGRIS, Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and National Land Records Modernization Programme (NLRMP). Concept of Medical GIS, evolution of Medical GIS, Use of GIS in public health, Spatio-temporal behaviour of disease pattern, Health Services and GIS, Geostatistical analysis in Epidemiological studies, advances in medical GIS. Crime Pattern Theory, point pattern analysis, types of crime analysis, GIS in crime analysis, Multi criteria Decision, spatial and temporal analysis of Crime using GIS, Crime mapping software. Line of sight analysis, Signal strength mapping, GIS in asset management of Power/Electric, mobile tower planning, Line routing, load**	**New course introduced based on emerging technologies.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		as crime, PWD etc. • Explain geo-statistical analysis to be used in utility applications.		forecasting, utility/assets management in PWD. **Recommended Books:** 1. Drummond, J. (2007). *Dynamic and Mobile GIS: Investigating Changes in Space and Time*. Boca Raton, FL: CRC Press. 2. Kurland, K. S., &Gorr, W. L. (2012). *GIS tutorial for Health* (4th ed.). New Delhi, India: ESRI Press. 3. Meehan, B. (2007). *Empowering Electric and Gas Utilities with GIS (Case Studies in GIS)*. New Delhi, India: ESRI Press. 4. Peng, Z. R., &Tsou, M. H. (2003). *Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks.* Hoboken, NJ: Wiley. **Suggested e-learning materials:** 1. R-APDRP http://www.ipds.gov.in/Forms/Know_More.aspx 2. Geospatial technologies in Government projects https://www.digitalindia.gov.in/ 3. QGIS https://qgis.org/en/site/ 4. SAGA http://www.saga-gis.org/en/index.html	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
5.	RS ___R: Remote sensing in Hydrology and Water Resources	After the completion of this course, students should be able to: • Describe fundamentals related to satellite imaging based hydrological investigation. • Apply hydro geomorphology based interpretation knowledge for the identification of potential ground water resources. • Explain concepts of watersheds leading to its inventory and effective management. • Explain methods of snow cover		Fundamental of hydrological cycle and its major components; Interception and infiltration: their role in water balance in catchments; Surface and ground water, classification of stream and rivers, type of aquifers, Movement of groundwater:Darcy,s Law, Aquifer transmissivity/transmissibility, storativity and effective hydraulic conductivity; intrinsic property of aquifer materials:porosityand permeability, specific yield and retention, depression storage and hydrological losses; parameters in hydrology and water resources currently available from satellite observation; GIS-based components for rainfall-runoff models.Watershedinventory and management: definition and scope, morphometric parameters, drainage network and patterns; Advances in remote sensing-based hydro-geomorphological interpretation: hydrological applications of data from GRACE satellites, SARAL-Altika data and inland waterbodies, Quantitative Precipitation Estimates (QPE) based on remote sensing platforms. Significance of periodical and precise mapping of the snow covers for hydrological applications. Recommended Books: 1. Pawlik, A. R., Pagliara, S., &Hradecky, J. (Eds.). (2017). *Open Channel Hydraulics, River Hydraulic Structures and Fluvial Geomorphology: For Engineers, Geomorphologists and Physical Geographers*. Boca Raton, FL: CRC Press. 2. Chang, N. B., & Hong, Y. (Eds.). (2017). *Multiscale Hydrologic Remote Sensing: Perspectives and Applications*. Boca Raton, FL: CRC Press. 3. Shaw, E. M., Beven, K. J., Chappell, N.A. & Lamb, R. (Eds.). (2010). *Hydrology in Practice* (4th ed.). London, United Kingdom: CRC Press. 4. Lyon, J. G. (2002). *GIS for Water Resource and Watershed Management*. London, United Kingdom: CRC Press. Suggested e-learning materials: 1. Remote Sensing based QPE's http://satellite.imd.gov.in/dynamic/insat_3DR.htm 2. Movement of groundwater	The learning outcomes and Suggested e-learning material have been reviewed. Recent and emerging technologies have been added. Hydrology related programs are also added.

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		mapping based on hydrological and GIS based models.		https://nptel.ac.in/courses/105103026/3 **3. Hydrological cycle and its components** http://www.fao.org	
6.	**RS ___R: Spatial Planning and Urban Development**	**After the completion of this course, students should be able to:** • **Identify the potentials of remote sensing in allied sectors.** • **Describe the land reforms in India.** • **Apply spatial planning in effective urban management.** • **Explain national and international initiatives for urban development sector.**		Geo-informatics for human settlements and infrastructure, **Evolution of human settlements,**, Economic planning, **SEZ's: Special Economic Zones in India;**Land Use / Land Cover classification in India, **Eco-Village Concept and Environment Information System (ENVIS).**Rural development plan, City development plan, Urban Master Plan and guidelines, **Urban Population Dynamics,** Housing problems and development: **United Nations-Global Housing Strategy (UN-GHS), National Urban Housing and Habitat Policy, National Urban Information System (NUIS) - ISRO: Slum upgradation: Key for overall urban development. Slum Networking Programme (SNP) in India. Land reforms in India: Vision for urban equity, inclusivity and opportunity, Concepts related to "Resilient City and Smart City". Town Planning Schemes, Urban Land Pooling Mechanism, Institutions for urban planning education, vision for national GIS (Indian context). Sustainable solutions: United Nations - Sustainable Development Goals (UN-SDG's) and United Nations Development Program, India -Millennium Development Goals (UNDP-MDG's). Spatial planning and climate change mitigation, Spatial planning strategies: (1) Macro—regions and metropolitan areas; (2) Meso—sub-regions, districts, and corridors; and (3) Micro—	**New course introduced based on emerging technologies.**

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				neighbourhoods, streets, and blocks. **Recommended Books:** **1. Lavender, S., & Lavender, A. (2015). *Practical Handbook of Remote Sensing*. Boca Raton, FL: CRC Press.** **2. Maarseveen, M. V., Martinez, J., &Flacke, J. (Eds.). (2019). GIS in Sustainable Urban Planning and Management: A Global Perspective. Boca Raton, FL: CRC Press.** **3. Rashed, T., &Jurgen, C. (Eds.). (2010). *Remote Sensing for Urban and Suburban Areas.* London, United Kingdom: Springer.** **4. Weng, Q., Quattrochi, D., &Gamba, P. E. (Eds.). (2018). *Urban Remote Sensing* (2nd ed.). Boca Raton, FL: CRC Press.** **Suggested e-learning materials:** **1. SEZ's in India http://sezindia.nic.in/** **2. ISRO-NICES https://nrsc.gov.in/nices** **3. India and the MDGs http://www.in.undp.org/content/india/en/home/post-2015/mdgoverview.html** **4. UN-Habitat's Strategic Plan https://unhabitat.org/un-habitats-strategic-plan-2014-2019/** **5. Housing & slum upgrading https://unhabitat.org/urban-themes/housing-slum-upgrading/** **6. Visions for Urban Equity, Inclusivity and Opportunity https://relocal.eu/the-just-city-essays-visions-for-urban-equity-inclusivity-and-opportunity/** **7. ENVIS http://envis.nic.in/ENVIS_html/about.html** **8. National Urban Information System (NUIS) https://www.nrsc.gov.in/NUIS**	

NOTE: Yellow highlighted and bold content illustrate the modification in the syllabus.

Verified

Offg. Secretary
Banasthali Vidyapith
P.O. Banasthali Vidyapith
Distt. Tonk (Raj.)-304022