Department of Geography

Banasthali Vidyapith, Banasthali

Minutes of the meeting of Board of Studies held on 30 September 2010 at 10.00 AM in Conference Room No 209 of Aim & Act Banasthali University.

Following members were invited to the third meeting of Board of Studies in Geography on 30.09.2010.

1.	Prof. Sadhana Kothari	Udaipur University
2.	Prof. R. N. Mishra	University of Rajasthan
3.	Dr. Rashmi Sharma	Internal Member
4.	Dr. Ashutosh	Internal Member
5.	Dr. Vipin Kaushik	Internal Member
6.	Dr. Khundra Kapam Moiranglima	Internal Member
7.	Dr. Salahuddin Mohd.	Internal Member
8.	Prof. Brij. Bhushan	Convener

All invited members were present. The meeting began with hearty welcome to the members by convener. As scheduled, the meeting took place in Room No. 209 of Apaji Institute at 10:00 am. After exchange of a few words of greetings, the BOS members, particularly new members, were apprised of the aim and proceedings of the BOS. The members then took up the first agenda item of the given Agenda (Enclosure 0) for the meeting.

Agenda Item 1 **:** As an action on this agenda item members were to confirm the minutes of second meeting of BOS held in January, 2010. After a few clarifications and a brief discussion the minutes were confirmed (Enclosure 1)

Agenda Item 2 **:** As an action on this second agenda, BOS members were to reconsider the existing list of Examiners (Theory and Practicals) for any revision. Considering the state and convenience of some of the senior Geographers in attending the examination work, some younger examiners were adopted in place of very senior members as per recommendation of the BOS. The revised list of examiners is placed as Enclosure 2.

Agenda Item 3 **:** This agenda was on acceptance of continuation of existing syllabus for Under Graduate and also for acceptance of existing scheme of examination for B. A. examination in Geography. BOS members were of the view that the existing syllabi may be continued, together with existing scheme of examination, as it was revised very recently in January 2010. Existing scheme of examination is placed as Enclosure 3.

The fresh syllabi for M.A. / M.Sc. Geography prepared by faculty members of Geography Dept. was discussed from various points of view i.e. volume of new course, its commensuration with course of other universities of repute, semester – wise distribution of course etc.

Scheme of examination was also drawn. Detailed outlines of accepted syllabi for M.A. / M. Sc. (Geography) and the scheme of examination are given in Enclosures 4 & 5 respectively. Syllabi was planned so as to be covered in four semesters as per scheme of examination.

Course for M. Tech (Remote Sensing), Enclosure 6, prepared by Geography Department was perused by BOS members. While appreciating the enthusiasm of dept. and quality of syllabus, BOS members came to decision that such a Technical Post Graduate course be taught by a Department of Banasthali University Office other than Geography Department so that students of Geography after finishing course a as high as MA / M.Sc. may feel a sense of completeness rather than of unsatisfaction.
Therefore, syllabi for M Tech (Remote Sensing) was not further commented and was given up for consideration by concerned department's BOS.

Agenda Item 4 : Examiners' report of past examinations of undergraduates were to be evaluated. All the available reports were submitted before BOS members. Members observed high opinions given by examiners and expressed their satisfaction on the reports showing hard work by students.

Agenda Item 5 : Standard of B. A. examinations' question papers was to be evaluated through available Question papers of past examinations. All members expressed satisfaction on continuous improvement of standard of Question Papers of periodicals and annual examinations. The standard was observed to be as high as of any long standing Geography Department of a leading University in India. However BOS members recommended revision of format of question papers of future annual examination so that these are in conformity with the format of many a competitions.
BOS suggested following format: -

(1) *Every question paper in geography may have first Question as compulsory in ten sub – parts. This constituted section – A.*

(2) *Under Section – B, there would be five questions each one with a choice. One question (together with choice question) will be selected from each of the five units of syllabus. The examinees will be asked to answer all five questions (availing choice) each one within 100-150 words.*

(3) *Section – C : It may contain four Questions, one from any four units of syllabi five units. Students will be required to answer any two, each with maximum of 400 – 500 words.*

BOS members had completed action on all the agenda items by 1415 Hrs, the meeting was closed at 14.30 hrs. Convener thanked the members for their co-operation and suggesting valuable changes given above.

M. Tech in Remote Sensing

I Semester [July – December]

S. No	Paper	Contact hrs/week		Cont. Ass. Marks		Ann. Ass. Marks		Total Marks	
		T	P	T	P	T	P	T	P
1	Principles of remote sensing	4		20		40		60	
2	Fundamentals of geographic information sciences	4	4*	20	10	40	20	60	30
3	Applied statistics & cartography and digital mapping	4	2**	20	5	40	10	60	15
4	Surveying, global positioning systems and mobile mapping	4	2#	20	5	40	10	60	15
5	Computer programming	4	4##	20	10	40	20	60	30
		20	12	100	30	200	60	300	90

TOTAL: 390

* Practical- fundamentals of geographic information sciences

** Practical- cartography and digital mapping

Practical- global positioning systems and mobile mapping

Practical- computer programming

II Semester [Dec – May]

S.No	Paper	Contact hrs/week		Cont. Ass. Marks		Ann. Ass. Marks		Total Marks	
		T	**P**	**T**	**P**	**T**	**P**	**T**	**P**
1	Spatial database systems, analysis and modeling	4	2*	20	5	40	10	60	15
2	Digital image processing	4	6**	20	15	40	30	60	45
3	Spatial decision support systems	4		20		40		60	
4	Research methodology & project management	4		20		40		60	
5	Applications of remote sensing	4	4***	20	10	40	20	60	30
		20	12	100	30	200	60	300	90

TOTAL: 390

* Practical - spatial database systems, analysis and modeling

** Practical- digital image processing

*** Practical- applications of remote sensing

III-IV Semester [July – May]

Project Work: M Tech. RESEARCH DISSERTATION

- Synopsis consisting of relevance of the problem to be studied and its aims and objectives, Methodology adopted to study such problem
- Chapter Scheme
- Review of Literature
- Preliminary base work carried out
- Presentation

On satisfactory completion of the taught component of the course, students will normally proceed for the M.Tech. Research Dissertation must be completed by the end second year. This should be a substantial piece of research work, which both reinforces the skills learned in the taught component of the course and provides a genuine opportunity to undertake valuable research. Each student is required to defend his / her thesis through a presentation in front of an external expert and faculty and students.

1. UIL Project

Reading Elective –I	40
Reading Elective –II	40
Thesis /Project (Duration 30 weeks)	
Part-I	100
Part-II	100
Part-III	100
Part-IV I. Dissertation & Project	120
II Interim report	50
III Seminar	70
IV Viva Voce	100
TOTAL	**720**

GRAND TOTAL =1500

FIRST SEMESTER

PAPER-1.1 PRINCIPLES OF REMOTE SENSING

Section - A

BASIC PRINCIPLES

Introduction: Definition of Remote sensing, Advantages and limitations, Remote sensing process, Electromagnetic Radiation (EMR): EMR Spectrum and its properties, EMR wavelength regions and their applications, Atmospheric windows, Interaction of EMR with matter, Spectral signatures, Resolutions: Spectral, Spatial, Temporal and Radiometric

MICROWAVE REMOTE SENSING

Passive Microwave Sensors, Active Microwave Sensors, Side looking RADAR, Scatterometer

THERMAL INFRARED REMOTE SENSING

Brief Introduction to Thermal Infrared Radiation Properties: Kinetic Heat, Temperature, Radiant Energy and Flux, methods of transferring heat, Thermal properties of terrain: Thermal Capacity, Thermal conductivity, Thermal Inertia, Thermal Infrared Multispectral scanners, Thermal IR Remote sensing examples

Section - B

AERIAL PHOTOGRAPHY AND PHOTOGRAMMETRY

Introduction- Fundamentals of aerial photography, Vertical and Oblique aerial photography, Aerial cameras, Filters and Films, Aerial photography planning Photogrammetry; Basic concepts of scale, object height and length, object area and perimeter, grayscale tone/color of objects, Photo interpretation techniques, Stereo photogrammetry and stereovision, Parallax bar and its applications, Softcopy photogrammetry

SENSORS, SCANNERS AND DETECTORS

Photographic System: Cameras, Sensor classification: Active and Passive, Opto-Mechanical Scanners & Push-broom scanners, Infrared Scanners, Thermal Sensors and Microwave Sensors

Section - C

REMOTE SENSING SATELLITES

Introduction to commonly used multi-spectral remote sensing satellite systems: IRS Series of Satellites, LANDSAT, SPOT, IKONOS, QUICKBIRD, MODIS, RADARSAT, NOAA, TERRA, MOS and ERS, Brief introduction to Weather and Communication Satellites

SPECTRAL DATA ANALYSIS AND RS APPLICATIONS

Spectral Signature and its Response: of Soil, Vegetation and Water, Ground Truth Collection; Commonly Used Ground Truth Equipment-GTR, Radiometric Calibration, Digital and Analog Methods, Brief introduction to Remote Sensing (RS) Applications: in Agriculture, Forestry, Land cover/Land use, Water resources & Earth System Science

TEXT BOOKS

1. Jensen, J.R., "Remote Sensing of the Environment – An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pte. Ltd., Indian edition, Delhi, 2000
2. George Joseph, "Fundamentals of remote sensing", Universities press (India) Pte Ltd., Hyderabad, 2003

REFERENCE BOOKS

1. Sabins, F.F. Jr., 'Remote Sensing – Principles and Interpretation", W.H. Freeman & Co., 2002 Edition.
2. Reeves, Robert G., "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA
3. Lillesand, Thomas M. and Kiefer, Ralph, W., "Remote Sensing and Image Interpretation", 4th Edition, John Wiley and Sons, New York, 2000
4. Rampal, K.K., Handbook of Aerial Photography and Interpretation, Concept Publishing Company, New Delhi, 1999

PAPER-1.2 FUNDAMENTALS OF GEOGRAPHIC INFORMATION SCIENCES

Section - A

FUNDAMENTAL GEOGRAPHIC CONCEPTS FOR GISCIENCE

Basic Concepts about spatial information, Philosophy and definition of GIS, features, pictures, variables: points, lines, areas, Position on the earth; Geo-referencing; Mapping the earth; Projections and transformations, Spatial relationships, attributes of relationship; scale and geographic detail; generalization, Manual vs Automated GIS

IMPLEMENTING GEOGRAPHIC CONCEPTS IN GISYSTEMS & DATA STRUCTURES

Fundamentals of Data Storage, Information Organization and Data Structure Basic File Structures; Tabular Databases; Advantages of Databases, Types of Databases- hierarchical systems, network systems, relational systems and Object-oriented database systems (OODS), Data Models-Entity Relationship model, Relational Model, Adapting database to GIS use; Data Structures; Raster Structures, Vector Structures, Hybrid Model, Non-spatial Database Models, data modeling

Section - B

SPATIAL DATA INPUT AND EDITING

GIS Data Requirement, sources and collection, Methods of data capture-scanning, digitization and associated errors, Conversion from Other Digital Sources, Attribute data input and management, Edge matching, creating digital data - remote sensing; GPS; data exchange; generating data from existing data ; metadata ;Different Kinds of geospatial data, , Detecting and Evaluating Errors, Data Quality Measurement and Assessment, digital output options;

DATA STORAGE & EXPLORATION

Image storage formats, Data retrieval, Data compression, Supplying the data; Public access to geographic information; Digital Libraries, NSDI,GSDI; geographic information in decision making; human resources and education; Interactive data exploration, Vector & Raster data query, Geographic visualization;

Section - C

RASTER DATA ANALYSIS

Data base and structure, Local operations, Neighborhood operations, Zonal operations, Distance measure operations, Spatial auto correlations, DEM generation, Spatial Modeling, combining data; terrain mapping finding and quantifying relationships; generalization; spatial statistics; geostatistics; spatial interpolation; Artificial Neural Networks for Spatial Data Analysis, interoperability; knowledge base and expert systems; collaborative spatial decision making

VECTOR DATA ANALYSIS

Vector data base , Topological Relationships; Creation of Topology and Error Correction; Accuracy and Precision; The Importance of Error, Accuracy, and Precision, types of error, sources of error, data quality, Spatial interpolation, Overlay Operations and Buffering, Neighborhood functions Distant Measurement , Map Manipulation, Network analyses,

DATA INTEGRATION AND MANAGEMENT

GIS and Remote Sensing data Integration, Thematic Mapping , GIS and Integration of other types of data, Virtual GIS and SDSS, Project design and management, need assessment; conceptual design of the GIS; survey of available data; database planning and design; pilot studies ; GIS system integration; GIS application development; GIS use and maintenance

TEXT BOOKS

1.Kang-tsung Chang 2002,'Introduction to Geographic Information Systems' Tata McGraw Hill, New Delhi.

2.C.P.Lo and Albert K.W.Yeung 2005 “Concepts and Techniques of Geographic Information Systems” Prentice Hall of India, New Delhi.

REFERENCE BOOKS

1.Burrough, Peter A. and Rachael McDonnell,1998, ‘ Principles of Geographical Information Systems’ Oxford University Press, New York.

2.Magwire, D. J., Goodchild, M.F. and Rhind, D. M. Ed. 1991,‘Geographical Information Systems: Principles and Applications', Longman Group, U.K.

PAPER-1.2 (Practicals) FUNDAMENTALS OF GEOGRAPHIC INFORMATION SCIENCES

List of Practicals -

Lab 1. Analog to Digital Conversion – Scanning methods

Lab 2. Introduction to software

Lab 3. Digital database creation – Point features, Line features, Polygon features

Lab 4. Data Editing-Removal of errors – Overshoot & Undershoot, Snapping

Lab 5. Data Collection and Integration, Non-spatial data attachment working with tables

Lab 6. Dissolving and Merging

Lab 7. Clipping, Intersection and Union

Lab 8. Buffering techniques

Lab 9. Spatial and Attribute query and Analysis

Lab 10. Contouring and DEM

Lab 11. Advanced Analysis – Network analysis

Lab 12. Advanced analysis – Geo-Processing

Lab 13. Spatial Analysis and Modelling

Lab 14. Layout Generation and report

PAPER-1.3 APPLIED STATISTICS & CARTOGRAPHY AND DIGITAL MAPPING

Section - A

INTRODUCTION

Meaning, Scope and Importance of Statistics, Collection of data - sampling methods; random and systematic method; source of data - primary and secondary, Organization of data - array, frequency, class intervals, histograms, and distribution, Presentation of Data: Tables, Diagrams - Geometric form (bar diagrams, pie-diagrams), Frequency diagrams (histogram, polygon), Arithmetic line graphs (time series graph)

COMPUTATION OF DATA

Grouped data and ungrouped data, Geographical data: discrete and continuous series, scales of measurement, Measures of Central Tendency - mean, median, mode, quartiles, Arithmetic mean, Geometric mean, Harmonic mean, Quadratic mean and their interrelated Relations; Moments, Skew ness, Kurtosis, Measures of Dispersion – absolute dispersion (range, quartile deviation, mean deviation, standard deviation), relative dispersion (coefficient of quartile deviation, coefficient of mean deviation, coefficient of variation), Correlation: meaning, scatter diagram, standard deviation, variance, Measures of correlation – Karl Pearson's method (two variables ungrouped data) Spearman's rank correlation methods.

Section - B

PROBABILITY AND THEORY OF S AMPLING

Probability: Binomial, Normal, and Poisson distribution, Theory of Sampling: sampling distributions of means and proportions, standard errors, confidence interval estimation for population means, standard deviations, difference of means, sums, Time series analysis - moving averages

BASIC CONCEPT OF CARTOGRAPHY

Basic Concept, Categories of maps, Interpretation of topographic maps, Cartographic databases, data measurement, cartographic design issues, colour and pattern, map lettering, map compilation, map scale, Generalization, symbolization, dot, isopleth and choropleth mapping, multivariate and dynamic mapping, map production, methods of map printing,

Section - C

PROJECTIONS

Basic Assumptions, Map Projections, Grouping of map projections: conic projection, cylindrical projection, Zenithal, Projection Types: Mercator, Transverse Mercator, Polyconic, Lambert, Orthomorphic, UTM Projections and their comparison, Choosing a Map Projection, Map Projection transformation, Analysis and visualization of distortion,

DIGITAL MAPPING

Computer Cartography, the nature of Data, Database and Data structures, Data Input: Method of data capture, digitization and scanning method, Techniques and procedure for digitizing, Vector and Raster;

Data output: Screen display system, file organization and formats, rectification of digital maps, software for digital mapping.

VISUALIZATION

Visualization of geospatial data: Design aspects, Multiscale and geometric aspects scale, dissemination of (visualized) geospatial data, data products, use and users of products,. 3D Visualization, Various issues in map visualization, Interactive Cartography

TEXT BOOKS

1. Paul L. Meyer: Introductory Probability and Statistical Applications, Addison Wesley

2. Chiles, J.P. (1999). Geo-statistics: Modelling spatial uncertainty, Wiley Interscience Publ.

3. Sharma, D.D. (2002). Geo-statistics with application in Earth Sciences, Capital Publ.

4. Keates, J.S. (1973): Cartographic Design and production, London, Longman

5. Ramesh, P. A. (2000): Fundamentals of Cartography, Concept Publishing Co., New Delhi.

6. Rampal, K.K. (1993): Mapping and Compilation, Concept Publishing Co.,New Delhi.

7. Anson, R.W.& Ormeling, F.J. (1993), Basic Cartography, Vol. 1, 2nd ed., Elsevier Applied Science Publishers, London.

REFERENCES

1. Robinson A.H. & Morrison J.L, (1995) Elements of Cartography, John Wiley & Sons

2. Gregory, S. (1978): Statistical Methods for Geographers, Longman

3. Singh, R.L & Dutt. P.K, "Elements of Practical geography", Students Friends Allahabad

4. Peterson, M.P. (1995) "Interactive and Animated Cartography" Upper Sadde River, NJ: Prentice Hall.

5. Murray R. Spiegel, (1981), Theory and Problems of Statistics , Schaum's Outline Series

PAPER-1.3 (Practicals) CARTOGRAPHY & DIGITAL MAPPING

List of Practical -

Lab 1. Construction of different types of scales (i) Simple (ii) Comparitive (iii) Diagonal Scale.

Lab 2. Construction of different types of map projection

Conical projection

Cylindrical Projection

Zenithal Projection

Lab 3. Preparation of UTM grid

Lab 4. Base Map

Lab 5. Designing and Symbolization

Lab 6. Analog to Digital Conversion

Lab 7. Analysis of Toposheet

Lab 8. Updation of Toposheet from Satellite Imagery.

PAPER-1.4 GLOBAL POSITIONING SYSTEMS AND MOBILE MAPPING

Section - A

FUNDAMENTALS OF GPS

Introduction of Global Positioning System, Satellite constellation, GPS signals and data, Geopositioning-Basic Concepts. NAVSTAR, GLONASS

GEODESY

Basic geodesy, Geoid/datum/Ellipsoid,- definition and basic concepts, Coordinate Systems, Special Referencing system, Map Scale, Scale factors, Application of Geodesy-Indian geodetic System

COMPONENTS OF GLOBAL POSITIONING SYSTEM

Control Segment, Space Segments, User Segment, GPS Positioning Types- Absolute Positioning, Differential positioning

Section - B

GPS SURVEYING METHODS AND ACCURACY

Methods-Static & Rapid static, Kinematic-Real time kinematic Survey- DGPS-GPS data processing and Accuracy.

FACTORS AFFECTING GPS ACCURACY

Number of satellites, Multi path, Ionosphere, Troposphere, Satellite Geometry, Satellite signals and its strength, receiver System errors, Radio frequency (RF) interference.

Section - C

REFERENCE STATION, REFERENCE EQUIPMENTS AND RADIOS

Selection of Reference Station, Reference Station Equipment: GPS receiver, GPS antenna. Radio and its types, Radio Antenna

MOBILE MAPPING AND GPS APPLICATIONS

Mobile Mapping basic concepts and Applications , GPS Application in Surveying and Mapping, Navigation Military, Location Based Services, Vehicle tracking, Seismic Applications- Crustal deformation and tectonic movements

TEXT BOOK

1. Leicka. A.: GPS Satellite Surveying, John Wiley & Sons, use. New York
2. Terry-Karen Steede, 2002, Integrating GIS and the Global Positioning System, ESRI Press
3. N.K.Agrawal Essentials of GPS, Spatial Network Pvt Ltd 2004
4. Sathish Gopi , GPS and Surveying using GPS

PAPER-1.4 (Practicals) GLOBAL POSITIONING SYSTEM

List of Practical

1) Introduction to Leica GPS and initial setting

2) Creating codes and attribute table is Leica GPS receiver

3) Point Data collection using GPS with different datum

4) Line data collection using GPS and measurements

5) GPS data collection for area calculation

6) GPS Data collection in DGPS mode.

7) Leica Post Processing – Introduction

8) Post processing of the GPS data

9) Creating attribute table in Leica pro software and Export functions.

10) GPS and GIS integrations output preparation

PAPER-1.5: COMPUTER PROGRAMMING

Section - A

BASICS OF COMPUTING

Principles of computing, Generation of computers, Computer System Architecture – Basic Computer organization, CPU, ALU, I/O Units, CU, Types of memory (RAM, ROM), Binary Digits, Boolean Algebra

INTRODUCTION TO PROGRAMMING

Basic concepts, program constructions – flowcharts, algorithms, pseudo codes, data structures – stacks, queues, linked lists etc., approaches to programming – top-down, bottom-up approach, divide & conquer, modular programming

PROGRAMMING LANGUAGES

Procedural and object oriented programming, evaluation of programming languages, constants, expressions, evaluation strategy of expressions, statements, scope and life of variables, modules, subprograms, parameter passing, types and type casting, HLL, LLL, 4GL

Section - B

BASICS OF C LANGUAGE

C Fundaments, data types, variables, constants, operators, expressions, statements, control structures, C preprocessors,

C WITH FUNCTIONS AND POINTERS

Functions, passing parameters to functions, recursive functions, (Arrays 1-Dimensional and 2-Dimensional), Concepts of Pointers, strings

C WITH USER DEFINED DATA STRUCTURES

User defined data structures – enumerators, unions & structures, File handling (sequential & random files)

Section - C

VISUAL BASIC 6.0 LANGUAGE

Fundaments VB concepts, data types, variables, constants, operators, expressions, statements, control structures, arrays, functions, Integrated development environment (IDE), MDI, OLE, ActiveX controls, object oriented programming in VB. Customization: definition, types of customization, need of customization, customization using VB.

TEXT BOOKS:

1. E Balaguruswamy " Programming in ANSI C " TMH 2nd Edition 2000
2. Rajaraman Y., "Fundamentals of Computers", Prentice Hall of India, New Delhi, 1999.
3. Mohmmed Azam " Programming with VB 6.0 ",Vikash Publishing House Pvt. Ltd.
4. Evangelos Petroutsos "Mastering Visual Basic 6.0" , BPB Publications, Edition 1998

REFERENCE BOOKS:

1 Yashwant Kanetkar, "Let us C", BPB Publications, 2001

2 Peter Norton and Michael Groh, "Guide to Visual Basic 6", Techmedia, SAMS, Seventh Edition

3 R G Dromey, "How to solve it by Computer", PHI, Edition 1999

4 Scott Warner, "Teach Yourself Visual Basic 6.0", TMH, 1999.

5 MSDN digital library

PAPER-1.5 (Practicals) COMPUTER PROGRAMMING

List of Practical -

Lab 1. Introduction to computers & programming concept

Lab 2. Programming using concepts of variables, operators

Lab 3. Programming using control structures

Lab 4. Programming using functions and arrays

Lab 5. Programming using strings

Lab 6. Programming using data structure

Lab 7. Programming using file handling

Lab 8. Creation of forms and using control variables

Lab 9. Creating menus in forms

Lab 10. Developing application package

Lab 11. Creation of execution packages

Lab 12. Connecting with database

Lab 13. Adding maps in VB Projects

Lab 14. Adding database of maps in the projects

SECOND SEMESTER

PAPER-2.1 SPATIAL DATABASE SYSTEMS, ANALYSIS AND MODELING

Section - A

INTRODUCTION

Introduction to Database System: Definition, purpose, data abstraction, instances, schema, DDL, DML, database manager, database administrator, and basic concepts of entity, relationship and primary key. Basic components of computers, Hardware, Software requirements for GIS Processors, Internet, Operating Systems, Programming languages

SPATIAL DATABASE

GIS and Remote Sensing data, Formats & exchange etc: Image storage formats, Data retrieval & Data compression techniques. Data Structures: Geographical data; spatial & non spatial, geographical data in computers, Data Models: Spatial data Model – (i) Cartographic Map model – Raster structure, Quadtree Tassellation (ii) Georelational Model – Vector Data structure, Advantages & Disadvantages of Both

Data base structure: Non spatial: Hierarchical structure, Network structure, Relational Structure ,Spatial Data Bases: Hybrid Data Model, Integrated Data Model. Spatial Data and Data in Thematic Layers, Spatial data in GIS using a Raster data model, Description of spatial data, structures used in GIS, Methods of recording and assessing the quality of spatial data

Section - B

SPATIAL DATABASE CREATION AND EDITING

Creating and Editing Geodatabase Features, Creating and Editing Linearly Referenced Features, Creating, Editing and Managing Geo-databases, Surface analysis

SPATIAL DATABASE QUALITY

Data Quality and Errors in GIS: Nature of geographic data – types of uncertainty in a GIS,.Sources of Errors in GIS data base: Obvious sources from natural variations & original measurements, Errors through processing, errors associated with overlaying of polygons, Data Quality parameters: Positional accuracy, Attribute accuracy, Logical consistency, Completeness Lineage. Handling Errors in GIS,,Normalization in GIS,Levels of Measurements: Nominal, Ordinal, Ratio and Interval Advantages of RDBMS over DBMS

Section - C

DATA RESOURCES AND APPLICATIONS

GIS applications available today, Implications of using spatial data/information, Technological developments in GIS, GIS resources on local and global networks, Number of models, Application of 3-dimensional data in geographical analysis, Role of spatial statistics and related to GIS techniques

SPATIAL DATA ANALYSIS

Data Manipulation Techniques, Overlay Operations and Buffering, Neighborhood functions, Interpolation methods, Factors and Weights, Visibility Elevation Model (DEM) generation, Methods of Spatial analysis. Sapatial Modeling:

Introduction to Modeling & Flowcharting, Map Algebra - Operators & Operations, Functional Operations, Modeling Essentials, Spatial interaction models, Conceptualizing the Model, Model Formulation, Single Criteria vs. Multiple Criteria, Decision-Making, Conflict Resolution and Prescriptive Modeling, Model Verification

TEXT BOOKS

1) Principles of Geographical Information Systems. Oxford University Press, New York Burrough, Peter A. and Rachael McDonnell. 1998.
2) Fundamentals of Spatial Information Systems. Academic Pr., London Laurini, Robert, and Derek Thompson.
3) Spatial Interaction Models: Formulations and Applications. Kluwer Fotheringham A S, O'Kelly M E.
4) Goodchild, M.F. (1978) - Statistical Aspects of the Polygon Overlay Problems, in Harvard papers on GIS, Ed. G. Dulton, Vol. 6, Addison Wesley, Reading Press.
5) Mac Donald, A. 1999, Building a Geodatabase, Redlands CA: ESRI Press.

REFERENCE BOOKS

1) Geographical Information Systems. Principles, Techniques, Applications and Management. John Wiley & Sons, Paul Longley, Michael Goodchild, David Maguire and David Rhind: (Editors).
2) Sanghavi, Hitesh (1998) Oracle Miracles, Express computers methods, 1998.
3) Samet, H. 1990, The Design and Analysis of Spatial Data Structures, Addison–Wesley.
4) A. Silberschats, Henry F. Korth "Database System Concepts", 3rd Edition, TMH, 1998
5) Bonham Carter G.F (1994) GIS for Geoscientists: Modeling with GIS Pergamon Publications.

PAPER-2.1 (Practicals) SPATIAL DATABASE SYSTEMS, ANALYSIS AND MODELING

List of Practical -

1.	Concept of entity and relationship.
2.	Creation of Tables
3,4 and 5.	Concept of SQL
6.	Performing various actions over table
7.	Merging of tables by using primary key
8.	Maintaining database

PAPER-2.2: DIGITAL IMAGE PROCESSING

Section - A

INTRODUCTION

Concepts about digital image and its characteristics, Spectral, Spatial, Radiometric and Temporal resolution, Visual vs. Digital methods, Image data storage and retrieval, Types of image displays and FCC

BASIC PRINCIPLES

System design considerations , Sources of image degradation - Image restoration and Noise abatement , Radiometric and Geometric correction technique, Interpolation methods – linear and nor linear transformation for geometric corrections

Section - B

IMAGE ENHANCEMENT

Look-up Tables (LUT) and Image display, Radiometric enhancement techniques, Spatial enhancement techniques, Contrast stretching: Linear and non-linear methods

FILTERING TECHNIQUES

Low Pass Filtering: Image smoothing, High Pass Filtering: Edge enhancement and Edge detection , Gradient filters , Directional and non-directional filtering

MULTI-BAND ENHANCEMENT TECHNIQUES

Band ratio, Types of Vegetation indices, Principal Component Analysis, Multi dated data analysis and Change detection

Section - C

PATTERN RECOGNITION

Concept of Pattern Recognition, Multi-spectral pattern recognition, Spectral discrimination, Signature bank, Parametric and Non-Parametric classifiers, Unsupervised

classification methods, Supervised classification techniques, Limitations of standard classifiers

ADVANCED TECHNIQUES

Artificial Intelligence, Fuzzy logic, Neural Networks, Expert systems, Hyperspectral remote sensing, Image compression

TEXT BOOKS:

1) Sabins, Floyd F., Remote Sensing: Principles and Interpretation, H. Freeman and C., New York.
2) Thomas M. Lillesand & Kiefer, Ralph W., Remote Sensing and Image Interpretation, John Wiley & Sons, New York.
3) Jensen, JR., Remote Sensing of the Environment – An Earth Resources Perspective, Prentice Hall Inc.

REFERENCE BOOKS:

1) Rencz, Andrew N. (Ed), Remote Sensing for the Earth Sciences: Manual of Remote Sensing, 3rd ed., John Wiley & Sons, Inc., New York.
2) Curran, P., Principles of Remote Sensing, Longman, London.
3) Campbell, James B., Introductory Remote Sensing: Principles and Concepts, Routledge.
4) Gibson, P.J., Introduction to Remote Sensing, 2nd ed., Taylor & Francis, London.
5) Cracknell, A.P. & Hayes, L.W B., Introduction to Remote Sensing, Taylor & Francis, London.

PAPER-2.2 (Practicals) DIGITAL IMAGE PROCESSING

List of Practical –

1 Introduction to ERDAS IMAGINE 8.5

2 Study of the marginal information given on the C.D. Rom/Digital data

3 Import / Export of files using ERDAS IMAGINE 8.5

4 Geo-reference of the toposheet and imageries

5 Display, Analysis and interpretation of black & white images and FCC

6 Study of the various contrast enhancement techniques

7 Low Pass Filter: Compression of the high frequency component & enhancement of the low frequency component

8 High Pass Filter: Compression of the low frequency component and enhancement of the high frequency component

9 Sub-setting of area of interest from the satellite image

10 Principal Component Analysis

11 Resolution Merging

12 Unsupervised Classification

13 Supervised Classification

14 Map composition

PAPER-2.3 SPATIAL DECISION SUPPORT SYSTEMS

Section - A

INTRODUCTION

GIS and decision support systems , SDSS Definition and characteristics , Introduction to decision making process and decision support systems , Introduction of a frame work for planning and decision making , Spatial Decision Making

SDSS Architecture

DATABASE MANAGEMENT

Database management system, Model based management system, Graphical and tabular report generator, User interface

Section - B

ANALYSIS AND DECISION MAKING

Principles and components of multiple-criteria decision making , Main multiple-criteria evaluation methods/techniques

Spatial multiple criteria decision making , Multiple-criteria decision making in spatial data analysis ,

Spatial multiple criteria evaluation in planning and decision making

TECHNOLOGY AND DEVELOPMENT

Development of DSS, Technology levels, Functions and roles, Status of SDSS

Section - C

INTERFACE DEVELOPMENT

Interface development GUI, Tools, Programming languages, Spatial and Non Spatial analysis Modelling

SDSS APPLICATIONS

Micro level planning, Spatial Multimedia techniques, Case studies

PLANNING AND EXECUTION

Planning, User assessment, Capacity building, Modern planning and management

TEXT BOOKS

1) Bonczek, R.H., C.W. Holsapple, and A.B. Whinston, 1981. Foundations of Decision Support Systems, Academic Press, New York. Basic text on DSS.
2) Geoffrion, A.M., 1983. "Can OR/MS evolve fast enough?" Interfaces 13:10. Source for six essential characteristics of DSS.
3) House, W.C. (ed.), 1983. Decision Support Systems, Petrocelli, New York. Basic DSS text.
4) Sprague, R.H., 1980. "A framework for the development of decision support systems," Management Information Sciences Quarterly 4:1-26. Source for DSS development model.
    1. Sprague, R.H., and Carlson, E.D., 1982. Building Effective Decision Support Systems, Prentice-Hall, Englewood Cliffs NJ. Basic DSS text.

PAPER-2.4 RESEARCH METHODOLOGY & PROJECT MANAGEMENT

Section - A

Problems of GI research. Identification of problems of regional and Locale level, geographic data sources and natures of data to be used. Hypotheses and Models, Formulation of research schemes.

Preparation of research projects and writing of reports, Preparation of field reports, spatial data, classification and sampling problems. Need for sampling, types of sampling, sample size, sampling area.

Section - B

Project Definition, Importance of Projects and Project Management, Project Management context. Basics of project management, Project formulation, Time management, Budget estimates, Cost-benefit calculation techniques

Project bidding, Project plan, Task Definition, Project Resource, Scheduling, line Management, Project Team.

Section – C

Managing the Projects Activities, Project Administrator, Classification of Projects. Product Management, Problems and opportunities in Projects.

Tools & Methods: Project Communications and Presentation, Project Management Software, Project Administration.

Evolution, Revolution, & Termination of Project, Project Change, End of Projects, Project report preparation.

TEXT BOOKS:

1 W.E. Huxold & A.G. Lerinsons Aronoft.S.(1989) Managing Geographic Information Projects.

2 Earickson, R,. and Harlin, J. (1994) Geographic Measurement & Quantitative Analysis Macmillan, N.York

REFERENCE BOOKS:

1. Bennet P. Lientz & Kathryn P. (1995) Project Management for the 21st Century Academic Press, California

PAPER-2.5 APPLICATIONS OF REMOTE SENSING

Section – A

Introduction: Emergence of Remote Sensing technology in application areas, understanding potentials of Remote Sensing in allied sectors, Remote Sensing advantage over conventional techniques. Indian satellite missions with focused applications, Recent trends in Remote Sensing applications.

Application in Land Resource: Remote sensing in mapping soil degradation, impact of surface mining on land resources, forest resources.

Application in Water Resources: Remote sensing in hydrogeomorphological interpretation for groundwater exploration, water quality monitoring, reservoir sedimentation, snow cover mapping and modeling approaches.

Section - B

Application in Disaster Management: Mapping and modeling Landslide hazards, floods, Cyclones Forest fire and drought.

Application in Urban Planning: Mapping urban landuse, transportation network, Utility-Facility mapping, urban sprawl, site selection for urban development, Urban Information System

Section - C

Application in Geo-technical Engineering: Slope stability and drainage network analysis, Digital Terrain Modeling, Geoinformatics in Dam site selection, Highways, and Tunnel Alignment studies.

Application in Environmental Management: Selection of disposal sites for industrial and municipal wastes, solid waste management, Environmental Impact Assessment (EIA)

TEXT BOOKS:

Schultz, G. A. and Engman, E. T. 2000. Remote Sensing in Hydrology and Water Management, Springer-Verlag, Berlin, Germany.

Lillisand, T. M. and Keifer, R. W. 1994. Remote Sensing and Image interpretation', John Willey and Sons, New York, Third Edition

Jenson, J.R. 2000. Remote Sensing of the environment – An Earth Resource Perspective, Prentice Hall Inc.

P.S. Roy (2000). Natural Disaster and their mitigation. Published by Indian Institute of Remote Sensing (IIRS), 2000.

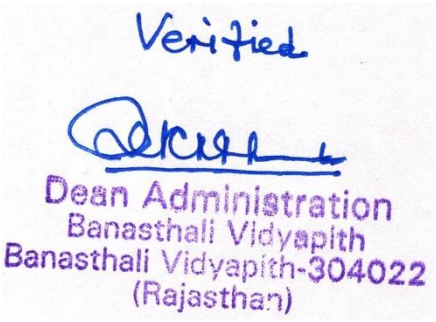
REFERENCE BOOK:

Spatial Technologies for Natural Hazard Management. Proceedings of ISRS National Symposium, Nov. 21-22, 2000, IIT, Kharagpur.

PAPER-2.5 (Practicals) REMOTE SENSING APPLICATIONS

List of Practical -

1. Satellite image based hydrogeomorphological interpretation for ground water targeting.
2. Open cast mining impacts on land resources using satellite images.
3. Mapping flood hazards in a region using satellite images
4. Mapping landslide hazards in a region using satellite images
5. Urban sprawl mapping of a township using satellite images
6. Utility-facility mapping for regional development analysis in GIS
7. Application of Remote Sensing for identification of waste disposal sites.
8. Digital terrain models for selection of dam site and road infrastructure.



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).**

BANASTHALI VIDYAPITH

SCHOOL OF EARTH SCIENCES

MASTER OF TECHNOLOGY (REMOTE SENSING)

Annexure- 13

Name ofProgramme: M. Tech. (Remote Sensing)

Programme Educational Objectives:

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

Realizing the potential of Remote Sensing Technology in Natural Resource management, Banasthali Vidyapith, took the lead in establishing the first Remote Sensing M.Tech. Programme for Women in India to cater the human resource development in scientific field of remote sensing. M.Tech. students carried out their dissertation research at various esteemed institutions and multinational industries, i.e., ISRO, DRDO, and NIH.

The M.Tech. Remote Sensing programme offers a flexible and complete education in the field of Remote Sensing technology and Geoinformatics. Students will comprehend the major Earth surface imaging systems and Geomatics based research & development. The integrated Remote Sensing technology plays a major role in natural resource management and develops multidisciplinary research environment.

The main objectives of the M.Tech. Remote Sensing programme are:

- **To strengthen the ability for assessing and solving the real-time geospatial problems.**
- **To inculcate skills for developing realistic solutions to the challenges of emerging field of earth observation technology.**
- **To provide an adequate professional and technical environment that assists both in academia and industries**
- **To acquire skills in leaning modern earth observation techniques such as SAR, hyper-spectral, thermal and LiDAR scanning for mapping, modeling and monitoring.**
- **To prepare students for solving complex engineering problems by using innovative research.**

Programme Outcomes (PO)

PO1: Remote Sensing Knowledge: Describe the standard principle and concepts of advance 'Earth Observation' (EO) Technologies that ensure the effective use of Geoinformatics based generic applications to solve concurrent global and regional environmental problems.

PO2: Problem Analysis: Formulate robust, generic and ubiquitous research methodologies and approaches based on 'close-to-far' range remote sensing technology to resolve issues associated with natural resources.

PO3: Design/Development of Solutions: Develop and distribute free tools and realistic solutions based on Geoinformatics that can assist in natural resource management, environmental resiliency and infrastructure to expedite information sharing, which can be adapted and tailored to societal needs.

PO4: Conduct investigations of complex problems: Implement the Geoinformatics based operational research methods and optimization techniques in the extension of Geospatial policy for both academia and industrial arena. Share professional acumen to provide intellectual solutions for the complex geospatial problems with valid conclusions.

PO5: Modern tool usage: Construct, relate, and implement suitable geospatial techniques, industrialized resources, and cutting-edge Information Technology (IT) tools to forecast and modeling to manifold engineering activities with generous societal benefits.

PO6: Remote Sensing professionals and society: Implement the contemporary technical information and improved understanding of mapping sciences to encourage the development of responsible societal applications of Remote Sensing, Geographical Information Systems (GIS) and associate technologies.

PO7: Environment and sustainability: Perceive and relate the acceleration and impact of earth observation science, resource use, which increased the urgency to obtain quantitative, timely information about the environment at a variety of scales in space and time.

PO8: Professional ethics: Identify the significance of transparency in sharing of geospatial information in terms of a national policy to ensure data availability, accessibility, and quality to meet development goals of national mapping and imaging agencies, in accordance with issues associated to national security and intellectual integrity.

PO9: Individual and team work: Contribute as a team leader as well as individual in multi-disciplinary research groups in order to achieve common goals. Offer rational decisions based on objectivity to solve complex geospatial problems.

PO10: Communication: Empathize with relative arguments derived by the professionals during execution of the various global technological events. Create, design and disseminate effective reports, scientific articles and deliver presentations from different platforms.

PO11: Project management and finance: Demonstrate considerate interactions and knowledge of the remote sensing technology in real-time project management. Implement principles of project management into fields of applied remote sensing and interdisciplinary environments.

PO12: Life-long learning: Develop an attitude to ensure independent learning with value-added motivation in promptly changing scenario of global technical competence. Retain life-long intellect based on attained technological skills for sustainable development.

Programme Scheme:

Semester I

Existing					
CourseCode	**Course Name**	**L**	**T**	**P**	**C**
RS502	Applied Statistics and Research Methodology	4	0	0	4
RS504	Fundamentals of Geographic Information Sciences and Digital Cartography	4	0	0	4
RS505	GIS Programming and Scripting	4	0	0	4
RS506	Microwave, Thermal and Hyperspectral Remote Sensing	4	0	0	4
RS508	Principles of Remote Sensing	4	0	0	4
RS502L	Applied Statistics and Research Methodology Lab	0	0	2	1
RS504L	Fundamentals of Geographic Information Sciences and Digital Cartography Lab	0	0	4	2
RS505L	GIS Programming and Scripting Lab	0	0	2	1
RS506L	Microwave, Thermal and Hyperspectral Remote Sensing Lab	0	0	2	1
RS508L	Principles of Remote SensingLab	0	0	2	1
	Total:	**20**	**0**	**12**	**26**

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
RS504	**Fundamentals of Geographic Information Sciences and Digital Cartography**	**4**	**0**	**0**	**4**
RS508	**Principles of Remote Sensing**	**4**	**0**	**0**	**4**
RS__L	**Remote Sensing Lab-I**	**0**	**0**	**6**	**3**
RS__L	**Remote Sensing Lab-II**	**0**	**0**	**6**	**3**
	Discipline Elective I	**4**	**0**	**0**	**4**
	Discipline Elective II	**4**	**0**	**0**	**4**
RS__	**Term Paper-I/Minor Project-I/Seminar-I**	**0**	**0**	**8**	**4**
	Total:	**16**	**0**	**20**	**26**

Semester II

Existing					
CourseCode	**Course Name**	**L**	**T**	**P**	**C**
RS501	Applications of remote sensing	4	0	0	4
RS503	Digital image processing	4	0	0	4
RS507	Photogrammetry, Global Positioning System and mobile mapping	4	0	0	4
RS509	Spatial database systems, analysis and modeling	4	0	0	4
RS510	Spatial decision supports systems	4	0	0	4
RS501L	Applications of remote sensing Lab	0	0	2	1
RS503L	Digital image processing Lab	0	0	4	2
RS507L	Photogrammetry, Global Positioning System and mobile mapping Lab	0	0	2	1
RS509L	Spatial database systems, analysis and modeling Lab	0	0	4	2
	Total:	**20**	**0**	**12**	**26**

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
RS503	**Digital Image Processing**	4	0	0	4
RS507	**Photogrammetry, Global Positioning Systems and Mobile Mapping**	4	0	0	4
RS__L	**Remote Sensing Lab-III**	**0**	**0**	**6**	**3**
RS__L	**Remote Sensing Lab-IV**	**0**	**0**	**6**	**3**
	Discipline Elective III	**4**	**0**	**0**	**4**
	Open Elective	**4**	**0**	**0**	**4**
RS__	**Term Paper-II/Minor Project-II/Seminar-II**	**0**	**0**	**8**	**4**
	Total:	**16**	**0**	**20**	**26**

Semester III

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
	Reading Elective-I	0	0	4	2
RS603P	Project (Part-I)	0	0	48	24
	Total:	**0**	**0**	**52**	**26**

Proposed					
CourseCode	**Course Name**	**L**	**T**	**P**	**C**
	Reading Elective I	0	0	0	2
RS603P	Project (Part I)	0	0	48	24
	Total:	**0**	**0**	**48**	**26**

ReadingElective I

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
~~RS601R~~	~~Geoinformatics in Human Settlement Analysis~~	0	0	4	2
~~RS602R~~	~~Pattern Recognition and Processing~~	0	0	4	2
~~RS605R~~	~~Remote Sensing in Environment Studies~~	0	0	4	2

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**

SemesterIV

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
	Reading Elective-II	0	0	4	2
RS604P	Project (Part-II)	0	0	48	24
	Total:	**0**	**0**	**52**	**26**

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
	Reading Elective II	0	0	0	2
RS604P	Project (Part II)	0	0	48	24
	Total:	**0**	**0**	**48**	**26**

Reading Electives II

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
~~RS606R~~	Remote Sensing in hydrology and Water Resources	0	0	4	2
~~RS607R~~	~~Remote Sensing in Resource Management~~	0	0	4	2
~~RS608R~~	~~Spatial Modeling and Resource Model~~	0	0	4	2

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**

List of Discipline Electives

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
RS___	Applications of Remote Sensing	4	0	0	4
RS	Applied Statistics and Research Methodology	4	0	0	4
RS ___	**Geospatial Entrepreneurship**	4	0	0	4
RS___	**Geospatial Intelligence**	4	0	0	4
RS___	GIS Programming and Scripting	4	0	0	4
RS___	Microwave, Thermal and Hyperspectral Remote Sensing	4	0	0	4
RS___	Spatial Database Systems, Analysis and Modeling	4	0	0	4
RS	**Spatial Decision Supports Systems**	4	0	0	4

List of Reading Electives

Existing					
Course Code	**Course Name**	**L**	**T**	**P**	**C**

Proposed					
Course Code	**Course Name**	**L**	**T**	**P**	**C**
RS___R	**Environmental Remote Sensing and Modeling**	**0**	0	0	2
RS___R	**Geo-informatics for Resource Management**	**0**	0	0	2
RS___R	**Geospatial BigData: Challenges and Opportunities**	**0**	0	0	2
RS___R	**Open Source Software, Services and Utility Application**	**0**	0	0	2
RS___R	**Remote Sensing in Hydrology and Water Resources**	**0**	0	0	2
RS___R	**Spatial Planning and Urban Development**	**0**	0	0	2

Note:

Semester I

Introduction of Discipline electives and Term Paper –I/Minor Project-I/Seminar-I .

RS502L Applied Statistics and Research Methodology Lab has been removed.

RS508L Principles of Remote SensingLab and RS506L Microwave, Thermal and Hyperspectral Remote Sensing Lab has been combined in Remote Sensing Lab-I

RS504L Fundamentals of Geographic Information Sciences and Digital Cartography Lab and RS505L GIS Programming and Scripting Lab has been combined in Remote Sensing Lab-II

Semester II

Introduction of Discipline elective, open elective and Term Paper –II/Minor Project-II/Seminar-II.

RS503L Digital image processing Lab and RS501LApplications of remote sensing Lab has been combined in Remote Sensing Lab-III

RS507L Photogrammetry, Global Positioning System and mobile mapping Lab and RS509L Spatial database systems, analysis and modeling Lab has been combined in Remote Sensing Lab-IV

Semester III

RS601R Geoinformatics in Human Settlement Analysis has been replaced by new course RS___R Spatial Planning and Urban Development

RS602R Pattern Recognition and Processing has been replaced by new course RS___R Geospatial BigData: Challenges and Opportunities

RS605R Remote Sensing in Environment Studies has been replaced by new course RS___R Environmental Remote Sensing and Modeling

Semester IV

RS607R Remote Sensing in Resource Management has been replaced by new course RS___R Geo-informatics for Resource Management

RS608R Spatial Modeling and Resource Model has been replaced by new course RS___R Open Source Software, Services and Utility Application

Pool of Reading electives has been introduced in III and IV semester

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

BANASTHALI VIDYAPITH

SCHOOL OF EARTH SCIENCES

MASTER OF TECHNOLOGY (REMOTE SENSING)

Annexure-14

Name of Programme:M. Tech. (Remote Sensing)

Course Details:

FIRST SEMESTER

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	**RS-~~502:~~ Applied Statistics and Research Methodology**	**After the completion of this course, students should be able to:** • **Formulate research problems using geo-statistical methods.** • **Apply statistical knowledge to the geospatial variability.** • **Define research problems and selection of survey methods.** • **Writing project proposal for various funding**	**Section A** **DATA DISTRIBUTION AND BASIC STATISTICS** Scope and importance of statistics, Source of data-primary and secondary, Collection of data-sampling methods; Random and systematic method; Organization of data-array, Frequency, Class intervals, Histograms, and distribution, Presentation of data-Tables, Diagrams; Geometric form (Bar diagrams, Pie-diagrams), Frequency diagrams (histogram, polygon), Arithmetic line graphs (time series graph); Data grouping, Geographical data- Discrete and continuous series, Scales of measurement, Measures of central tendency-Mean, Median, Mode, Quartiles, Arithmetic mean, Geometric mean, Harmonic mean, Quadratic mean and their interrelated relations; Measures of dispersion-Absolute dispersion (range, quartile deviation, mean deviation, standard deviation); Relative dispersion (Coefficient of quartile deviation, Coefficient of variation), Moments, Skewness, Kurtosis **Section B** **CORRELATION, PROBABILITY AND HYPOTHESIS TESTING** Correlation-meaning, Scatter diagram, standard deviation, Variance, Measures of Correlation-Karl Pearson's method (Two variables ungrouped data) Spearman's rank correlation methods.	**Discipline Elective**	**This course has been shifted from core course of I semester to elective Pool**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		agencies.	Probability-Binomial, Normal, and Poisson distribution; Theory of Sampling - Sampling distributions of means and proportions, Standard errors, Confidence interval estimation for population means, Standard deviations, Testing of Hypothesis – Large and small sample test. **BASIC CONCEPT OF RESEARCH METHODOLOGY** Definition of Research Problem, Identification of problems of regional and Local level, Considerations in selection of problem, Research process, Review of literature, Research objectives and research questions, Research scheme/design. **Section C** **DATA COLLECTION, ANALYSIS AND REPORTS** Methods of data collection, Survey methods, Samples-Type and methods, Data processes and analysis, Reporting of results, References, Future scope of work. **PREPARATION OF RESEARCH PROJECTS** Writing of proposals, Objectives of project, Research hypothesis and design, Research Questions, Scope of project, Brain storming sessions, Finalization of methodology, Review of similar studies and present level of research, Time scheduling (PERT), Financial estimates, Submission of Proposal. Project planning, Project activities/tasks, Feasibility, Resource requirements and allocation, Project management software, Project review, Project Completion-Quality assurance, Evaluation of individual tasks, Financial auditing, Problems and opportunities in Projects. ~~**TEXT BOOK**~~ ~~T1 Paul L. Meyer: Introductory Probability and Statistical Applications, Addison Wesley~~ ~~T2 Gupta. S. C. and Kapoor. V. K., 2000," Fundamental of~~		

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			~~Mathematical Statistics" S Chand Publication, New Delhi~~ ~~T3 CR Kothari, 2004, Research Methodology Methods and Technique, New Age International Pvt Ltd. New Delhi~~ ~~T4 S L Gupta and Hitesh Gupta, 2011 Research Methodology Text and Cases with SPSS Applications, International book House Pvt. Ltd., New Delhi.~~ ~~**REFERENCE BOOKS**~~ ~~R1 Murray R. Spiegel, (1981), Theory and Problems of Statistics, Schaum's Outline Series~~		
2.	**RS 504: Fundamentals of Geographic Information Sciences and Digital Cartography**	**After the completion of this course, students should be able to:** • **Differentiate GIS and science of map making, non-spatial vs. spatial data.** • **Georeference the Topomaps and imagery and handle geospatial database.** • **Describe concepts of**	**Section A** **FUNDAMENTAL GEOGRAPHIC CONCEPTS FOR GIS** Basic concepts about spatial information: Brief history and definition of GIS, Manual mapping Vs GIS mapping, Geometrical feature and real word Pictures, Variables- Points, Lines and Areas, Network and Surface, Application and Trends of GIS including Desktop GIS, Mobile GIS, Web GIS. Basic Objectives and Component of GIS – details of hardware, software and management **MAP AND MAP PROJECTION** Basic Concept, Categories of maps, Interpretation of topographic maps, Coordinate system, Polar and Cartesian, Map projections, Grouping of map Projections-Conical projection, Cylindrical projection, Azimuthal Projection; Mercator, Transverse Mercator, Polyconic, Lambert and UTM. **GEOGRAPHICAL DATA, MODEL AND DATA INPUT**	**Section A** **Fundamental Geographic Concepts For GIS** Basic concepts about spatial information: Brief history and definition of GIS, Manual mapping Vs GIS mapping, Geometrical feature and real word Pictures, Variables- Points, Lines and Areas, Network and Surface, Application and Trends of GIS including Desktop GIS, Mobile GIS, Web GIS. Basic Objectives and Component of GIS – details of hardware, software and management **Map and Map Projection** Basic Concept, Categories of maps, Interpretation of topographic maps, Coordinate system, Polar and Cartesian, Map projections, Grouping of map Projections-Conical projection, Cylindrical projection, Azimuthal Projection; Mercator, Transverse Mercator, Polyconic, Lambert and UTM. **Geographical Data, Model and Data Input**	**The learning outcomes and Suggested e-learning material have been reviewed.** **The topics of DBMS concepts to fill the gap is added and the generalization of topics is added to cover the**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		database management system within spatial analytical framework. • **Design and frame initial requirements for WebGIS development.**	Conceptual models of real world phenomena, Geographical data models; Fundamentals of data storage: entities or Fields, Introduction to database system: Definition, Purpose, Data abstraction, Instances, Schema, DDL, DML, database manager, RDBMS~~, Relationship and primary/secondary/composite key.~~ Information organization and data structure; Basic file structures, Tabular databases, Advantages of databases, Types of Databases-Hierarchical systems, Network systems, Relational systems and Object-oriented database systems (OODS); Data models - Entity relationship model, Relational model **Section B** **SPATIAL DATA INPUT AND EDITING** Spatial and Non-spatial data base, spatial data model: Geo relational Vector data model, Object based vector data model, Geodatabase, Raster data model, Hybrid relational database Vs Object orientation. Comparative analysis of spatial database, GIS data Requirement, sources and collection, Methods of data capture-scanning, digitization and associated errors; Conversion from other digital Sources, Attribute data input and management, creating digital data-remote sensing; GPS; data exchange; generating data from existing data; metadata; Different kinds of geospatial data, ~~Detecting and evaluating errors,~~ Topological relationships; Creation of topology and error correction; Edge matching, Data quality measurement and assessment, Digital output options. **DATA STORAGE, INTEGRATION AND MANAGEMENT** Data retrieval; Data compression; ~~Thematic mapping;~~ GIS and integration of other types of data; GIS and Remote Sensing data Integration, Image storage formats, ~~Types of uncertainty in a GIS,~~Sources of errors in GIS database: Errors through processing, Errors associated with overlaying of polygons, ~~Data quality parameters: Positional accuracy, Attribute accuracy, Logical consistency, Completeness lineage, Handling errors in GIS,~~ Survey of	Conceptual models of real world phenomena, Geographical data models; Fundamentals of data storage: entities or Fields, **Information organization and data structure; Basic file structures, Tabular databases,** Introduction to database system: Definition, Purpose, Data abstraction, Instances, Schema, **Database Languages,** database manager, RDBMS**, keys.** Advantages of databases, Types of **Data Model**-Hierarchical systems, Network systems, Relational systems and Object-oriented database systems (OODS); Entity relationship model, **Attribute data query, SQL** **Section B** **Spatial Data Input and Editing** Spatial and Non-spatial data base, spatial data model: Geo relational Vector data model, Object based vector data model, Geodatabase, Raster data model, Hybrid relational database Vs Object orientation. Comparative analysis of spatial database, GIS data Requirement, sources and collection, Methods of data capture-scanning, digitization and associated errors; Conversion from other digital Sources, Attribute data input and management, creating digital data-remote sensing, GPS; data exchange; generating data from existing data; metadata; Different kinds of geospatial data, **Topological relationships; Creation of topology and error correction,**Edge matching, Data quality measurement and assessment, Digital output options. **Data Storage, IntegrationandManagement** Data retrieval; Data compression; GIS and integration of other types of data ; GIS and Remote Sensing data Integration, Image storage formats, Sources of errors in GIS database: Errors through processing, Errors associated with overlaying of polygons, Survey of available data, Public access to geographic information; Digital libraries, National & Global Standard -	**broader category of components.** **Topics reframed to maintain the contiguity.** **Detail descriptions are added.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			available data, Public access to geographic information; Digital libraries, National & Global Standard - NSDI, GSDI; Global geospatial portals, OGC. **Section C** **INTRODUCTION TO VECTOR DATA ANALYSIS** Logical, Boolean, Arithmetical operation and function, Attribute data query, SQL, Topological relationships; Creation of topology and error correction; Overlay operations (union and intersection), Feature base topological function –buffer, Eliminate, dissolve, Layer based overlay analysis~~: point to polygon, line to polygon~~, clip, erase, split, identity, union and intersection **INTRODUCTION TO RASTER DATA ANALYSIS** Raster Data base and structure, Local operations, Neighbourhood operations, Zonal operations ~~**TEXT BOOKS**~~ ~~T1 Burrough, Peter A. and Rachael McDonnell, 1998, 'Principles of Geographical Information Systems' Oxford University Press, New York.~~ ~~T2 Kang tsung Chang 2002, 'Introduction to Geographic Information Systems' Tata McGraw Hill, New Delhi.~~ ~~T3 C.P. Lo and Albert K.W.Yeung 2005 "Concepts and Techniques of Geographic Information Systems" Prentice Hall of India, New Delhi.~~ ~~**REFERENCE BOOKS**~~ ~~R1 Magwire, D. J., Goodchild, M.F. and Rhind, D. M. Ed. 1991,~~	NSDI, GSDI; Globalgeospatial portals, OGC. **Section C** **Introductionto Vector data Analysis** Logical, Boolean, Arithmetical operation and function, Overlay operations (union and intersection), Feature base topological function –buffer, **point in polygon,** Layer based overlay analysis: **Reclassification, point in polygon, line in polygon, polygon on polygon, (Eliminate, dissolve,**clip, erase, split, identity, union and intersection) **Introduction to Raster Data Analysis** Raster Data base and structure, Local operations, Neighbourhood operations, **Extended Neighbourhood**,Zonal operations. **Recommended Books:** **1. Burrough, P. A., & McDonnell, R. (1998). *Principles of Geographical Information Systems*(3rd ed.). New York, NY: Oxford University Press.** **2. Chang, K.T. (2002). *Introduction to Geographic Information Systems*(3rd ed.). New Delhi, India: Tata McGraw Hill.** **3. Clarke, K. C., Parks,B.O.,&Crane, M. P. (Eds.). (2002). *Geographic Information Systems and Environmental modelling*. New Delhi, India: PHI Learning.** **4. Drummond, J., Billen, R., Joao, E.,& Forrest, D. (Eds.). (2006). *Dynamic and Mobile GIS*. New York, NY:CRC Press.** **5. Harvey, F. (2008). *A Primer of GIS*. New York, NY: The Guilford Press.**	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			~~'Geographical Information Systems: Principles and Applications', Longman Group, U.K.~~ ~~R2 Clarke. Keith C., Parks Bradley O. And Crane Michael P Ed. 2002, "Geographic Information Systems and Environmental modelling, PHI Learning Pvt Ltd, New Delhi~~ ~~R3 Drummond. J., Billen. R., Joao. E., and Forrest. D., Ed 2007, "Dynamic and Mobile GIS" CRC Press, New York.~~ ~~R4 Francis Harvey, 2009 "A Primer of GIS" Rawat Publication, Jaipur~~	**6. Lo, C.P., &Yeung, A. K.W. (2005). *Concepts and Techniques of Geographic Information Systems*(2nd ed.). New Delhi, India: Prentice Hall India Learning.** **7. Magwire, D. J., Goodchild, M.F., &Rhind, D. M. (1991). *Geographical Information Systems: Principles and Applications*. Harlow, England: Longman Scientific & Technical.** **Suggested e-learning materials:** **1. Introduction to GIS** **https://nptel.ac.in/courses/105102015/1** **2. Spatial Analysis** **https://nptel.ac.in/courses/105102015/25** **3. Introduction to geographic information systems, overlaying operations** **https://swayam.gov.in/courses/3691-introduction-to-geographic-information-systems** **4. Digital Elevation Models and Applications** **https://swayam.gov.in/courses/4395-digital-elevation-models-and-applications** 5. **Interpolation** **https://nptel.ac.in/courses/105102015/14**	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
3.	RS-~~505~~: GIS Programming and Scripting	After the completion of this course, students should be able to: • Describe object-oriented models and functional modeling in GIS Framework. • Explain concepts of common language infrastructure and class library. • Explain .NET and Python programming languages for geospatial tool development. • Rationalize the concepts of WebGIS, Server, and geo-processing functionalities.	**Section A** **INTRODUCTION TO OBJECT ORIENTED** Introduction to Object Oriented modelling and Design**;** Definition object oriented (OO), Object modelling Concepts, OO methodology, OO themes, Introduction to OO modelling techniques: Modelling, modelling techniques, object model, Dynamic Model and Functional Model, relationship among models. Object Modelling:Object and Classes: Object modelling concepts in details: links, association, generalization, inheritance, metadata, etc. A sample Object Model**.** Dynamic Modelling:Dynamic modelling concepts. A sample dynamic model, Relation of object and dynamic model with example. Functional Modelling:Functional Modelling Concepts, A sample functional model. **Section B** **. NET FRAMEWORK** Concept of .NET framework, Common Language Infrastructure, Base Class Library and Framework Class Library ~~Understanding Visual Basic .NET terminology - specifications, design, code, test, and document Visual Basic .NET programs - maintenance, repair, and enhance Visual Basic .NET programs - create custom dialog boxes, clocks, menus, and animation effects - manage text files and use encryption and sorting algorithms - master programming fundamentals, including variables, decision structures, loops, and functions~~ **Section C** **PYTHON PROGRAMMING** Introduction to Python, variables, built- in data types, statements and	**Discipline Elective**	**This course has been shifted from core course of I semester to elective Pool .** **The learning outcomes and Suggested e-learning material have been reviewed.** **the content is reframed to enforce the in-depth extends must for learning object-oriented programming skills** **The repeated content is removed to maintain the level of detailing and an essential**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			expressions, strings, lists, python objects. Conditional statements- ~~controlling flow,~~ commenting scripts, Modules and packages, function, classes, Geoprocessing Python Scripts: Importing ArcPy, accessing data, accessing toolboxes, intersection, union and buffering, querying **Web GIS Development** Introduction to Web GIS, Principles, Architecture - Web Server, Map Server and Data Server, Technologies for WebGIS applications, Scripting for serving maps, map editing and geoprocessing functionalities for GIS server ~~**TEXT BOOKS:**~~ ~~T1 Pimpler E., "Programming ArcGIS 10.1 with python cookbook". Packt Publishing.2013~~ ~~T2 Fu P., Sun J., "Webgis principles and applications". ESRI press.2011~~ ~~T3 Zandbergen P.A., "Python scripting for ArcGIS". ESRI Press.2013~~ ~~T4 Zhuang Y., Wrazien D., Wang M., Huang X., "Programming ASP.NET for ArcGIS Server". Thomson. 2005~~		**component for programing logic is introduced.**
4.	**RS ~~506:~~ Microwave, Thermal and Hyperspectral Remote Sensing**	**After the completion of this course, students should be able to:** • **Explain concepts and components of satellite radar imaging.**	**Section A** ~~MICROWAVE REMOTE SENSING~~ Concept of Microwave remote sensing and its components- Wavelength, Frequency and Pulse; Penetration of Radar signals : Skin depth, Azimuth and Range direction, Look angle, Depression angle, Incident angle and Polarization, Slant Range, Ground Range, Range Resolution, Azimuth Resolution, RAR/SLAR and SAR : Concepts, Radar Image geometry: Layover, Foreshortening, Radar Relief Displacement, Speckle and Shadows, Radar Equation, Radar Image interpretation variables : Surface roughness,	**Discipline Elective**	**This course has been shifted from core course of I semester to elective Pool.** **The learning outcomes and**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		• **Explain different microwave sensors data (SLC and GRD) and their characteristics .** • **Describe pre-processing requirements and discuss SAR image processing techniques.** • **Rationalize outlook of SAR, thermal, and hyperspectral images.**	Dielectric properties, Volume Scattering. Backscattering, Radar Interferometry, Application of Microwave remote sensing, Satellite Imaging Radars, Ground Penetration Radar **Section B** **THERMAL INFRARED REMOTE SENSING** Introduction to Thermal IR radiation Properties and Laws: ~~Kinetic Heat, Temperature, Radiant Energy and Flux, Methods of transferring heat,~~ Thermal properties of terrain: emissivity, Thermal capacity, Thermal conductivity, Thermal Inertia, Reflectance to temperature, Geometry of Thermal Images, Thermal IR multispectral scanners and Bands, Thermal Image Interpretation, Application of Thermal IR Remote Sensing. ~~LIDAR~~ ~~LIDAR Principles, LIDAR Profiling, Processing of LIDAR image data, LIDAR Intensity, Types of Imaging LIDAR, Applications of LIDAR~~ **Section C** **HYPERSPECTRAL REMOTE SENSING** History of Hyperspectral Imaging, Spectral Radiometry – Principle, solid angle, Radiance Vs. Reflectance, Spectroscopy- Introduction, reflectance spectroscopy, absorption processes – charge transfer, electronic & vibrational, Spectral library- concept, parameters controlling the spectra-spectral range, bandwidth, FWHM, spectral sampling, S/N ratio, BRDF, Illumination; continuum, Imaging Spectrometers, sensors – airborne &spaceborne. ~~**TEXT BOOKS:**~~		**Suggested e-learning material have been reviewed.** **Unit heading is modified with adequate relevance with course content** **Content is reordered by adding significant inescapable fundamentals and introductory part of advanced technical headings associated with GPR and Radar Imaging.** **Newly added content/topi**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			~~T1 Woodhouse, I.H., 2006, 'Introduction to Microwave Remote Sensing' CRC Press.~~ ~~T2 Jensen, J.R., "Remote Sensing of the Environment An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi, 2000.~~ ~~T3 George Joseph, "Fundamentals of remote sensing", Universities press (India) Pte Ltd., Hyderabad, 2003.~~ ~~T4 Campbell J.B., Wynne R.H., "Introduction to Remote Sensing", T5 BorengasserM., HungateW.S., Watkins R. "Hyperspectral Remote Sensing: Principles and Applications", CRC Press.2007~~ ~~T6 Thenkabail P.S., Lyon J.G., Huete A. "Hyperspectral Remote Sensing of Vegetation ", CRC Press.2011~~		**cs are required for underpinning the essential component for further research** **work in microwave imaging based earth observations .** **Necessary technical contents are added that strengthen the fundamental as well as methodological approach for temperature retrieval using satellite imaging.** **The**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
					LiDARrelated topics are shifted to the DIP course of the second semester of M.Tech. RS, accordingly. **Topics are reorganized accordingly.**
5.	**RS 508: Principles of Remote Sensing**	**After the completion of this course, students should be able to:** • **Explain fundamental principles of earth observation or imaging.** • **Differentiate various earth imaging satellites and sensors.** • **Know the appropriate use of aerial**	**Section A** **BASIC PRINCIPLES AND EMR RESPONSE** Definition of Remote Sensing: advantages and limitations, Electro-Magnetic Radiation (EMR)- spectrum properties, wavelength regions and their applications, Atmospheric interferenceand Atmospheric windows, Interaction of EMR with matter, Fundamentals of Radiometry: concept & laws, radiance, reflectance, Spectral signature and its response for Soil, Vegetation and Water; Ground Truthing, uses of ground data, equipment used. **CAMERAS AND SENSOR** Cameras and sensor classification: active and passive, optical – infrared sensors, microwave sensors, data reception and data product: ground segment organization, data product generation, georeferencing and resampling. **Section B** **PHOTO INTERPRETATION**	**Section A** **Basic Principles and EMR Response** Definition of Remote Sensing: advantages and limitations, Electro-Magnetic Radiation (EMR)- spectrum properties, wavelength regions and their applications, Atmospheric interference and Atmospheric windows, Interaction of EMR with matter, Fundamentals of Radiometry: concept & laws, radiance, reflectance, Spectral signature and its response for Soil, Vegetation and Water; Ground Truthing, uses of ground data, equipment used. **Cameras and Sensor** Cameras and sensor classification: active and passive, optical – infrared sensors, microwave sensors, data reception and data product: ground segment organization, data product generation, georeferencing and resampling. **Section B** **Photo Interpretation**	**The learning outcomes and Suggested e-learning material have been reviewed.** **The relevant detail is added to enrich the concept in depth.** **Recent available platforms and satellites are added.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		photographs for different applications. • **Explain the importance of ground truthing and ground equipment's used in validation process.**	Photo interpretation techniques, Fundamentals and elements of visual photo interpretation, Satellite image vs. Aerial photo interpretation, Digital and analog methods of Image Interpretation. **DIGITAL IMAGE CHARACTERISTICS** Concepts of digital image and its characteristics, Spectral, Spatial, Radiometric and Temporal resolution, Image data storage and retrieval, Types of image displays, Colour port and spectral band, B/W image, Gray Image, True/Pseudo Image and Standard FCC. **Section C** **PLATFORMS AND SATELLITES** Evolution of Indian Space programme, Introduction to Weather, Communication and Earth Observation satellites systems: IRS series of satellites. Global earth Observation Systems: Landsat, SPOT, IKONOS, Quickbird, Terra, Aqua, Radarsat, NOAA, EO-1, Data dissemination sources. ~~**TEXT BOOKS:**~~ ~~T1 Jensen, J.R., "Remote Sensing of the Environment-An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi, 2000.~~ ~~T2 George Joseph, "Fundamentals of remote sensing", Universities press (India) Pte Ltd., Hyderabad, 2003.~~ ~~T3 Lillesand, Thomas M. and Kiefer, Ralph, W., "Remote Sensing and Image Interpretation", 4th Edition, John Wiley and Sons, New York, 2000.~~ ~~T4 Moffitt F. H. and Mikail E.M "Photogrammetry", 3rd edition,~~	Photo interpretation techniques, Fundamentals and elements of visual photo interpretation, Satellite image vs. Aerial photo interpretation, Digital and analog methods of Image Interpretation. **Digital Image Characteristics** Concepts of digital image and its characteristics, Spectral, Spatial, Radiometric and Temporal resolution, Image data storage and retrieval, Types of image displays, **Look-up Tables (LUT) , Spatial profile and Spectral profile,** Colour port and spectral band, B/W image,Gray Image, True/Pseudo Image and Standard False Colour Composite (FCC). **Section C** **Platforms and Satellites** Evolution of Indian Space programme, Introduction to Weather, Communication and Earth Observation satellites systems: IRS series of satellites. Global earth Observation Systems: Landsat, SPOT, IKONOS, QuickBird, Terra, Aqua, RADARSAT, NOAA, EO-1, **Sentinel, RISAT, ASTER**, Data dissemination sources. **Recommended Books:** **1. Jensen, J. R. (2007). *Remote Sensing of the Environment - An Earth Resources Perspective* (2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall.** **2. Joseph, G., &Jeganathan, C. (2018). *Fundamentals of Remote Sensing* (3rd ed.). Hyderabad, India: Universities Press.** **3. Lillesand, T. M., Kiefer, R. W., &Chipman, J.W. (2003). *Remote Sensing and Image Interpretation* (5th ed.). New York, NY: John**	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			~~Happer& Row Publisher, New York, 1980.~~ ~~**REFERENCE BOOKS**~~ ~~R1 Sabins, F.F. Jr., 'Remote Sensing Principles and Interpretation", W.H. Freeman & Co., 2002~~ ~~Edition.~~ ~~R2 Reeves, Robert G., "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA~~ ~~R3 Rampal, K.K., Handbook of Aerial Photography and Interpretation, Concept Publishing Company,~~ ~~New Delhi, 1999.~~	**Wiley & Sons.** **4. Moffitt, F. H., &Mikail, E.M. (1980). *Photogrammetry* (3rd ed.). New York, NY: Happer& Row.** **5. Rampal, K.K. (1999). *Handbook of Aerial Photography and Interpretation.* New Delhi, India: Concept Publishing Company.** **6. Sabins, F.F. (2002). *Remote Sensing-Principles and Interpretation* (3rd ed.). Long Grove, IL: Waveland press.** **Suggested e-learning materials:** **1. Introduction to Remote Sensing https://swayam.gov.in/courses/3612-introduction-to-remote-sensing** **2. Basic Concepts of Remote Sensing https://nptel.ac.in/courses/105108077/**	
6.	**~~RS 502LApplied Statistics and Research Methodology Lab~~**	**After the completion of this course, students should be able to:** • **Represent geo-statistical data in diagrammatically and graphically.** • **Describe fundamental statistical measures for geospatial analysis.**	~~Lab 1. Diagrammatic and graphical representation of data~~ ~~Lab 2. Measures of central tendency: mean, median, mode, quartiles, AM, GM, HM~~ ~~Lab 3. Measures of dispersion: range, quartile deviation, mean deviation, standard deviation~~ ~~Lab 4. Skewness, kurtosis, Moments~~ ~~Lab 5. Relative methods: coefficient of variation, coefficient of quartile deviation~~ ~~Lab 6. Karl Pearson's correlation, rank correlation~~ ~~Lab 7. Fitting of distributions: Binomial, Poisson, Normal~~ ~~Lab 8. Applications of t, F and Chi square~~ ~~Lab 9. Large sample tests: for difference of means, proportions~~		**The course content has been removed.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		• **Describe different geographical survey sample data using statistical software's.** • **Apply statistical knowledge to solve complex geospatial queries using standard software's.**			
7.	~~**RS 504L: Fundamentals of Geographic Information Sciences and Digital Cartography Lab**~~	**After the completion of this course, students should be able to:** • **Implement the knowledge about SQL in solving attribute queries.** • **Analyze errors in spatial data and their removal.** • **Digitize and geospatial data creation for various thematic overlay analysis.**	Lab 1. Analog to Digital conversion -Scanning methods Lab 2. Introduction to software Lab 3 Map Rectification, Define projection and Reprojection. Lab 4. Digital database creation -Point features, Line features, Polygon features Lab 5. Data Editing-Removal of errors -Overshoot &Undershoot, Snapping, Topology Creation Lab6: Vector Transformation – Affine and Polynomial, Co-ordinate definition. Map Bound. Lab 7. Data collection and Integration, Non-spatial data attachment working with tables Lab 8. Concept of entity and relationship Lab 9. Creation of Tables		**Thecontent has been shifted and consolidated as Remote Sensing Lab-II** **The learning outcomes and Suggested e-learning material have been reviewed.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		• **Design and produce the base map using map algebra, complex query generation.**	Lab 10. Concept of SQL Lab 11. Performing various actions over table Lab 12. Merging of tables by using primary key Lab 13. Maintaining database Lab 14. Dissolving and Merging Lab 15. Clipping, Intersection and Union Lab 16. Proximity Analysis Lab 17. Spatial and Attribute query and Analysis Lab18. Map algebra / Math in Raster data Lab 19. Layout generation and report Lab 20. Analysis of toposheet Lab 21. Base map Lab 22. Updation of toposheet from satellite imagery. Lab 23. Digital Map preparation using Dot, Isopleth and Choropleth		**Restructuring of the exercises have been done.**
8.	~~**RS 505L: GIS Programming and Scripting Lab**~~	**After the completion of this course, students should be able to:** • **Write and describe .NET and Python scripting in their specified**	Lab 1. .NET framework concepts Lab 2. Window forms application Lab 3. Python concepts Lab 4. Geo-processing with python Lab 5. Introduction to ArcGIS server		**Thecontent has been shifted and consolidated as Remote Sensing Lab-II**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		frameworks. • **Perform geo-processing using Python, and ArcGIS Server.** • **Publishing newly generated geospatial maps on web.** • **Connect the desktop based GIS operation with real-time web operations.**	Lab 6. Creating GIS Server connectivity Lab 7. Map publishing on web		**The learning outcomes and Suggested e-learning material have been reviewed.** **Restructuring of the exercises have been done.**
9.	~~**RS 506L: Microwave, Thermal and Hyperspectral Remote Sensing Lab**~~	**After the completion of this course, students should be able to:** • **Perform image fusion with different multispectral data and SAR data products.** • **Pre-process raw SAR images for monitoring of urban and environment al**	Lab 1. Risat-1 data visualization Lab 2. Reading, displaying and header extraction of SAR images Lab 3. Visual image interpretation Lab 4. SAR image fusion with optical data Lab 5. Speckle filtering techniques Lab 6. Hyperspectral data interpretation Lab 7. Spectral profile Lab 8. Hyperspectral data cube generation		**Thecontent has been shifted and consolidated as Remote Sensing Lab-I** **The learning outcomes and Suggested e-learning material have been reviewed.** **New lab exercises are**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		applications. • Visualize indigenous as well as country outside agency SAR data products. • Pre-process airborne-space borne hyperspectral imagery and their interpretation.			introduced according to the theoretical course content that would be helpful in enhancing the practical knowledge of the students from "procurement of the satellitedata" to "efficient pre-processing".
10.	~~RS 508L: Principles of Remote Sensing Lab~~	After the completion of this course, students should be able to: • Interpret satellite FCC images and aerial photographs. • Explain the different resolutions of satellite imagery.	----		Thecontent has been shifted and consolidated as Remote Sensing Lab-I The learning outcomes and Suggested e-

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		• **Generate spectral profiles for various LULC features.** • **Perform basic image pre-processing operations on raw imaging data products**			**learning material have been reviewed.**
11.	**RS ___L Remote Sensing Lab-I**	**After the completion of this course, students should be able to:** • **Perform image fusion with different multispectral data and SAR data products.** • **Generate spectral profiles for various LULC features, pre-process raw SAR images and explain their resolution components.** • **Visualize indigenous as well as country outside agency SAR data**		1. Introduction to ERDAS IMAGINE 2011 2. Study of the marginal information given on the C.D. ROM/Digital data 3. Import / Export of files using ERDAS IMAGINE 2011 4. Mosaic and Subset of imagery 5. Stacking of different layers 6. Map rectification of Topomaps using Keyboard or GPS data. 7. Geo-reference of the Topomaps and Imageries 8. Display, analysis and interpretation of black & white images, Gary image, Pseudo image and FCC **9.** Study of the Spectral Signature of water, Built-up, Bare Soil, Vegetation, Plantation, Crop land, Snow and Cloud. **10. Overview of RS imaging online data portals and procurement of imagery (Thermal, Radar, and Hyperspectral).** **11. Familiarization to the ISSDC, and procurement of available RS data products.** **12. Familiarization to software tools for handling SAR, and Hyperspectral Datasets.** **13. SAR metadata extraction and Visualization of (SLC and GRD Products).** **14. SAR Image visual interpretation and comparative study with optical, hyperspectral and thermal imagery.** **15. Radiometric terrain correction of SAR Data.** **16.** Speckle filtering **of SAR Data.** **17.** SAR Image Fusion with Optical **and Hyperspectral images.**	**The components have been modified and consolidated. The learning outcomes and Suggested e-learning material have been reviewed. New lab exercises are introduced according to the theoretical course content that would be**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		products. • Interpret satellite FCC images and aerial photographs, pre-process airborne-space borne raw imaging data products and their interpretation.		18. Familiarization to the InSAR Data, Interferogram and their interpretation. 19. Familiarization to "Thermal data products" their visualization, and LST retrieval using thermal bands. 20. Familiarization to the Erdas Imagine "Spatial Modeler". 21. Hyperspectral data cube generation and its interpretation. 22. Hyperspectral Imagery profile and visual interpretation. **Recommended Books:** 1. Baghdadi, N., &Zribi, M. (2016). *Microwave Remote Sensing of Land Surfaces - Techniques and Methods*. London, United Kingdom: ISTC Press-Elsevier. 2. Richards, J. A. (2009). *Remote Sensing with Imaging Radar*. Heidelberg, Germany: Springer 3. Thenkabail, P. S., Lyon, J. G., &Huete, A. (2011). *Hyperspectral Remote Sensing of Vegetation*. Boca Raton, FL: CRC Press. 4. Jensen, J. R. (2007). *Remote Sensing of the Environment - An Earth Resources Perspective* (2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall. 5. Joseph, G., &Jeganathan, C. (2018). *Fundamentals of Remote Sensing* (3rd ed.). Hyderabad, India: Universities Press. 6. Lillesand, T. M., Kiefer, R. W., &Chipman, J.W. (2003). *Remote Sensing and Image Interpretation* (5th ed.). New York, NY: John Wiley & Sons. **Suggested e-learning materials:** 1. Sentinel Missions https://earth.esa.int/web/guest/missions/esa-operational-eo-missions 2. Hyperspectral Image Analysis https://www.harrisgeospatial.com/Support/SelfHelpTools/Tutorials.asp 3. Optical - Radar Fusion http://community.hexagongeospatial.com/t5/Spatial-Recipes/Optical-Radar-Fusion/ta-p/752 4. Radar Courses https://earth.esa.int / web / guest / missions / esa – operational - eo missions / ers / instruments /sar / applications / radar-courses	helpful in enhancing the practical knowledge of the students from "procurement of the satellitedata" to "efficient pre-processing".

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				5. ENVI Tutorials (Hyperspectral Image Analysis) https://www.harrisgeospatial.com/Support/SelfHelpTools/Tutorials.aspx **6. ERDAS Hexagone Geospatial Tutorials http://community.hexagongeospatial.com/t5/Spatial-Recipes/Optical-Radar-Fusion/ta-p/752** **7. Introduction to Remote Sensing** https://swayam.gov.in/courses/3612-introduction-to-remote-sensing **8. Basic Concepts of Remote Sensing https://nptel.ac.in/courses/105108077/**	
12	**RS ___L Remote Sensing Lab-II**	**After the completion of this course, students should be able to:** **• Implement the knowledge about SQL in solving attribute queries.** **• Analyze errors in spatial data and their removal.Design and produce the base map using map algebra, complex query generation.** **• Write and describe .NET and Python scripting in their specified frameworks.** **• Perform geo-processing using Python, and ArcGIS Server.** **• Connect the**		1. Analog to Digital conversion -Scanning methods **2. Introduction to GIS software** 3. Map Rectification, Define projection and Reprojection. 4. Digital database creation-Point features, Line features, Polygon features 5. Data Editing-Removal of errors -Overshoot & Undershoot, Snapping, Topology Creation 6. Vector Transformation - Affine and Polynomial, Co-ordinate definition. Map Bound. 7. Data collection and Integration, Non-spatial data attachment working with tables **8. Creation of Tables, Performing various actions over table, and Merging of tables by using primary key** 9. Concept of SQL **10. Dissolving, Merging, Clipping, Intersection, Union, and Proximity Analysis** 11. Spatial and Attribute query and Analysis 12. Map algebra / Math in Raster data 13. Layout generation and report 14. Updation of Toposheet from satellite imagery. 15. Digital Map preparation using Dot, Isopleth and Choropleth 16. .NET framework concepts. 17. Window forms application. 18. **Console Programming.** 19. Python concepts. 20. **Conditional & Looping applications.** 21. **Concept of ArcPy.** 22. Geo-processing with Python. 23. Introduction to ArcGIS server.	**The components have been modified and consolidated.** **Restructuring of the exercises have been done.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		desktop based GIS operation with real-time web operations and publishing newly generated geospatial maps on web.		24. Creating GIS Server connectivity. 25. Map publishing on web. **Recommended Books:** **1. Burrough, P. A., & McDonnell, R. (1998). *Principles of Geographical Information Systems*(3rd ed.). New York, NY: Oxford University Press.** **2. Chang, K.T. (2002). *Introduction to Geographic Information Systems*(3rd ed.). New Delhi, India: Tata McGraw Hill.** **3. Fu, P.,& Sun, J. (2011). *WebGIS principles and applications*. New Delhi, India: ESRI press.** **4. Zandbergen, P. A. (2013). *Python scripting for ArcGIS*. New Delhi, India: ESRI Press.** **5. Zhuang, V., Wrazien, D. R., Wang, M., & Huang, X. (2005). *Programming ASP.NET for ArcGIS Server*. Florence, KY: Thomson Delmar Learning.** **Suggested e-learning materials:** **1. Introduction to GIS** **https://nptel.ac.in/courses/105102015/1** **2. Spatial Analysis** **https://nptel.ac.in/courses/105102015/25** **3. Introduction to geographic information systems, overlaying operations** **https://swayam.gov.in/courses/3691-introduction-to-geographic-information-systems** **4. Digital Elevation Models and Applications** **https://swayam.gov.in/courses/4395-digital-elevation-models-and-applications** **5. Interpolation** **https://nptel.ac.in/courses/105102015/14** **6. VB.NET Programming Tutorial** **https://www.tutorialspoint.com/vb.net/index.htm** **7. VBA Tutorial** **https://www.tutorialspoint.com/vba/index.htm** **8. Algorithm and programming** https://nptel.ac.in/courses/106106145/	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				9. **Python – Tutorial https://www.tutorialspoint.com/python/index.htm**	
1.	**RS ___ Term Paper-I/Minor Project-I/Seminar-I**	**After the completion, students should be able to:** • **. Identify and formulate the statements of the research problem and objectives related to earth system sciences, and geocomputation for effective geospatial solutions.** • **Review existing literature relevant to the problem selected and explore the research gap.** • **Collect various geospatial data products, required to carry out the research and formulate the methodology to solve the identified problem.**			**New component have been introduced.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		• **Deliver an effective technical presentation on selected research problem and prepare the term paper/project/ seminar report.**			

SECOND SEMESTER

S. N.	Course List	• Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	**RS ~~501~~Applications of Remote Sensing**	**After the completion of this course, students should be able to:** • **Identify the potentials of remote sensing in allied sectors.** • **Describe trends in**	**Section A** **INTRODUCTION** Emergence of Remote Sensing technology in application areas, Understanding potentials of Remote Sensing in ~~allied sectors,~~ Indian satellite missions with focused applications, recent trends in Remote Sensing applications. **APPLICATION IN LAND AND WATER RESOURCE**	**Discipline Elective**	**This course has been shifted from core course of II semester to elective Pool** **The learning**

		remote sensing applications. • **Apply remote sensing technology in natural resource and disaster management.** • **Explain basics about Environmental Impact Assessment (EIA).**	Remote sensing in mapping Land use / land cover classification and monitoring, Crop forecasting, Forest resources management, soil taxonomy and degradation, geomorphology and surface mining on land resources, groundwater modelling, Water quality Monitoring, Reservoir sedimentation, Snow covers mapping and modelling approaches **Section B** **APPLICATION IN CLIMATE CHANGE AND DISASTER MANAGEMENT** Concept of climate and weather, Climatic classification, paleo-climate, Adaptation and vulnerability, mapping of landslide, Floods, Cyclones, Forest fire and Drought. **APPLICATION IN URBAN PLANNING** Mapping urban land use, Urban sprawl, Site selection for urban development, Urban Information System, Urban master plans, Urban green spaces, 3 D city modelling, SMART city **Section C** **APPLICATION IN GEO-TECHNICAL ENGINEERING** Digital Terrain Modelling, Geoinformatics in water harvesting site selection, Highways and Tunnel alignment studies. **APPLICATION IN ENVIRONMENTAL MANAGEMENT** Selection of disposal sites for industrial and municipal wastes, Solid waste management, Environmental Impact Assessment (EIA). ~~**TEXT BOOKS**~~ ~~T1 Schultz, G. A. and Engman, E. T., 2000, Remote Sensing in Hydrology and Water Management, Springer-Verlag, Berlin, German.~~		**outcomes and Suggested e-learning material have been reviewed.** **Essential application is added following the modified national security policies.**

			~~T2 Lillisand, T. M. and Keifer, R. W., 1994, Remote Sensing and Image interpretation, John Willey and Sons, New York, Third Edition.~~ ~~T3 Jenson, J.R., 2000, Remote Sensing of the environment An Earth Resource Perspective, Prentice Hall Inc.~~ ~~T4 Kumar P., Rani M, Pandey P., 2012, Conservation areas to beat the heat, Lambert Publication,Germani.~~ ~~T5 P.K. Joshi, P. Pani,S. .N. Mohapartra and T.P. Singh, Ed 2010, Geoinformatics for Natural Resource Management, Nova Publishers,India~~ ~~T6 P.K. Joshi and T.P. Singh, 2011, Geoinformatics for Climate Change Studies, TERI Press, New Delhi.~~ ~~T7 P. S. Roy, 2000, Natural Disaster and their mitigation. Published by Indian Institute of~~ ~~Remote Sensing (IIRS), 2000.~~ ~~**REFERENCE BOOKS:**~~ ~~R1 Spatial Technologies for Natural Hazard Management. Proceedings of ISRS National Symposium, Nov. 21-22, 2000, IIT, Kharagpur.~~		
2.	**RS 503: Digital Image Processing**	**After the completion of this course, students should be able to:** • **Explain sources of image degradation and their rectification.** • **Describe various filtering operation and multispectral**	**SECTION A** **BASIC PRINCIPLES** System design considerations, Sources of image degradation, Radiometric and Geometric error, Types of atmospheric correction: absolute atmospheric correction and relative atmospheric correction, correction for slope and aspect effects. Interpolation methods, Spatial and Spectral interpolation	**SECTION A** **Basic Principles** System design considerations, Sources of image degradation, Radiometric errors and **corrections:**Types of atmospheric correction - absolute and relative; **atmospheric correction for hyperspectral imagery. Slope and aspect induced errors: topographic corrections - Minnaertmethod**.Geometric errors and **corrections**:Interpolation: Spatial and Spectral. **Image Enhancement techniques:** Contrast stretching: Linear and non-linear methods.	**The learning outcomes and Suggested e-learning material have been reviewed.** **Topics are reordered**

		image enhancement techniques. • **Describe geospatial data dimensionality reduction techniques for fast and effective interpretation of the image variables.** • **Describe utilization of artificial intelligence techniques for solving problems related to environmental monitoring and management**	~~IMAGE ENHANCEMENT~~ ~~Look up Tables (LUT) and Image display, Spatial profile and Spectral profile,~~ Contrast stretching: Linear and non-linear methods **SECTION B** **FILTERING AND MULTI-BAND ENHANCEMENT TECHNIQUES** Frequency component, low pass filter: Image smoothing, edge-preserving median filter, High passes filtering: Edge enhancement and Edge detection, Gradient filters, Directional and non-directional filtering, Fourier Transformation, Band ratio, Types of vegetation indices, Tassled Cap Analysis (TCA), Principal component analysis (PCA), Texture analysis, temporal data analysis and change detection. **PATTERN RECOGNITION** Concept of ~~pattern recognition,~~ Multi-spectral pattern recognition, Spectral discrimination, ~~Signature Bank~~, Parametric and Non-Parametric classifiers, Unsupervised classification methods, Supervised classification techniques, Accuracy Assessment: ~~User and Producer accuracy, Kappa accuracy KHAT statistics.~~ **SECTION C** **ADVANCED TECHNIQUES** Artificial intelligence, Fuzzy logic, neural networks, Image Fusion, ~~Object Oriented Classification, Hyper spectral remote sensing: atmospheric correction, Data reduction techniques, texture analysis and mineral & vegetation mapping.~~ ~~**TEXT BOOKS:**~~ ~~T1 Jensen, JR., 2004, Remote Introductory Digital Image Processing~~	**SECTION B** **Multi-Band Enhancement Techniques** **Image gradient, thresholds and segmentation**. Image Filtering: LPF, HPF, Directional, non-directional, Gradient, and **Statistical filters,**Edge detection, Band Ratio/**Indices: vegetation, water, snow, and built-up indices; Factors affecting development of band indices. Principal Component Analysis, Tasseled Cap Analysis. Image**Texture analysis: **Gray-Level Co-occurrence Matrix (GLCM).** Frequency component, Fourier Transformation. **Pattern Recognition** Concept of Multi-spectral pattern recognition, **Image Classification: Concepts**, Spectral discrimination, Classifiers: Parametric and Non-Parametric; Methods: Unsupervised, Supervised, Object-oriented, and **knowledge base classification**; Accuracy Assessment: **$\hat{K}$ statistics. Multi-temporal information extraction: concepts and considerations. Change detection analysis.** **SECTION C** **Advanced Techniques** Artificial intelligence **and Machine Learning: concepts,** techniques: Fuzzy logic,**Artificial**Neural Networks **(ANN), Genetic algorithms (GA). Image Fusion. Imaging spectroscopy for vegetation, Martian and Lunar surfaces: Mineral Spectra Extraction: concepts and considerations. LiDAR: Principles, Types, LiDAR Intensity, and Processing of LiDARdata. Terrestrial Laser Scanning (TLS).** **Recommended Books:** **1. Campbell, J. B., & Wynne, R. H. (2011). *Introduction to Remote Sensing (*5th**ed.). New York, NY: The Guilford Press.** **2. Cracknell, A. P., & Hayes, L. (2007). *Introduction to***	**for adequate and systematic learning of the subject.** **Some of the topics are shifted to different courses according to their technical relevance** **Unit heading is modified with adequate relevance with course content.** **Topics are reordered for adequate and systematic learning of the subject.** **Some of the advanced techniques are added to the unit content for**

			~~(3rd Edition), Prentice Hall~~ ~~T2 Thomas M. Lillesand& Kiefer, Ralph W., Remote Sensing and Image Interpretation, John Wiley & Sons, New York.~~ ~~T3 Jensen, JR., Remote Sensing of the Environment An Earth Resources Perspective, Prentice Hall Inc.~~ ~~T4 Sabins, Floyd F., Remote Sensing: Principles and Interpretation, H. Freeman and C., New York.~~ ~~**REFERENCE BOOKS:**~~ ~~R1 Rencz, Andrew N. (Ed), Remote Sensing for the Earth Sciences: Manual of Remote Sensing, 3rd ed., John Wiley & Sons, Inc., New York.~~ ~~R2 Curran, P., Principles of Remote Sensing, Longman, London.~~ ~~R3 Campbell, James B., Introductory Remote Sensing: Principles and Concepts, Routledge.~~ ~~R4 Gibson, P.J., Introduction to Remote Sensing, 2nd ed., Taylor & Francis, London.~~ ~~R5 Cracknell, A.P. & Hayes, L.W B., Introduction to Remote Sensing, Taylor & Francis, London.~~	***remote sensing* (2nd ed.). Boca Raton, FL: CRC Press.** **3. Dong, P., & Chen, Q. (2018). *LiDAR Remote Sensing and Applications*. Boca Raton, FL: CRC Press.** **4. Jensen, J. R. (2007). *Remote Sensing of the Environment- An Earth Resources Perspective* (2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall.** **5. Jensen, J. R., (2004). *Introductory Digital Image Processing: A Remote Sensing Perspective* (4th ed.), Glenview, IL: Pearson Education.** **6. Lillesand, T., Kiefer, R. W., &Chipman, J. (2015). *Remote Sensing and Image Interpretation* (7th ed.). New York, NY: John Wiley & Sons.** **7. Rencz, A. N., & Ryerson, R. A. (Eds.). (1999). *Manual of Remote Sensing: Remote Sensing for the Earth Sciences* (3rd ed. vol. 3). New York, NY: John Wiley & Sons.** **8. Sabins, F. F. (2007). *Remote Sensing: Principles and Interpretation* (3rd ed.). Long Grove, IL: Waveland Press.** **9. Shan, J., &Toth, C. K. (2018). *Topographic Laser Ranging and Scanning- Principles and Processing* (2nd ed.). Boca Raton, FL: CRC Press.** **10. Tso, B., & Mather, P. M. (2009). *Classification methods for Remotely Sensed Data* (2nd ed.). Boca Raton, FL: CRC Press.** **Suggested e-learning materials:** **1. Image Processing** **http://geoinfo.amu.edu.pl/wpk/rst/rst/AppB/B4.html** **2. Fundamentals of Satellite Remote Sensing** **https://arset.gsfc.nasa.gov** **3. Digital Image Processing: Introduction to Object Recognition** **https://nptel.ac.in/courses/117105079/4**	**strengthening the high level research in digital image processing domain.**

3.	**RS 507: Photogrammetry, Global Positioning Systems and Mobile Mapping**	**After the completion of this course, students should be able to:** • **Explain concepts related to aerial photography, planning and execution of photographic flights.** • **Describe standard digital photogrammetric operations i.e., Ortho-rectification.** • **Describe concepts related to aerial camera lenses, and digital terrain modeling.** • **Integrate the knowledge about GPS.**	**Section A** **AERIALPHOTOGRAPHY** Fundamentals of aerial photography, geometry of aerial photograph, Basics concepts of Perspective projection and Orthographic projection, Types of aerial photographs: Vertical and Oblique/High Oblique aerial photography Scale of photograph, Concept of stereoscope, Relief displacement and applications, tilt displacement, stereoscopic parallax, measurement of height difference from aerial photograph. Planning and execution of photographic flight, Computation of flight plan. **AERIAL FILM AND FILTERS AND DIGITAL PHOTOGRAMMETRY** Basics of photography, Aerial cameras lenses, Filters and Films, Photographic scale: Object height and Length, Basic of Optics: Reflection & refraction and lens distortion; Photo mosaic, Ortho photo, Photograph co-ordinate and ground coordinate of Vertical and tilted photographs, Block adjustment, orthorectification, Digital Terrain Model, Terrain editing, Digital orthophotos. **Section B** **FUNDAMENTALS OF GPS AND ITS COMPONENTS** Introduction of Global Positioning System, Control Segment, Space Segments, User Segment, GPS signals and data, Geopositioning – Basic concepts; NAVSTAR, GLONASS and GAGAN, ~~GPS Positioning Types- Absolute Positioning, Differential positioning.~~ **GEODESY** Basics geodesy, Geoid/ datum/Ellipsoid-definition and basic concepts, Application of Geodesy, Coordinate system: Cartesian 3-D coordinate systems, Earth Centred, Earth Fixed X, Y and Z, Geographic Coordinate System Transformation, Geocentric Translation **Section C** **SURVEYING METHODS AND FACTORS AFFECTING ACCURACY**	**Section A** **Aerial Photography** Fundamentals of aerial photography, geometry of aerial photograph, Basics concepts of Perspective projection and Orthographic projection, Types of aerial photographs: Vertical and Oblique/High Oblique aerial photography Scale of photograph, Concept of stereoscope, Relief displacement and applications, tilt displacement, stereoscopic parallax, measurement of height difference from aerial photograph. Planning and execution of photographic flight, Computation of flight plan. **Aerial Film and Filters and Digital Photogrammetry** Basics of photography, Aerial cameras lenses, Filters and Films, Photographic scale: Object height and Length, Basic of Optics: Reflection & refraction and lens distortion; Photo mosaic, Ortho photo, Photograph co-ordinate and ground coordinate of Vertical and tilted photographs, **Types of Photogrammetry** Block adjustment, orthorectification, Digital Terrain Model, Terrain editing, Digital orthophotos. **Section B** **Fundamentalsof GPS And Its Components** Introduction of Global Positioning System, Control Segment, Space Segments, User Segment, GPS signals and data, Geopositioning – Basic concepts; NAVSTAR, GLONASS and GAGAN, GPS Positioning, **Satellite-based Augmentation System**. **Geodesy** Basics geodesy, Geoid/ datum/Ellipsoid-definition and basic concepts, Application of Geodesy, Coordinate system: Cartesian 3-D coordinate systems, Earth Centred, Earth Fixed X, Y and Z, Geographic Coordinate	**The learning outcomes and Suggested e-learning material have been reviewed.** **Broader coverage of types is added to cover the various available recent technologies** **Content is added to remove the gaps**

			Satellite Geometry, Satellite signals and its strength, Number of satellites, Effects of Multi path, Ionosphere, Troposphere, Methods-Static & Rapid static, Kinematic-Real time kinematic, Survey: DGPS data processing. **REFERENCE STATION AND MOBILE MAPPING** Selection of reference station, Reference station equipment- GPS receiver & GPS antenna. Mobile mapping basic concepts and applications, GPS application in surveying and mapping: Navigation military, Location based services, Vehicle tracking, Seismic Applications-Crustal deformation and tectonic movements. New Cellular mapping – GSM and CDMA technology. ~~**TEXT BOOK**~~ ~~T1 Moffitt F. H. and Mikail E.M "Photogrammetry", 3rd edition, Happer& Row Publisher, New York, 1980~~ ~~T2 Lillesand, Thomas M. and Kiefer, Ralph, W., "Remote Sensing and Image~~ ~~Interpretation", 4th Edition, John Wiley and Sons, New York, 2000~~ ~~T3 N.K. Agrawal Essentials of GPS, Spatial Network Pvt Ltd 2004~~ ~~T4 SathishGopi , GPS and Surveying using GPS~~ ~~T5 Drummond. J., Billen. R., Joao. E., and Forrest. D., Ed 2007, "Dynamic and Mobile GIS" CRC Press, New York.~~ ~~T6 Terry Karen Steede, 2002, Integrating GIS and the Global Positioning System, ESRI Press.~~ ~~**REFERENCE BOOKS**~~	System Transformation, Geocentric Translation **Section C** **SurveyingMethodsand Factors Affecting Accuracy** Satellite Geometry, Satellite signals and its strength, Number of satellites, Effects of Multi path, Ionosphere, Troposphere, Methods-Static & Rapid static, Kinematic-Real time kinematic, Survey: DGPS data processing. **Reference Station and Mobile Mapping** Selection of reference station, Reference station equipment- GPS receiver & GPS antenna. Mobile mapping basic concepts and applications, GPS application in surveying and mapping: Navigation military, Location based services, Vehicle tracking, Seismic Applications-Crustal deformation and tectonic movements. New Cellular mapping – Global System for Mobile Communication (GSM) and Code Division Multiple Access (CDMA) technology. **Recommended Books:** **1. Drummond, J., Billen, R., Joao, E.,& Forrest, D. (Eds.). (2006). *Dynamic and Mobile GIS.* New York, NY: CRC Press.** **2. Gopi, S. (2005). *GPS and Surveying using GPS*.NewDelhi, India:Tata McGraw-Hill.** **3. Leick, A. (2004). *GPS Satellite Surveying*(3rd ed.). New York, NY: John Wiley & Sons.** **4. Lillesand, T., Kiefer, R. W., &Chipman, J. (2015). *Remote Sensing and Image Interpretation* (7th ed.). New York, NY: John Wiley & Sons.** **5. Moffitt F. H., &Mikail, E.M. (1980).*Photogrammetry***	

			~~R1 Sabins, F.F. Jr., 'Remote Sensing-Principles and Interpretation', W.H. Freeman & Co., 2002 Edition.~~ ~~R2 Reeves, Robert G., "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA~~ ~~R3 Rampal, K.K., Handbook of Aerial Photography and Interpretation, Concept Publishing Company, New Delhi, 1999~~ ~~R4 Leica. A.: GPS Satellite Surveying, John Wiley & Sons, use. New York~~	**(3rd ed.).New York, NY:Happer& Row.** **6. Rampal, K.K. (1999). *Handbook of Aerial Photography and Interpretation*. New Delhi, India: Concept.** **7. Colwell, R. N. (1983). *Manual of Remote Sensing*(2nd ed. vol.1).Falls Church, VA: ASPRS** **8. Sabins, F. F. (2007). *Remote Sensing: Principles and Interpretation* (3rd ed.). Long Grove, IL: Waveland Press.** **9. Terry, K. S. (2000).*Integrating GIS and the Global Positioning System*. New Delhi, India: ESRI Press.** **Suggested e-learning materials:** **1. Aerial Photography https://nptel.ac.in/courses/105104167/4** **2. Photogrammetry https://nptel.ac.in/courses/105104100/18** **3. Drone https://www.dronethusiast.com/tutorials**	
4.	**RS-~~509:~~ Spatial Database Systems, Analysis and Modeling**	**After the completion of this course, students should be able to:** • **Statistically evaluate the spatial entities their topological, geometric, or geographic properties.** • **Learn different analytic approaches.** • **Describe and design the concept of spatial databases its components,**	**SECTION A** **ADVANCE ATTRIBUTE ANALYSIS** Basics Matrix: Addition, subtraction, multiplication, Identity, Determinant and Inverse, **SPATIAL MODELING** Spatial analysis concept: Distance, Adjacency, Interaction and neighbourhood Geospatial models- types and Modeling: Descriptive, prescriptive and predictive; Normalization, level of measurement, Introduction to modeling& flowcharting, Map algebra-operators & operations, Functional operations, Modeling essentials, Spatial interaction models Conceptualizing the model, Model formulation, Conflict resolution and Prescriptive modeling, Model verification	**Discipline Elective**	**This course has been shifted from core course of II semester to elective Pool** **The learning outcomes and Suggested e-learning material have been reviewed.** **An application component**

		models, mining, analysis and visualization. • **Apply the strength and applications of Arc model builder.**	**SECTION B** **SPATIAL ANALYSIS** Point Analysis: Coordinate, Distance – Nearest Neighbour Distance, Density – Quadrant and other methods **GEO-STATISTICS** Spatial Interpolation and Geostatistics: Local and global methods, Gravity model, Regression model, Pattern analysis, Moran's Index, Cluster analysis, Trend surface Analysis Thiessen polygon, Density estimation, Inverse Distance Weight (IDW), Thin – plate Spline, Kriging – ordinary and Universal, Semivariogram; Spatial Autocorrelation **Section C** **GEOCODING AND NETWORK ANALYSIS** Address Geocoding, Optimum Routing, Closest facilities, Resource Allocation, Network Analysis, Dynamic Segmentation: Route, Section, Events and its application. **DIGITAL TERRAIN** Terrain mapping: Source of existing elevation data, quality and standard of DEM data, Counting, Vertical profile, Hill shading, Slope, Aspect, Surface Curvature, Digital terrain visualization 2D and 3D; Application of Digital terrain models **ARC GIS MODEL BUILDER** Concepts of Model Builder, Model elements: Tools, Variables, Connectors, setting up Models, Executing Model, Model Validation, Model builder to create Tools – Advance techniques in Model Builder,		**based on matrix is introduced.**

			Geoprocessing Techniques in Model Builder ~~**TEXT BOOKS**~~ ~~T1 David L. Verbyla, 2002, "Practical GIS Analysis", Taylor &Francis~~ ~~T2 David O' Sullivan and David Unwin, 2003 "Geographic Information analysis, John Wiley and Sons, Hoboken, USA~~ ~~T3 Burrough, Peter A. and Rachael McDonnell. 1998. Principles of Geographical Information Systems. Oxford University Press, New York~~ ~~T4 Kang-tsung Chang, 2002, 'Introduction to Geographic Information Systems' Tata McGraw Hill, New Delhi.~~ ~~T5 C.P.Lo and Albert K.W.Yeung, 2005, "Concepts and Techniques of Geographic Information Systems" Prentice Hall of India, New Delhi~~ ~~T6 Laurini, Robert, and Derek Thompson "Fundamentals of Spatial Information Systems", Academic Pr. London~~ ~~T7 Kluwer FotheringhamA S, O'Kelly M E, "Spatial Interaction Models: Formulations and Applications".~~ ~~T8 Goodchild, M.F. (1978) Statistical Aspects of the Polygon Overlay Problems, in Harvard papers on GIS, Ed. G. Dulton, Vol. 6, Addison Wesley, Reading Press.~~ ~~T9 Mac Donald, A. 1999, Building a Geodatabase, Redlands CA: ESRI Press.~~ ~~**REFERENCE BOOKS**~~ ~~R1 Geographical Information Systems. Principles, Techniques, Applications and Management. John Wiley & Sons, Paul Longley,~~		

			~~Michael Goodchild, David Maguire and David Rhind: (Editors).~~ ~~R2 Sanghavi, Hitesh (1998) Oracle Miracles, Express computers methods, 1998.~~ ~~R3 Samet, H., 1990, The Design and Analysis of Spatial Data Structures, Addison Wesley.~~ ~~R4 A. Silberschats, Henry F. Korth, 1998, "Database System Concepts", 3rd Edition, TMH,~~ ~~R5 Bonham Carter G.F., 1994, GIS for Geoscientists: Modeling with GIS Pergamon Publications.~~		
5.	**RS ~~510:~~ Spatial decision support system**	• **After the completion of this course, students should be able to:** • **Study the spatial information systems developed for a specific problem or decision-making situation.** • **Observe key concepts and theories underlying spatial information systems and technology trends.** • **Explore and reform the solutions to spatial problems by**	**Section A** **INTRODUCTION** GIS and decision support systems, SDSS definition and characteristics, Introduction to decision making process and decision support systems, Introduction of a frame work for planning and decision making, Spatial Decision Making, SDSS architecture. **DATABASE MANAGEMENT** Data base management system, Model based management system, Graphical and tabular report generator, User interface. **Section B** **ANALYSIS AND DECISION MAKING** Principles and ~~components~~ of multiple-criteria decision ~~making~~, Main multiple-criteria evaluation methods/techniques, Spatial multiple criteria decision making, ~~Multiple-criteria decision making in spatial data analysis,~~ Spatial multiple criteria evaluation in planning and decision making	**Discipline Elective**	**This course has been shifted from semester II to elective pool .**

		generating a set of alternatives and selecting from among those that appear to be viable through multi criteria analytics. • **Illustrate and assess the emerging concepts that may impact spatial information system development and applications.**	**TECHNOLOGY AND DEVELOPMENT** Development of DSS, Technology levels, Functions and roles, Status of SDSS, Open source tools. **Section C** **SDSS SOFTWARES AND ITS APPLICATIONS** Classification of DSS software, Problem specific SDSS, Generic SDSS, Domain level SDSS, Desktop SDSS, Web-Based SDSS, SDSS applications in: natural resource management, environmental, urban, agriculture, utilities and business ~~**Text Books:**~~ ~~T1 Silberschatz, A., Korth, H. F., &Sudarshan, S. (2011). Database System Concepts. McGraw Hill.~~ ~~T2 Sugumaran, R., &Degroote, J. (2011). Spatial Decision Support System (Principles and Practices). Newyork: CRC Press.~~ ~~T3 Scholl, R. P., &Voisard, M. (2002). Spatial Applications with Applications to GIS. Morgan Kaufmann.~~ ~~**Reference Books:**~~ ~~R1 Bonczek, R. H., Holsapple, C. W., &Whinston, A. B. (1981). Foundadation of Decision Support System. New York: Academic Press.~~ ~~R2 House, W. C. (1983). Decision Support Systems. New York: Petrocelli.~~ ~~R3 Sprague, R. H., & Carlson, E. D. (1982). Building Effective Decision Support Systems. NJ: Prentice Hall.~~		

6.	**~~RS 501L: Applications of Remote Sensing Lab~~**	**After the completion of this course, students should be able to:** • **Perform Land Use/ Land Cover Mapping for natural resource monitoring.** • **Develop the Forecasting models for the crop production, flood hazards.** • **Identify the suitable waste disposal sites.** • **Mapping the landslide hazard zonation maps.**	Lab 1. Land use \ land cover mapping Lab 2 Mapping flood hazards in a region using satellite images Lab 3. Urban sprawl mapping of a township using satellite images Lab 4. Crop forecasting using multi-dates satellite images Lab 5. Application of remote sensing for identification of waste disposal sites Lab 6. Forest cover and density mapping using geospatial techniques Lab 7. Mapping landslide hazards in a region using satellite images		**Thecontent has been shifted and consolidated as Remote Sensing Lab-III** **The learning outcomes and Suggested e-learning material have been reviewed.** **Recent trend based applications have been added**
7.	**~~RS 503L: Digital Image Processing Lab~~**	**After the completion of this course, students should be able to:** • **Perform standard radiometric**	Lab 1. Haze and noise reduction/ Lab 2. Absolute radiometric correction Lab 3. Relative radiometric correction Lab 4. Perform the various band ratio calculations		**Thecontent has been shifted and consolidated as Remote Sensing**

		corrections on satellite imagery. • **Classify the imagery using knowledge base for advanced mapping of LULC.** • **Perform band indices calculations for enhancement of the natural features on imagery.** • **Perform the accuracy assessment of the classified remote sensing imagery.**	Lab 5. Image enhancement and filtering: Lab 6. Data compression techniques (PCA, TCA) Lab 7. Resolution merging and its assessment Lab 8. Unsupervised classification Lab 9. Supervised classification Lab 10. Object oriented classification Lab 11 Knowledge base classification ~~Lab 12. Accuracy assessment~~ Lab 13. Visualisation and presentation Lab 14. Hyperspectral pre-processing Lab 15 Atmospheric correction of hyperspectral data Lab 16. Classification of hyperspectral data		**Lab-III** **The learning outcomes and Suggested e-learning material have been reviewed.** **New lab exercises are introduced according to the theoretical course content that would be helpful in enhancing the practical knowledge of the students from "efficient pre-processing of the data" to "advanced pattern recognitio**

					n exercises”.
8.	~~**RS 507L Photogrammetry, Global Positioning System and Mobile Mapping Lab**~~	**After the completion of this course, students should be able to:** • **Prepare the Ortho- images using Photogrammetry software’s** • **Rectify the geographic co-ordinates using GPS** • **Collect geographic co-ordinates using DGPS and post-processing of the attributes using standard software’s.** • **Generate contour maps for the DEM generation.**	Lab1: Stereovision exercise Lab 2. Preparation of ortho image using Leica Photogrammetry Suite Lab 3. Contour generation using orthophoto or Images Lab 4. Introduction to GPS and initial setting Lab 5. Creating codes and attribute table in receiver Lab 6. Point data collection using GPS with different datum Lab 7. Line data collection using GPS and measurements Lab 8.GPS data collection for area calculation Lab 9. Post processing of the DGPS data Lab 10.GPS and GIS integrations output preparation Lab 11. Contour generation using GPS point data Lab 12. Image rectification using GPS coordinate data		**Thecontent has been shifted and consolidated as Remote Sensing Lab-IV** **The learning outcomes and Suggested e-learning material have been reviewed.**

9.	**~~RS 509L: Spatial Database Systems, Analysis and Modeling Lab~~**	**After the completion of this course, students should be able to:** • **Statistically evaluate the spatial entities their topological, geometric, or geographic properties.** • **Learn different analytic approaches.** • **Describe and design the concept of spatial databases its components, models, mining, analysis and visualization.** • **Acquire and apply the strength and applications of Arc model builder.**	----		**Thecontent has been shifted and consolidated as Remote Sensing Lab-IV** **The learning outcomes and Suggested e-learning material have been reviewed.**
12	**RS ___L Remote Sensing Lab-III**	**After the completion of this course, students should be able to:** • **Perform standard radiometric corrections on**		**Course Content:** 1. **De-hazing and noise reduction in RS imagery.** 2. **DN-Radiance-at sensor reflectance conversion of satellite imagery.** 3. **Retrieval of true planetary surface reflectance (i.e., atmospheric correction).**	**The components have been modified and consolidated.**

		satellite imagery andcalculateband indices for enhancement of the natural features on imagery. • **Classify the imagery using knowledge base for advanced mapping of LULC.** • **Develop the Forecasting models for the crop production, flood hazards.** • **Identify the suitable waste disposal sites, and Mapping the landslide hazard zonation maps.**		**4. Derive band ratios/indices for multispectral and hyperspectral imagery.** 5. Image Enhancement and filtering. 6. Data **dimensionality reduction** techniques (PCA, TCT). **7. RGB-to-HSV Transformation and interpretation.** 8. Resolution merging and its assessment. 9. Unsupervised classification **and accuracy assessment**. 10. Supervised classification **and accuracy assessment.** 11. Object-Oriented classification. 12. Knowledge base classification. **13. Pre-processing of Hyperspectral data.** 14. Atmospheric correction of hyperspectral data. **15. Spectral Mixture Analysis for Hyperspectral Data.** **16.** Land use \ land cover mapping. **17. Monitoring flood risk zones using satellite images.** **18.** Urban sprawl mapping of a township using satellite images. **19.** Crop forecasting using multi-dates satellite images. **20.** Application of remote sensing for identification of waste disposal sites. **21.** Forest cover and density mapping using geospatial techniques. **22.** Mapping landslide hazards in a region using satellite images. **23. Mapping of Forest Fire using Remote Sensing and GIS.** **24. Identify Ground water potential zones using Geo spatial techniques.** **25. Draught Zone identification using Remote Sensing and GIS.** **26. Estimation of Land Surface Temperature using QGIS.** **Recommended Books:** **1. Dong, P., & Chen, Q. (2018). *LiDAR Remote Sensing and Applications*. Boca Raton, FL: CRC Press.** **2. Jensen, J. R. (2007). *Remote Sensing of the Environment-An Earth Resources Perspective* (2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall.** **3. Jensen, J. R., (2004). *Introductory Digital Image Processing: A Remote Sensing Perspective* (4th ed.), Glenview, IL: Pearson Education.** **4. Sabins, F. F. (2007). *Remote Sensing: Principles and Interpretation* (3rd ed.). Long Grove, IL: Waveland Press.** **5. Joshi, P.K., & Singh, T.P. (2011). *Geoinformatics for Climate Change Studies.* New Delhi, India: TERI Press.** **6. Joshi, P.K., Pani, P., Mohapartra, S. N., & Singh, T.P.**	**The learning outcomes and Suggested e-learning material have been reviewed.** **The learning outcomes and Suggested e-learning material have been reviewed.** **New lab exercises are introduced according to the theoretical course content that would be helpful in enhancing the practical knowledge of the students from "efficient pre-processing of**

				(2010). *Geoinformatics for Natural Resource Management*. New Delhi, India: Nova. 7. Lillesand, T. M., Kiefer, R. W., &Chipman, J. (2015). *Remote Sensing and Image interpretation* (7th ed.). New York, NY: John Willey & Sons. 8. Roy, P. S., Westen, C. J. V., Jha, V. K., Lakhera, R. C., & Ray, P. K. C. (Eds.). (2000). *Natural disasters and their mitigation: a remote sensing perspective*. Dehradun, India: IIRS. 9. Schultz, G. A., &Engman, E. T. (2000).*Remote sensing in Hydrology and Water Management.* Berlin, Germany: Springer Suggested e-learning materials: 1. ENVI Tutorials : (Hyperspectral Image Analysis) https://www.harrisgeospatial.com/Support/SelfHelpTools/Tutorials.asp 2. Erdas Imaging Exercises with Sample Data Sets https://download.hexagongeospatial.com/en/downloads/imagine/erdas-imagine-remote-sensing-example-data 3. Applications Guide https://www.itc.nl/ilwis/applications-guide/ 4. Data & Products http://glcf.umd.edu/data/ 5. Bhuvan Portal http://ww12.bhuvan.com 6. Data & Products https://earthexplorer.usgs.gov/ 7. Meteorological and Oceanographic Satellite Data Archival Centre https://www.mosdac.gov.in/ 8. National Information System for Climate and Environment Studies https://nrsc.gov.in/nices 9. Agriculture Practices https://nptel.ac.in/courses/126104002/ 10. Water Resources Information System http://www.india-wris.nrsc.gov.in/wrpinfo/index.php?title=Main_Page	the data" to "advanced pattern recognition exercises". Recent trend based applications have been added

12	**RS ___L Remote Sensing Lab-IV**	**After the completion of this course, students should be able to:** • **Prepare the Ortho-images using Photogrammetry software's** • **Collect geographic co-ordinates using DGPS and post-processing of the attributes using standard software's.** • **Generate contour maps for the DEM generation.** • **Describe and design the concept of spatial databases its components, models, mining, analysis and visualization.** • **Acquire and apply the strength and applications of Arc model builder.**		**Course Content:** 1. Stereovision exercise. 2. Preparation of ortho image using Leica Photogrammetry Suite 3. Contour generation using orthophoto or Images. 4. Introduction to GPS and initial setting. 5. Creating codes and attribute table in receiver. 6. Point data collection using GPS with different datum. 7. Line data collection using GPS and measurements. 8. GPS data collection for area calculation. 9. Post processing of the DGPS data. 10. GPS and GIS integrations output preparation. 11. Contour generation using GPS point data. 12. Image rectification using GPS coordinate data. **13. DEM generation using Interferometry.** **14. Construction of 3D model.** 15. Point pattern analysis. 16. Cluster analysis. 17. Geostatistics (Surface generation). 18. Network analysis. 19. Dynamic segmentation. 20. Terrain analysis. 21. Hydrological modelling. 22. Introduction to model builder. 23. Interactive model. **Recommended Books:** **1. Gopi, S. (2005). *GPS and Surveying using GPS*.New Delhi, India: Tata McGraw-Hill.** **2. Leick, A. (2004). *GPS Satellite Surveying*(3rd ed.). New York, NY: John Wiley & Sons.** **3. Rampal, K.K. (1999). *Handbook of Aerial Photography and Interpretation*. New Delhi, India: Concept.** **4. Colwell, R. N. (1983). *Manual of Remote Sensing*(2nd ed. vol.1).Falls Church, VA: ASPRS.** **5. Terry, K. S. (2000).*Integrating GIS and the Global Positioning System*. New Delhi, India: ESRI Press.** **6. Allen, D.W. (2011). *Getting to know ArcGIS Model builder*. New Delhi, India: ESRI Press.** **7. Carter, G. B. (1994). *GIS for Geoscientists: Modeling with GIS*. Amsterdam, Netherlands: Elsevier.**	**The components have been modified and consolidated.** **The learning outcomes and Suggested e-learning material have been reviewed.** **Restructuring of the exercises have been done.**

				8. Burrough, P. A., & McDonnell, R. (1998). *Principles of Geographical Information Systems*(3rd ed.). New York, NY: Oxford University Press. 9. Chang, K.T. (2002). *Introduction to Geographic Information Systems*(3rd ed.). New Delhi, India: Tata McGraw Hill. **Suggested e-learning materials:** 1. Aerial Photography https://nptel.ac.in/courses/105104167/4 2. Photogrammetry https://nptel.ac.in/courses/105104100/18 3. Drone https://www.dronethusiast.com/tutorials 4. Digital Elevation Model and applications https://swayam.gov.in/courses/4395-digital-elevation-models-and-applications 5. Digital Elevation Model http://gazebosim.org/tutorials?tut=dem 6. Hydrologic Simulation Models https://nptel.ac.in/courses/105101002/36	
13.	**RS ___** **Term Paper-II/Minor Project-II/Seminar-II**	**After the completion, students should be able to:** • Identify research problems related to the study domain. • Apply the principles, tools and techniques to solve the selected complex geospatial problem. • Analyze the research outcomes and suggest feasible/ practical solutions. • Deliver an effective technical			**New component have been introduced.**

		presentation on selected research problem and prepare the term paper/project/ seminar report.			

THIRD SEMESTER

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	~~**RS 601R: Geo-informatics in Human Settlement Analysis**~~	~~**After the completion of this course, students should be able to:**~~ ~~• **Study role of geoinformatics in human settlement analysis and planning.**~~ ~~• **Identify the factors for urban development and plans.**~~ ~~• **Describe the urban landuse classification.**~~ ~~• **Apply spatial planning in effective urban management.**~~	~~**Introduction**~~ ~~Geo-informatics for human settlement analysis; Planning definition; Scope and evaluation of human settlement, Economic planning, Data requirement of Urban and Regional planning~~ ~~**Interpretation of rural settlement**~~ ~~Type of rural settlement, existing rural land use, Interpretation of rural land use / land cover classification, rural development plan in India, rural poverty programme in India, Geo informatics for soil type, water, drainage system and transportation system in rural area.~~ ~~**Interpretation of urban settlements**~~ ~~Urban Master plan, city development plan and guidelines, urban land use classification; environmental and socioeconomic factors for urban development~~ ~~**Details development plans**~~ ~~Population projection, exiting urban land use, housing problems and development, urban information system~~ ~~**TEXT BOOKS:**~~ ~~T1 Jean Paul Donnay, Michael J.Barnsley and Paul A.Longley,2001, "Remote Sensing and Urban, Taylor & Francis, London~~ ~~T2 TarekRashed and CarstenJurgen, 2010, " Remote Sensing for Urban and Suburban Areas" Springer, London~~ ~~T3 Peter Hall and Mark Tewder Jones, 2011, "Urban and Regional planning", Taylor & Francis, London~~		**The course has been replaced by new course**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
2.	**RS 602R: Pattern Recognition and Processing**	**After the completion of this course, students should be able to:** • **Define techniques of Radiometric, Atmosphericand Geometric correction.** • **Explain spatial and spectral interpolation techniques.** • **Describe PCA and TCA techniques.** • **Applyadvanced pattern recognition, information extraction and image fusion techniques.**	**Fundamental** Radiometric and Geometric correction technique for various sensors, gains and bias value of different sensor, Atmospheric correction types and methods, Interpolation methods – linear and nor linear transformation for geometric corrections. **Advance Research** Advance research in Spatial and Spectral interpolation, spatial enhancement techniques, Contrast stretching: Linear and non linear methods. Principal component analyses, TCA, Texture Analysis and its types, conversion of radiance to temperature. **Pattern Recognition and Information Extraction** Concept of pattern recognition, Multi spectral pattern recognition, Spectral discrimination Artificial intelligence, Fuzzy algebra, Artificial Neural networks, Expert systems, analysis of hyper spectral data, Image compression technique and types. Image fusion techniques and application **TEXT BOOKS:** T1 Jensen, JR., Remote Introductory Digital Image Processing (3rd Edition), Prentice Hall, 2004 T2 Jensen, JR., Remote Sensing of the Environment-An Earth Resources Perspective, Prentice Hall Inc. T3 Sabins, Floyd F., Remote Sensing: Principles and Interpretation, H. Freeman and C., New York. **REFERENCE BOOKS:** R1 Gibson, P.J., Introduction to Remote Sensing, 2nd ed., Taylor & Francis, London		**The course has been replaced by new course**
3.	**RS 605R: Remote Sensing in Environment Studies**	**After the completion of this course, students should be able to:** • **Describe principles of environmental modeling.** • **Explain Remote Sensing applications in water, land and air quality management.** • **Integrate remote**	**Principles** Ecological and biological aspects of environment, atmosphere, hydrosphere, lithosphere, biosphere **Pollution** Types of pollution, chemistry of pollution, concentration of pollution, Remote sensing application for air, water and land and soil pollution **Environmental management** Water, land and air quality management, solid waste management, Application of remote sensing in solid waste management, pollution monitoring **Impact Assessment** Basic concept, Environmental Impact Assessment (EIA), Method of EIA, Benefit of EIA, impact of man on biosphere, Natural Disaster. **TEXT BOOKS:** T1 Jenson, J.R. 2000.Remote Sensing of the environment An Earth		**The course has been replaced by new course**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		~~**sensing in solid waste management.**~~ • ~~**Explain methods and benefits of Environmental Impact Assessment (EIA).**~~	~~Resource Perspective, Prentice Hall Inc~~ ~~T2 P.K. Joshi, P. Pani,S. .N. Mohapartra and T.P. Singh, Ed 2010 "Geoinformatics for Natural Resource Management", Nova Publishers,India~~ ~~T3 P.K. Joshi and T.P. Singh (2011). Geoinformatics for Climate Change Studies, TERI Press, New Delhi~~ ~~T4 P. S. Roy (2000).Natural Disaster and their mitigation. Published by Indian Institute of Remote Sensing (IIRS), 2000.~~		

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	**RS 603P Project** **(Part I)**	**After the completion, students should be able to:** • **Select a relevant research topic related to social and engineering problems, natural disaster, decision support system etc. with integration of geospatial technologies.** • **Evaluate and review significant existing literature of the topic selected.** • **Collect various geospatial data products, required to carry out the research and formulate the methodology to solve the identified problem** • **Deliver well-organized technical presentations and prepare the mid-term report.**			**The learning outcomes have beenreviewed.**

FOURTH SEMESTER

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
2.	**~~RS 606R: Remote sensing in Hydrology and Water Resources~~**	**After the completion of this course, students should be able to:** • **Describe fundamentals related to satellite imaging based hydrological investigation.** • **Apply hydro geomorphology based interpretation knowledge for the identification of potential ground water resources.** • **Explain concepts of watersheds leading to its inventory and effective management.** • **Explain methods of snow cover mapping based on hydrological and GIS based models.**	**Basic Concept** Hydrological cycle~~, hydrological parameter~~, Darcy,s Law, ~~porosity, permeability, Transmissibility, specific yield, specific capacity~~, ~~field capacity and depressionstorage; role of remote sensing in evaluation hydrological investigations.~~ **Ground Water Exploration** Surface and ground water, classification of stream and rivers, type of aquifer, ~~aquiclude, aquitard, aquifuge~~, ground water regimes, application of remote sensing for the hydro geomorphological interpretation. **Watershed Management** ~~Drainage network and drainage pattern,~~ watershed definition and scope, morphometric parameter, watershed inventory and management. **Remote sensing in water resource Evaluation** Estimation of precipitation, interception, soil moisture, evaporation run off and discharge, hydrological models in GIS and snow cover mapping. **~~TEXT BOOKS:~~** ~~T1 Karanth, K.A, 2008, "Ground water assessment Development and management Tata McGraw Hill~~ ~~T2 JVS Murty, 2004, "Watershed management" New Age International Pvt Ltd, New Delhi~~ ~~T3 Jenson, J.R. 2000.Remote Sensing of the environment An Earth Resource Perspective, Prentice Hall Inc.~~		**This course has been shifted to reading elective pool with significant pool.** **The learning outcomes and Suggested e-learning material have been reviewed.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
3.	**RS 607R: Remote sensing in Resource management.**	**After the completion of this course, students should be able to:** • **Define resource classification systems.** • **Identify parameters of natural resource inventory and mapping.** • **Explain desertification monitoring.** • **Describe the potentials of wildlife habitat and biodiversity conservation.**	**RS 607R: Remote Sensing in Resource Management** **Concept of Resources** Resources classification systems, criteria of classification, natural and cultural resources **Resources Inventories** Identification, resources survey, base map preparation, problem identification, thematic mapping and resources monitoring **Desertification Monitoring and habitat assessment** Desertification Assessment and monitoring,wildlife habitat assessment, animal population **Resources regions** Demarcation of resource potential, resource conservation and planning for development, resource and geographical information system. **TEXT BOOKS:** T1 Lillisand, T. M. and Keifer, R. W. 1994. Remote Sensing and Image interpretation', John Willey and Sons, New York, Third Edition. T2 Jenson, J.R. 2000.Remote Sensing of the environment An Earth Resource Perspective, Prentice Hall Inc. T3 Skidmore, Andrew, 2002,"Environmental Modelling With GIS and Remote Sensing", Taylor & Francis Routledge		**The course has been replaced by new course**
3.	**RS 608R: Spatial Modeling and Resource Model**	**After the completion of this course, students should be able to:** • **Define methods and applications of clustering.** • **Describe raster based modeling methods and mapping.** • **Explain the concepts of autocorrelation and its applications.** • **Apply Geo statistics using various approaches.**	**Vector Base Modeling** Clustering methods and application; Network analysis and its process: shortest path model, Smeed's Index; address Geocoding, Optimum Routing Dynamic Segmentation: Route, Section, Events; application of network and dynamic segmentation. **Raster Base Modeling** Process and derivation of local neighbourhood operation: Reclassification, filter, slope, Aspect; Method of optimum path and cost allocation; environmental modeling on cost analysis, corridor mapping. **Geo Statistics** Spatial Interpolation and Geostatistics with equation: Local and global methods, Gravity model, Regression model, Pattern analysis, Moran's I, Cluster analysis, Trend surface Analysis. **Spatial Interpolation** Equation and derivation: Thiessen polygon, Density estimation, Inverse Distance Weight (IDW), Thin – plate Spline, Kriging – ordinary and Universal, Semivariogram; Spatial Autocorrelation and its procedure,		**The course has been replaced by new course**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
			~~Application of spatial statistics in natural resources.~~ ~~**TEXT BOOKS:**~~ ~~T1 David L. Verbyla, 2002, "Practical GIS Analysis", Taylor &Francis~~ ~~T2 David O' Sullivan and David Unwin, 2003 " Geographic Information analysis, John Wiley and Sons, Hoboken, USA~~ ~~T3 Principles of Geographical Information Systems. Oxford University Press, New York Burrough, Peter A. and Rachael McDonnell. 1998.~~ ~~T4 Kang tsung Chang 2002, 'Introduction to Geographic Information Systems' Tata McGraw Hill, New Delhi.~~ ~~T5 C.P.Lo and Albert K.W.Yeung 2005 "Concepts and Techniques of Geographic Information Systems" Prentice Hall of India, New Delhi~~		

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	**RS 604P Project (Part II)**	**After the completion, students should be able to:** • **Select a relevant research topic related to social and engineering problems, natural disaster, decision support system etc. with integration of geospatial technologies.** • **Apply the principles, tools and techniques to solve the problem.** • **Process independent research to compute and resolve the chosen issue.** **At the end the student should be able to design and carry out an experiment on her own and prepare the final**			**The learning outcomes have been reviewed.**

		technical report.			

List of Discipline Electives

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	**RS ---- Applications of Remote Sensing**	**After the completion of this course, students should be able to:** • **Identify the potentials of remote sensing in allied sectors.** • **Describe trends in remote sensing applications.** • **Apply remote sensing technology in natural resource**		**Section A** **Introduction** Emergence of Remote Sensing technology in application areas, Understanding potentials of Remote Sensing in **Defence Applications, I**ndian satellite missions with focused applications, recent trends in Remote Sensing applications. **Applicationin Land And Water Resource** Remote sensing in mapping Land use / land cover classification and monitoring, Crop forecasting, Forest resources management, soil taxonomy and degradation, geomorphology and surface mining on land resources, groundwater modelling, Water quality Monitoring, Reservoir sedimentation, Snow covers mapping and modelling approaches.	**This Course has been shifted from semester II to elective pool.** **The learning outcomes and Suggested e-learning material have been**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		and disaster management. • **Explain basics about Environmental Impact Assessment (EIA).**		**Section B** **Application in Climate Change and Disaster Management** Concept of climate and weather, Climatic classification, paleo-climate, Adaptation and vulnerability, mapping of landslide, Floods, Cyclones, Forest fire and Drought. **Application in Urban Planning** Mapping urban land use, Urban sprawl, Site selection for urban development, Urban Information System, Urban master plans, Urban green spaces, 3 D city modelling, SMART city **Section C** **Application in Geo-Technical Engineering** Digital Terrain Modelling, Geoinformatics in water harvesting site selection, Highways and Tunnel alignment studies. **Application in Environmental Management** Selection of disposal sites for industrial and municipal wastes, Solid waste management, Environmental Impact Assessment (EIA). **Recommended Books:** **1. Jenson, J.R. (2000). *Remote Sensing of the environment-An Earth Resource Perspective*(2nded.). Upper Saddle River, NJ: Pearson Prentice Hall.** **2. Joshi, P.K., & Singh, T.P. (2011). *Geoinformatics for Climate Change Studies.* New Delhi, India: TERI Press.** **3. Joshi, P.K., Pani, P., Mohapartra, S. N., & Singh, T.P. (2010). *Geoinformatics for Natural Resource Management*. New Delhi, India: Nova.** **4. Lillesand, T. M., Kiefer, R. W., &Chipman, J. (2015). *Remote Sensing and Image interpretation* (7th ed.). New York, NY: John**	**reviewed.** **Essential application is added following the modified national security policies.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				Wiley & Sons. **5. Roy, P. S., Westen, C. J. V., Jha, V. K., Lakhera, R. C., & Ray, P. K. C. (Eds.). (2000). *Natural disasters and their mitigation: a remote sensing perspective*. Dehradun, India: IIRS.** **6. Schultz, G. A., &Engman, E. T. (2000).*Remote Sensing in Hydrology and Water Management.* Berlin, Germany: Springer.** **Suggested e-learning materials:** **1. Applications Guide** **https://www.itc.nl/ilwis/applications-guide/** **2. Data & Products** **http://glcf.umd.edu/data/** **3. Bhuvan Portal** **http://ww12.bhuvan.com** **4. Data & Products** **https://earthexplorer.usgs.gov/** **5. Meteorological and Oceanographic Satellite Data ArchivalCentre** **https://www.mosdac.gov.in/** **6. National Information System for Climate and Environment Studies** **https://nrsc.gov.in/nices** **7. Agriculture Practices** **https://nptel.ac.in/courses/126104002/** **8. Water Resources Information System** **http://www.indiawris.nrsc.gov.in/wrpinfo/index.php?title=Main_Page**	
2.	**RS ____: Applied Statistics and Research Methodology**	**After the completion of this course, students should be able to:** • **Formulate research problems using geo-statistical methods.** • **Apply statistical knowledge to the geospatial**		**Section A** **Data Distribution and Basic Statistics** Scope and importance of statistics, Source of data-primary and secondary, Collection of data-sampling methods; Random and systematic method; Organization of data-array, Frequency, Class intervals, Histograms, and distribution, Presentation of data-Tables, Diagrams; Geometric form (Bar diagrams, Pie-diagrams), Frequency diagrams (histogram, polygon), Arithmetic line graphs (time series graph); Data grouping, Geographical data- Discrete and continuous series, Scales of measurement, Measures of central tendency-Mean, Median, Mode, Quartiles, Arithmetic mean, Geometric mean, Harmonic mean, Quadratic mean and their interrelated relations; Measures of dispersion-Absolute dispersion (range, quartile deviation, mean deviation, standard deviation); Relative dispersion (Coefficient of	**This Course has been shifted from semester I to elective pool.** **The learning outcomes and**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		variability. • **Define research problems and selection of survey methods.** • **Writing project proposal for various funding**		quartile deviation, Coefficient of variation), Moments, Skewness, Kurtosis **Section B** **Correlation, Probability and Hypothesis Testing** Correlation-meaning, Scatter diagram, standard deviation, Variance, Measures of Correlation-Karl Pearson's method (Two variables ungrouped data) Spearman's rank correlation methods. Probability-Binomial, Normal, and Poisson distribution; Theory of Sampling - Sampling distributions of means and proportions, Standard errors, Confidence interval estimation for population means, Standard deviations, Testing of Hypothesis – Large and small sample test. **Basic Conceptof Research Methodology** Definition of Research Problem, Identification of problems of regional and Local level, Considerations in selection of problem, Research process, Review of literature, Research objectives and research questions, Research scheme/design. **Section C** **Data Collection, Analysis and Reports** Methods of data collection, Survey methods, Samples-Type and methods, Data processes and analysis, Reporting of results, References, Future scope of work. **Preparationof Research Projects** Writing of proposals, Objectives of project, Research hypothesis and design, Research Questions, Scope of project, Brain storming sessions, Finalization of methodology, Review of similar studies and present level of research, Time scheduling (PERT), Financial estimates, Submission of Proposal. Project planning, Project activities/tasks, Feasibility, Resource requirements and allocation, Project management software, Project review, Project Completion-Quality assurance, Evaluation of individual tasks, Financial auditing, Problems and opportunities in Projects. **Recommended Books:** **1. Gupta, S. C., &Kapoor, V. K. (2000). *Fundamental of Mathematical Statistics* (10th ed.). New Delhi, India: S. Chand.** **2. Gupta, S. L., & Gupta, H. (2011). *Research Methodology Text and Cases with SPSS Applications.* New Delhi, India:**	**Suggested e-learning material have been reviewed.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				International book House. **3. Kothari, C. R. (2004). *Research Methodology Methods and Technique* (2nd ed.). New Delhi, India: New Age International.** **4. Meyer, P. L. (1970). *Introductory Probability and Statistical Applications* (2nd ed.). Washington, WA: Addison-Wesley.** **5. Spiegel, M. R. (2011). *Theory and Problems of Statistics* (4th ed.). New York, NY: McGraw Hills.** **Suggested e-learning materials:** **1. Sampling distribution** **https://nptel.ac.in/courses/111105041/23**	
3.	**RS ___: GeospatialEntrepreneurship**	**After the completion of this course, students should be able to:** • **identify the elements of success of entrepreneurial ventures,** • **evaluate the effectiveness of different entrepreneurial strategies** • **Interpret importance of the entrepreneurial infrastructure** • **recogniseGeo**		**Section A** **Concepts and theory of Entrepreneurship** Entrepreneurship- definition, Need and Significance of Entrepreneurship Development in Global contexts. Entrepreneurship Development – concepts, Process, Experience and strategies. Dynamics of Entrepreneurship Development,Entrepreneurs Skills and Competencies **Section B** **Entrepreneurship Development** Characteristics and role demanded of an Entrepreneur, Process of Developing Entrepreneur Qualities Enterprise Launching & Resources: Government Programmes, Policies, Incentive and Institutional Networking for Enterprise setting, Steps of setting new Enterprise, Scanning Business Environment, Sensing Business opportunity & Identifying Product.Challenges of new startup. **Section C** **Geospatial innovation and Entrepreneurship** Geospatial sciences for harnessing technological Innovation. Enterprise GIS Role of various national and state agencies, .Remote sensing and GIS component in Government of India PSU and in MNC. Case study of successful geospatial Entrepreneurs in India.	**New course introduced based on professional skills**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		spatial technology for harnessing Innovation and Entrepreneurship		**Recommended Books:** 1. Sethi, A. (2016). *From Science to Startup: The Inside Track of Technology. Entrepreneurship.*Göttingen, Germany: Copernicus & Springer. 2. Westhead, P.,& Wright, M.(2013). *Entrepreneurship. A very short introduction*. Oxford, UK: Oxford University Press. 3. Roger Tomlinson (2013) *Thinking About GIS: Geographic Information System Planning for Managers, Fifth Edition*, New York, NY:ESRI Press. **Suggested e-learning materials:** 1. **Entrepreneurship Development** https://www.tutorialspoint.com/entrepreneurship_development/ 2. **Enterprise GIS** https://www.esri.com/library/bestpractices/enterprise-gis.pdf	
4	RS___: Geospatial Intelligence	After the completion of this course, students should be able to: • Explain concepts and components of Geospatial Intelligence. • Explain different aspects of spatial cognition and their characteristics. • Describe multiple intelligence and		**Section A** **Geospatial Intelligence: Introduction and Background** Geospatial intelligence (GEOINT): Definition, Introduction: perceptality and convergence of digital and physical worlds. Spatial Intelligence to Spatial Competence; Components of Spatial Intelligence: Identifying components of spatial thinking- spatial ability measures, examination of spatial expertise. Intelligence, Surveillance, and Reconnaissance (ISR); GEOINT Trends; GEOINT: Collection and platforms; Intelligence Tasking and Collection: TCPED approach; Automatic Target	New course introduced based on AI technology is spatial domain.

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		discuss applications of geospatial technology in strategic planning and operations. • **Rationalize outlook of basic architecture of GEOINT.**		Recognition (ATR) and Remote Sensing: Introduction and basic architecture; GEOINT: Challenges /Hard problems; Uses of GEOINT. **Section B** **Concepts of Spatial Cognition and Ontology** Spatial Cognition in Geographic Environment: Definition, Cognitive processing – Cognition, Perception, Moist Map, Images, Schemata, Conceptual-Propositions, Dual Coding Behaviour, Cognitive Maps, Neural Networks. Spatial Search Processes - Introduction, Cognitive theories of search- Feature Integration Theory (FIT), Attention Engagement Theory (AET), Guided Search Theory (GST). Similarity Judgment of Places. Spatial Cognition: as an Artificial Intelligence (AI) Perspective. Spatial Ontology: Introduction and Utility. **Section C** **Multiple Intelligence: Concepts and Applications** Multiple intelligence (Multi - INT): Imagery Intelligence (IMINT), Signals Intelligence (SIGINT), Human Intelligence / Intelligence Gathering (HUMINT), Measurement and Signature Intelligence (MASINT), Open Source Intelligence (OSINT): Concept, value and application. Human Geography and GEOINT; Terrain Analysis and Aerial Photography in GEOINT; Distributed Geospatial Intelligence Network (DGInet); Command, Control, Communications, Computers, Information/Intelligence, Surveillance, Targeting Acquisition and Reconnaissance (C4ISTAR): Concept and Utility. **Recommended Books:** 1. **Waller, D., &Nadel, L. (Eds.). (2013). *Handbook of Spatial Cognition*. Washington, DC: American Psychological Association** 2. **Vecchi, T., &Bottini, G. (Eds.). (2006). *Imagery and Spatial Cognition*. Amsterdam, Pennsylvania: PA: John Benjamin's.** 3. **Lloyd, R. (1997). *Spatial Cognition Geographic Environments*. NewYork, NY: Springer.** **Suggested e-learning materials:** 1. **Distributed Geospatial Intelligence Network (DGInet):** https://www.esri.com/~/media/Files/Pdfs/industries/defense/pdfs/dgin.pdf	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				2. Multi-INT: https://www.geospatialworld.net/article/multi-int-intelligence-effective-multi-sensor-data-fusion/ **3. Human Geography and GEOINT:** https://info.publicintelligence.net/NGIA-HumanGeography.pdf **4. GEOINT Basic Doctrine:** https://geog.utah.edu/pdf/certificates/NGA-doctrine-GEOINT.pdf **5. Geospatial Intelligence and National Security:** https://gistbok.ucgis.org/bok-topics/geospatial-intelligence-and-national-security	
5.	**RS ___: GIS Programming and Scripting**	**After the completion of this course, students should be able to:** • **Describe object-oriented models and functional modeling in GIS Framework.** • **Explain concepts of common language infrastructure and class library.** • **Explain .NET and Python programming languages for geospatial tool development.** • **Rationalize the concepts of**		**Section A** **Introduction to Object Oriented** Introduction to Object Oriented modelling and Design**;** Definitionobjectoriented (OO), Object modelling Concepts, OO methodology, OO themes, Introduction to OO modelling techniques: Modelling, modelling techniques, object model, Dynamic Model and Functional Model, relationship among models. Object Modelling:Object and Classes: Object modelling concepts in details: links, association, generalization, inheritance, metadata, etc. A sample Object Model**.** Dynamic Modelling:Dynamic modelling concepts. A sample dynamic model, Relation of object and dynamic model with example. Functional Modelling:Functional Modelling Concepts, A sample functional model. **Section B** **. NET Framework** Concept of .NET framework, Common Language Infrastructure, Base Class Library and Framework Class Library. **Visual Studio.NET – IDE, Languages Supported, Components. Visual Programming, VB.NET- Features, IDE- Menu System,**	**This Course has been shifted from semester I to elective pool.** **the content is reframed to enforce the in-depth extends must for learning object-oriented programming skills** **The repeated content is removed to maintain**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		WebGIS, Server, and geo-processing functionalities.		**Toolbars, Code Designer, Solution Explorer, Object Browser, Toolbox, Class View Window, Properties Window, Server Explorer, Task List, Output Window, Command Window.** **Elements of Visual Basic .NET** **Properties, Events and Methods of Form, Label, TextBox, ListBox, Combo Box, Radio Button, Button, CheckBox, Progress Bar, Date Time Picker, Calendar, PictureBox, HScrollbar, VScrollBar, Group Box, ToolTip, Timer.** **Data Types, Keywords, Variables and Constants, Operators, Scope and accessibility of variables, Conditional Statements, Looping Statement, Arrays- Static and Dynamic.** **Menus and toolbars, Built-In Dialog Boxes, InputBox, MsgBox Functions and Procedures- Built-In Functions/ User Defined Functions and Procedures.** **Creating Classes, Objects, Fields, Properties, Methods, Events,Inheritance, Polymorphism. Constructors and Destructors, Exception handling.** **Section C** **Python Programming** Introduction to Python, variables, built- in data types, statements and expressions, strings, lists, python objects. Conditional Statements, **Looping Statement** commenting scripts, Modules and packages, functions, classes. Geoprocessing Python Scripts: Importing ArcPy, accessing data, accessing toolboxes, intersection, union and buffering, querying. **WebGIS Development** Introduction to WebGIS, Principles, Architecture - Web Server, Map	**the level of detailing and an essential component for programing logic is introduced.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				Server and Data Server, Technologies for WebGIS applications, Scripting for serving maps, map editing and geo-processing functionalities for GIS server. **Recommended Books:** **1. Fu, P.,& Sun, J. (2011). *WebGIS principles and applications*. New Delhi, India: ESRI press.** **2. Pimpler, E. (2013). *Programming ArcGIS 10.1 with python cookbook*. Birmingham, England: Packt.** **3. Zandbergen, P. A. (2013). *Python scripting for ArcGIS*. New Delhi, India: ESRI Press.** **4. Zhuang, V., Wrazien, D. R., Wang, M., & Huang, X. (2005). *Programming ASP.NET for ArcGIS Server*. Florence, KY: Thomson Delmar Learning.** **Suggested e-learning materials:** **1. VB.Net Programming Tutorial** **https://www.tutorialspoint.com/vb.net/index.htm** **2. VBA Tutorial** **https://www.tutorialspoint.com/vba/index.htm** **3. Algorithm and programming** **https://nptel.ac.in/courses/106106145/** **4. Python – Tutorial** **https://www.tutorialspoint.com/python/index.htm**	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
6.	**RS ___: Microwave, Thermal and Hyperspectral Remote Sensing**	**After the completion of this course, students should be able to:** • **Explain concepts and components of satellite radar imaging.** • **Explain different microwave sensors data (SLC and GRD) and their characteristics.** • **Describe pre-processing requirements and discuss SAR image processing techniques.** • **Rationalize outlook of SAR, thermal, and hyperspectral images.**		**Section A** **Concepts of Imaging RADAR** Concept of Microwave **RS**and its components: - Wavelength, Frequency, Pulse and **Chirping of SAR Signals, Coherence, Scattering matrix, Looks,**polarization. RAR/SAR Imaging Geometry and Concepts: - Directions: Azimuth and Range; Angles: Look, Depression, and Incident; Ranges: Slant and Ground; Resolutions: Range and Azimuth; Penetration of radar signals: Skin depth. Radar Relief Displacement: Layover, Foreshortening, Shadows. **Antenna induced radiometric distortions**. Radar Equation. Radar Image interpretation variables: Surface roughness, Dielectric properties, Backscattering, Speckles. **Concepts of Radar Polarimetry, Interferometry, and Altimetry. GPR: Principals, scope, and interpretation of Radargrams.** **Section B** **Thermal Infrared Remote Sensing** Introduction to Thermal IR radiation Laws, Thermal properties of terrain: Thermal capacity, Thermal conductivity, Thermal Inertia. Thermal IR scanners and bands**. Retrieval of LSE from RS Data: Definition of LSE, *r*, *e* and Apparent Emissivity, Characteristics of emissivity: Angular and Spectral variation of Emissivity. LST retrieval from TIRS data: Definition of LST, Definition of temperature for flat and rough surfaces, Single-Channel method of LST Retrieval, Difficulties in the estimation of LST from Space Measurement.** Thermal Image Interpretation: **Considerations.** **Section C** **Hyperspectral Remote Sensing** Spectral Radiometry – Principle, solid angle, Radiance Vs. Reflectance,**Imaging** Spectroscopy - Introduction, absorption processes	**This Course has been shifted from semester I to elective pool.** **Unit heading is modified with adequate relevance with course content** **Content is reordered by adding significant inescapable fundamentals and introductory part of advanced technical headings associated with GPR and Radar Imaging.** **Newly**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				– charge transfer, electronic and vibrational, Spectral library **and Bank**- concept, development, parameters controlling the spectra- spectral range, bandwidth, Full Width Half Maximum (FWHM), spectral sampling, S/N ratio, Bidirectional Reflectance Distribution Function (BRDF), Continuum **removal,** Imaging Spectrometers **Recommended Books:** **1. Baghdadi, N., &Zribi, M. (2016). *Microwave Remote Sensing of Land Surfaces - Techniques and Methods*. London, United Kingdom: ISTC Press-Elsevier.** **2. Borengasser, M., Hungate, W. S., & Watkins, R. (2007). *Hyperspectral Remote Sensing: Principles and Applications*. Boca Raton, FL: CRC Press.** **3. Campbell, J. B., & Wynne, R. H. (2011). *Introduction to Remote Sensing* (5th ed.). New York, NY: The Guilford Press.** **4. Henderson, F. M., & Lewis, A. J. (1998). *Principles & Applications of Imaging Radar - Manual of Remote Sensing* (3rd ed. vol. 2). Hoboken, NJ: John Wiley & Sons.** **5. Jensen, J. R. (2007). *Remote Sensing of the Environment - An Earth Resources Perspective* (2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall.** **6. Joseph, G., &Jeganathan, C. (2018). *Fundamentals of Remote Sensing* (3rd ed.). Hyderabad, India: Universities Press.** **7. Richards, J. A. (2009). *Remote Sensing with Imaging Radar*. Heidelberg, Germany: Springer** **8. Thenkabail, P. S., Lyon, J. G., &Huete, A. (2011). *Hyperspectral Remote Sensing of Vegetation*. Boca Raton, FL: CRC Press.** **9. Woodhouse, I. H. (2006). *Introduction to Microwave Remote Sensing*. Boca Raton, FL: CRC Press.** **Suggested e-learning materials:** **1. How Does SAR Works** **www.radartutorial.eu/20.airborne/ab07.en.html** **2. History of Radar Imaging** **https://www.geos.ed.ac.uk/homes/ihw/timeline.html**	**added content/topics are required for underpinning the essential component for further research** **work in microwave imaging based earth observations.** **Necessary technical contents are added that strengthen the fundamental as well as methodological approach for temperature retrieval using**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				3. Visual Introduction to radar imaging **https://www.geos.ed.ac.uk/~ihw/hype/radar/intro2radar.html** **4. Hyperspectral Image Analysis** **https://www.harrisgeospatial.com/Support/SelfHelpTools/Tutorials.aspx**	**satellite imaging.** **The LiDAR related topics are shifted to the DIP course of the second semester of M.Tech. RS, accordingly .** **Topics are reorganized accordingly.**
7.	**RS ___: Spatial decision support system**	**After the completion of this course, students should be able to:** • **Study the spatial information systems developed for a specific problem or decision-making situation.** • **Observe key concepts and**		**Section A** **Introduction** GIS and decision support systems, SDSS definition and characteristics, Introduction to decision making process and decision support systems, Introduction of a frame work for planning and decision making, Spatial Decision Making, SDSS architecture. **Database Management** Data base management system, Model based management system, Graphical and tabular report generator, User interface. **Section B**	**This Course has been shifted from semester II to elective pool.** **The learning outcomes and Suggested e-learning material**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		theories underlying spatial information systems and technology trends. • **Explore and reform the solutions to spatial problems by generating a set of alternatives and selecting from among those that appear to be viable through multi criteria analytics.** • **Illustrate and assess the emerging concepts that may impact spatial information system development and applications.**		**Analysis and Decision Making** Principles and elements of multiple-criteria decision analysis, Spatial multiple criteria decision analysis, Main multiple-criteria evaluation methods/techniques, **criteria, alternatives, weights, decision rules and sensitivity analysis**. Spatial multiple criteria evaluation in planning and decision making. **Technology and Development** Development of DSS, Technology levels, Functions and roles, Status of SDSS, Open source tools. **Section C** **SDSS Software And Its Applications** Classification of DSS software, Problem specific SDSS, Generic SDSS, Domain level SDSS, Desktop SDSS, Web-Based SDSS, SDSS applications in: natural resource management, environmental, urban, agriculture, utilities and business. **Recommended Books:** **1. House, W.C. (1983). *Decision Support Systems.* New York, NY: Petrocelli.** **2. Silberschatz, A., Korth, H. F.,&Sudarshan, S. (2011). *Database System Concepts* (6th ed.). New York, NY: McGraw Hill.** **3. Malczewski, J. (1999). *GIS and Multicriteria Decision Analysis*. New York, NY: John Wiley & Sons.** **4. Ramanathan, S. (2011). *Spatial Decision Support Systems: Principles and Practices.* Boca Raton, FL: CRC Press.** **5. Sprague, R.H., & Carlson, E.D. (1982). *Building Effective Decision Support Systems.* Englewood Cliffs, NJ: Prentice-Hall.** **Suggested e-learning materials:**	**have been reviewed.** **The repetition has been removed and gaps have been filled to maintain the continuity .**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				1. Database Management Systems (DBMS) **https://onlinecourses.nptel.ac.in/noc18_cs15/preview** **2. Geographic Information and Analysis** **http://www.ncgia.ucsb.edu/**	
8.	**RS ___: Spatial Database Systems, Analysis and Modeling**	**After the completion of this course, students should be able to:** • **Statistically evaluate the spatial entities their topological, geometric, or geographic properties.** • **Learn different analytic approaches.** • **Describe and design the concept of spatial databases its components, models, mining, analysis and visualization.** • **Apply the strength**		**SECTION A** **Advance Attribute Analysis** Basics Matrix: Addition, subtraction, multiplication, Identity, Determinant and Inverse, **Linear equation solutions using matrix** **Spatial Modeling** Spatial analysis concept: Distance, Adjacency, Interaction and neighbourhood Geospatial models- types and Modeling: Descriptive, prescriptive and predictive; Normalization, level of measurement, Introduction to modeling& flowcharting, Map algebra-operators & operations, Functional operations, Modeling essentials, Spatial interaction models. Conceptualizing the model, Model formulation, Conflict resolution and Prescriptive modeling, Model verification. **SECTION B** **Spatial Analysis** Point Analysis: Coordinate, Distance – Nearest Neighbour Distance, Density – Quadrant and other methods	**This Course has been shifted from semester II to elective pool.** **The learning outcomes and Suggested e-learning material have been reviewed.** **An application component based on**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		and applications of Arc model builder.		**Geo-Statistics** Spatial Interpolation and Geostatistics: Local and global methods, Gravity model, Regression model, Pattern analysis, Moran's Index, Cluster analysis, Trend surface Analysis Thiessen polygon, Density estimation, Inverse Distance Weight (IDW), Thin – plate Spline, Kriging – ordinary and Universal, Semivariogram; Spatial Autocorrelation **Section C** **Geocoding and Network Analysis** Address Geocoding, Optimum Routing, Closest facilities, Resource Allocation, Network Analysis, Dynamic Segmentation: Route, Section, Events and its application. **Digital Terrain** Terrain mapping: Source of existing elevation data, quality and standard of DEM data, Counting, Vertical profile, Hill shading, Slope, Aspect, Surface Curvature, Digital terrain visualization 2D and 3D; Application of Digital terrain models **Arc GIS Model Builder** Concepts of Model Builder, Model elements: Tools, Variables, Connectors, setting up Models, Executing Model, Model Validation, Model builder to create Tools – Advance techniques in Model Builder, Geoprocessing Techniques in Model Builder **Recommended Books:**	**matrix is introduced.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				1. Allen, D.W. (2011). *Getting to know ArcGIS Model builder*. New Delhi, India: ESRI Press. 2. Carter, G. B. (1994). *GIS for Geoscientists: Modeling with GIS*. Amsterdam, Netherlands: Elsevier. 3. Burrough, P. A., & McDonnell, R. (1998). *Principles of Geographical Information Systems*(3rd ed.). New York, NY: Oxford University Press. 4. Chang, K.T. (2002). *Introduction to Geographic Information Systems*(3rd ed.). New Delhi, India: Tata McGraw Hill. 5. Fotheringham, A. (1988). *Spatial Interaction Models: Formulations and Applications*. Dordrecht, Netherlands: Springer. 6. Laurini, R., & Thompson, D. (1998). *Fundamentals of Spatial Information Systems*. London, England: Academic Press. 7. Lo, C.P., &Yeung, A. K.W. (2005). *Concepts and Techniques of Geographic Information Systems*(2nd ed.). New Delhi, India: Prentice Hall of India. 8. MacDonald, A. (1999). *Building a Geodatabase*. Redlands, CA: ESRI Press. 9. Samet, H. (1990). *The Design and Analysis of Spatial Data Structures*. Washington, WA: Addison–Wesley. 10. Silberschats, A.,&Korth, H.F. (1998). *Database System Concepts*(3rd ed.).New York, NY:McGraw-Hill. 11. Sullivan, D. O., &Unwin, D. (2010). *Geographic Information analysis* (2nd ed.). Hoboken, NJ: John Wiley & Sons. 12. Verbyla, D. L. (2002). *Practical GIS Analysis*. London, England: Taylor &Francis. **Suggested e-learning materials:** 1. Digital Elevation Model and applications https://swayam.gov.in/courses/4395-digital-elevation-models-and applications 2. Digital Elevation Model http://gazebosim.org/tutorials?tut=dem	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				3. Hydrologic Simulation Models **https://nptel.ac.in/courses/105101002/36** **4. Model Builder** **http://desktop.arcgis.com/en/arcmap/10.3/analyze/modelbuilder/what-is-modelbuilder.htm**	

List OfReading Electives

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
1.	**RS ___R: Environmental Remote Sensing and Modeling**	**After the completion of this course, students should be able to:** • **Describe principles of environmental modeling and taxonomy of environmental models in the spatial sciences.** • **Explain Remote Sensing applications to monitoring wetland dynamics and**		**Principles of environmental modeling. Taxonomy of environmental models in the spatial sciences**.Basic concept, Environmental Impact Assessment (EIA): Basic concepts, method, and Benefit. **Integrated Environmental Modeling (IEM): A vision and roadmap for the future. Sensitivity Analysis: Importance in environmental modeling. Spatial multi-criteria evaluation and environmentalmodeling.** Application of remote sensing in solid waste management, **waterpollution monitoring and air pollution monitoring. Remote Sensing of urban biophysical environment: components and "urban heat islands" monitoring. Remote Sensing applications to monitoring wetland dynamics: Functions and values of Ramsar Sites (India). Aboveground terrestrial biomass and carbon stock estimations from Multi-sensor remote sensing: Global carbon budgets and remote sensing. Ecological characterization of vegetation using multi-sensor**	**New course introduced based on emerging technologies.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		management of Ramsar sites. • **Apply concepts of remote sensing in urban biophysical environmental modeling and management.** • **Explain methods and benefits of Environmental Impact Assessment (EIA).**		**remote sensing in the solar reflective spectrum. Principles and Practices of data fusion in multi-sensor remote sensing for environmental monitoring.** **Recommended Books:** **1. Brimicombe, A. (2009). *GIS, Environmental Modeling and Engineering* (2nd ed.). Boca Raton, FL: CRC Press.** **2. Chang, N. B., &Bai, K. (2018). *Multisensor Data Fusion and Machine Learning for Environmental Remote Sensing*. Boca Raton, FL: CRC Press.** 3. Joshi, P. K., & Singh, T. P. (2011). *Geoinformatics for Climate Change Studies*. New Delhi, India: TERI Press. 4. Joshi, P. K., Pani, P., Mohapartra, S. N., & Singh, T. P. (Eds.). (2010). *Geoinformatics for Natural Resource Management*. Punjab, India: Nova. **5. Reddy, G. P. O., & Singh, S. K. (Eds.). (2018). *Geospatial Technologies in land resource mapping, monitoring and management.* New York, NY: Springer-nature.** **6. Skidmore, A. (2002). *Environmental Modelling with GIS and Remote Sensing.* London, United Kingdom: CRC Press.** **7. Thenkabail, P. S. (2015). *Land Resources Monitoring, Modeling, and Mapping with Remote Sensing*. Boca Raton, FL: CRC Press.** **8. Weng, Q. (2011). *Advances in Environmental Remote Sensing: Sensors, Algorithms, and Applications.* Boca Raton, FL: CRC Press.** **Suggested e-learning materials:** **1. Taxonomy of environmental models in the spatial sciences** https://research.utwente.nl/en/publications/taxonomy-of-environmental-models-in-the-spatial-sciences **2. Ramsar Convention** https://www.ramsar.org/about-the-ramsar-convention	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
2.	**RS ___R: Geo-informatics for resource management**	**After the completion of this course, students should be able to:** • **Define resource classification systems for different natural and cultural resources.** • **Explain methods related to natural resource inventory and mapping.** • **Apply concepts of multiresolution approach for wildlife habitat assessment and corridor mapping.** • **Explain the principles of biodiversity conservation, and essential ecosystem services for sustainable development.**		**Concepts of resources management in realms of environmental sustainability:** criteria and classification systems, **natural resources,** Natural **resources inventory and planning system in India:identification of local and regional problems**, base map preparation, thematic mapping and resources monitoring; Geospatial techniques in desertification assessment **and control; Multi-resolution approach for wildlife habitat modeling: Major causes-outcomes of Human-wildlife conflicts, concept of habitat connectivity, corridor, or GIS based habitat modelling, Habitat Suitability Index; The Illegal wildlife trade: issues and challenges, monitoring organizations (i.e., TRAFFIC: The wildlife trade monitoring network, WCCB-Wildlife Crime Control Bureau, India: Structure and function); Geoinformatics based identification of potential natural resources, their conservation and planning for Sustainable development;Biodiversity conservation: potential, benefits and essential ecosystem service; Application of GIS to biodiversity monitoring; United Nations Decade on Biodiversity (2011-2020)** **Recommended Books:** 1. **Adams, C. E. (2016).** ***Urban Wildlife Management*** **(3rd ed.). Boca Raton, FL: CRC Press.** 2. **Conover, M. R. (2001).** ***Resolving Human-Wildlife Conflicts: The Science of Wildlife Damage Management.*** **Boca Raton, FL: CRC Press.** 3. **Fulbright, T. E., & Hewitt, D. G. (Eds.). (2007).** ***Wildlife Science: Linking Ecological Theory and Management Applications*****. Boca Raton, FL: CRC Press.** 4. **Jenson, J. R. (2000).** ***Remote Sensing of the environment - An Earth Resource Perspective*** **(3rd ed.). Upper Saddle River, NJ: Pearson's Prentice Hall.** 5. **Singh, C. K. (2018).** ***Geospatial Applications for Natural Resources Management.*** **Boca Raton, FL: CRC Press.** 6. Skidmore, A. (2002). *Environmental Modelling With GIS and Remote Sensing*. London, United Kingdom: **CRC Press.** 7. **Thenkabail, P. S. (2015).** ***Land Resources Monitoring, Modeling, and Mapping with Remote Sensing*****. Boca Raton, FL: CRC Press.** **Suggested e-learning materials:**	**New course introduced based on emerging technologies.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				1. The Potential, Realized and Essential Ecosystem Service Benefits of Biodiversity Conservation http://www.gibbs-lab.com/wp-content/uploads/2015/09/ 2. TRAFFIC https://www.worldwildlife.org/initiatives/traffic-the-wildlife-trade-monitoring-network 3. 2011-2020 Decade on Biodiversity https://www.cbd.int/2011-2020/ 4. Habitat Connectivity Analysis https://waconnected.org/habitat-connectivity-analyses/ 5. GIS based Corridor modeling http://corridordesign.org/designing_corridors/resources/gistools	
3.	RS ___R: Geospatial BigData: Challenges and Opportunities	After the completion of this course, students should be able to: • Describe trinity of understanding BigData. • Describe geocomputation and massive remote sensing data handling and associated challenges. • Apply concepts of parallel computing and internet of Things (IoT) in Geospatial BigData handling. • Explain recent technology trends in public dissemination of the real-time geospatial data		Geospatial BigData: Introduction, Definition, trinity of understanding BigData, common and individual challenges. Geospatial data and virtual reality (VR) development: Augmented Reality, Mixed Reality, and Virtual Reality GIS (VR-GIS). Geospatial data, 4V's properties, and 3C's. Voxels: concepts and application in 3-D urban scene modeling. Internet of Things (IoT): Concept, real-time monitoring and ArcGIS GeoEvent Server. Spatial Online Analytical Processing (SOLAP): Introduction and applications in Geomatics. Geocomputation and Earth Observations: Introduction and concept of "Context-awareness" and "Geo-smart dust". Parallel computing and massive remote sensing data handling: concepts and terminology. Open Geospatial Data Consortium (OGC): Structure, initiatives and technology trends. United Nations - Global Geospatial Information Management (UN-GGIM): Genesis, Objectives, and Initiatives. Recommended Books: 1. Nilanjan, D., Chintan, B., &Ashour, A. S. (Eds.). (2019). *Big Data for Remote Sensing: Visualization, Analysis and Interpretation.* New York, NY: Springer. 2. Plaza, A. J., & Chang, C. I. (Eds.). (2007). *High Performance Computing in Remote Sensing.* New York, NY: Chapman and Hall/CRC Press. 3. Swarnalatha, P., &Sevugan, P. (2018). *Big Data Analytics for Satellite Image Processing and Remote Sensing (Advances in*	New course introduced based on emerging technologies.

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		and analysis.		***Computer and Electrical Engineering).*** **New Delhi,India: IGI Global Press.** **Suggested e-learning materials:** 1. **OGC A to Z** http://www.opengeospatial.org/ 2. **OGC Tech Trends** http://www.opengeospatial.org/OGCTechTrends 3. **Virtual Reality Landscape** https://www.intel.com/content/www/us/en/tech-tips-and-tricks/virtual-reality-vs-augmented-reality.html 4. **The Changing Face of Geospatial Analytics** https://tdwi.org/Articles/2015/11/17/Changing-Face-of-Geospatial-Analytics.aspx?Page=2 5. **UN-GGIM** http://ggim.un.org/about/ **6. GeoEvent Server** https://www.esri.com/en-us/arcgis/products/arcgis-geoevent-server **7. Parallel computing, concepts and terminology** https://computing.llnl.gov/tutorials/parallel_comp/	
4.	**RS ___R: Open source software, services and utility application**	**After the completion of this course, students should be able to:** • **Describe current trends in remote sensing and GIS based open source software's.** • **Understand role of Geospatial technologies in government projects.** • **Familiarise with geo-statistical analysis in utility applications such**		**Open source software in remote sensing and GIS (e. g., QGIS, SAGA, Grass, ILWIS), Mobile GIS, Mobile GIS software, Location based services using mobile devices. National Centre of Geo-Informatics (NCoG), Indian National GIS Organization (INGO), geospatial technologies in Government projects such as Re-structured Accelerated Power Development and Reform Programme (R-APDRP), AGRIS, Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and National Land Records Modernization Programme (NLRMP). Concept of Medical GIS, evolution of Medical GIS, Use of GIS in public health, Spatio-temporal behaviour of disease pattern, Health Services and GIS, Geostatistical analysis in Epidemiological studies, advances in medical GIS. Crime Pattern Theory, point pattern analysis, types of crime analysis, GIS in crime analysis, Multi criteria Decision, spatial and temporal analysis of Crime using GIS, Crime mapping software. Line of sight analysis, Signal strength mapping, GIS in asset management of Power/Electric, mobile tower planning, Line routing, load**	**New course introduced based on emerging technologies.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		as crime, PWD etc. • Explain geo-statistical analysis to be used in utility applications.		forecasting, utility/assets management in PWD. Recommended Books: 1. Drummond, J. (2007). *Dynamic and Mobile GIS: Investigating Changes in Space and Time*. Boca Raton, FL: CRC Press. 2. Kurland, K. S., &Gorr, W. L. (2012). *GIS tutorial for Health* (4th ed.). New Delhi, India: ESRI Press. 3. Meehan, B. (2007). *Empowering Electric and Gas Utilities with GIS (Case Studies in GIS)*. New Delhi, India: ESRI Press. 4. Peng, Z. R., &Tsou, M. H. (2003). *Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks.* Hoboken, NJ: Wiley. Suggested e-learning materials: 1. R-APDRP http://www.ipds.gov.in/Forms/Know_More.aspx 2. Geospatial technologies in Government projects https://www.digitalindia.gov.in/ 3. QGIS https://qgis.org/en/site/ 4. SAGA http://www.saga-gis.org/en/index.html	

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
5.	RS ___R: Remote sensing in Hydrology and Water Resources	After the completion of this course, students should be able to: • Describe fundamentals related to satellite imaging based hydrological investigation. • Apply hydro geomorphology based interpretation knowledge for the identification of potential ground water resources. • Explain concepts of watersheds leading to its inventory and effective management. • Explain methods of snow cover		Fundamental of hydrological cycle and its major components; Interception and infiltration: their role in water balance in catchments; Surface and ground water, classification of stream and rivers, type of aquifers, Movement of groundwater:Darcy,s Law, Aquifer transmissivity/transmissibility, storativity and effective hydraulic conductivity; intrinsic property of aquifer materials:porosityand permeability, specific yield and retention, depression storage and hydrological losses; parameters in hydrology and water resources currently available from satellite observation; GIS-based components for rainfall-runoff models.Watershedinventory and management: definition and scope, morphometric parameters, drainage network and patterns; Advances in remote sensing-based hydro-geomorphological interpretation: hydrological applications of data from GRACE satellites, SARAL-Altika data and inland waterbodies, Quantitative Precipitation Estimates (QPE) based on remote sensing platforms. Significance of periodical and precise mapping of the snow covers for hydrological applications. Recommended Books: 1. Pawlik, A. R., Pagliara, S., &Hradecky, J. (Eds.). (2017). *Open Channel Hydraulics, River Hydraulic Structures and Fluvial Geomorphology: For Engineers, Geomorphologists and Physical Geographers.* Boca Raton, FL: CRC Press. 2. Chang, N. B., & Hong, Y. (Eds.). (2017). *Multiscale Hydrologic Remote Sensing: Perspectives and Applications*. Boca Raton, FL: CRC Press. 3. Shaw, E. M., Beven, K. J., Chappell, N.A. & Lamb, R. (Eds.). (2010). *Hydrology in Practice* (4th ed.). London, United Kingdom: CRC Press. 4. Lyon, J. G. (2002). *GIS for Water Resource and Watershed Management*. London, United Kingdom: CRC Press. Suggested e-learning materials: 1. Remote Sensing based QPE's http://satellite.imd.gov.in/dynamic/insat_3DR.htm 2. Movement of groundwater	The learning outcomes and Suggested e-learning material have been reviewed. Recent and emerging technologies have been added. Hydrology related programs are also added.

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
		mapping based on hydrological and GIS based models.		https://nptel.ac.in/courses/105103026/3 **3. Hydrological cycle and its components** http://www.fao.org	
6.	**RS ___R: Spatial Planning and Urban Development**	**After the completion of this course, students should be able to:** • **Identify the potentials of remote sensing in allied sectors.** • **Describe the land reforms in India.** • **Apply spatial planning in effective urban management.** • **Explain national and international initiatives for urban development sector.**		Geo-informatics for human settlements and infrastructure, **Evolution of human settlements,**, Economic planning, **SEZ's: Special Economic Zones in India;**Land Use / Land Cover classification in India, **Eco-Village Concept and Environment Information System (ENVIS).**Rural development plan, City development plan, Urban Master Plan and guidelines, **Urban Population Dynamics,** Housing problems and development: **United Nations-Global Housing Strategy (UN-GHS), National Urban Housing and Habitat Policy, National Urban Information System (NUIS) - ISRO: Slum upgradation: Key for overall urban development. Slum Networking Programme (SNP) in India. Land reforms in India: Vision for urban equity, inclusivity and opportunity, Concepts related to "Resilient City and Smart City". Town Planning Schemes, Urban Land Pooling Mechanism, Institutions for urban planning education, vision for national GIS (Indian context). Sustainable solutions: United Nations - Sustainable Development Goals (UN-SDG's) and United Nations Development Program, India -Millennium Development Goals (UNDP-MDG's). Spatial planning and climate change mitigation, Spatial planning strategies: (1) Macro—regions and metropolitan areas; (2) Meso—sub-regions, districts, and corridors; and (3) Micro—	**New course introduced based on emerging technologies.**

S. N.	Course List	Learning Outcome	Existing Syllabus	Suggested Syllabus	Remarks
				neighbourhoods, streets, and blocks. **Recommended Books:** **1. Lavender, S., & Lavender, A. (2015). *Practical Handbook of Remote Sensing*. Boca Raton, FL: CRC Press.** **2. Maarseveen, M. V., Martinez, J., &Flacke, J. (Eds.). (2019). GIS in Sustainable Urban Planning and Management: A Global Perspective. Boca Raton, FL: CRC Press.** **3. Rashed, T., &Jurgen, C. (Eds.). (2010). *Remote Sensing for Urban and Suburban Areas.* London, United Kingdom: Springer.** **4. Weng, Q., Quattrochi, D., &Gamba, P. E. (Eds.). (2018). *Urban Remote Sensing* (2nd ed.). Boca Raton, FL: CRC Press.** **Suggested e-learning materials:** **1. SEZ's in India http://sezindia.nic.in/** **2. ISRO-NICES https://nrsc.gov.in/nices** **3. India and the MDGs http://www.in.undp.org/content/india/en/home/post-2015/mdgoverview.html** **4. UN-Habitat's Strategic Plan https://unhabitat.org/un-habitats-strategic-plan-2014-2019/** **5. Housing & slum upgrading https://unhabitat.org/urban-themes/housing-slum-upgrading/** **6. Visions for Urban Equity, Inclusivity and Opportunity https://relocal.eu/the-just-city-essays-visions-for-urban-equity-inclusivity-and-opportunity/** **7. ENVIS http://envis.nic.in/ENVIS_html/about.html** **8. National Urban Information System (NUIS) https://www.nrsc.gov.in/NUIS**	

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

Verified

Offg. Secretary
Banasthali Vidyapith
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