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 - 7

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**

SEMESTER IV

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.

Annexure - 8

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 ~~504~~ 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:**	Introduction 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.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/	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.

Verified

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