DEPARTMENT OF GEO-ENGINEERING

SCHEME OF INSTRUCTION AND SYLLABUS FOR
M.Tech. (GEO-ENGINEERING)

(With effect from 2019-20 admitted batch)
M.Tech. Geo engineering course:
An applicant for admission into the M.Tech. Geo Engineering should have at least a second class with not less than 55% marks degree in either:

B.E./B.Tech. in any Engineering

OR

Master’s degree in science

In the available number of seats, 50% are reserved for B.E./B.Tech. Applicants. If sufficient number of eligible applicants is not available in either of the two groups, the eligible applicants from the other group are given admission to fill all the available seats in M.Tech. (Geo-Engineering).

1. A) A regular course of study means attendance is not less than 75 per cent of lectures, practical, drawing exercises, workshop and practical and field and project work, if any, in such semester in such subject, according to the scheme of Instruction to be notified by the Head of the Institution, provided that in special cases for sufficient cause again the Vice-Chancellor may on the recommendation of the Principal, condone the deficiency in attendance, not exceeding 10 per cent, for reasons of ill-health when the application is submitted at the time of the actual illness and is supported by an authorized Medical Officer approved by the Principal.

B) However, in the case of students who participate in activities, such as NCC, Inter-University Tournaments, National Tournaments Inter University Courses, NSS and any such other activities deemed genuine by the Head of the Department Concerned, the period of their absence for the above purpose can be condoned by the Principal on the recommendation of the Head of the Department.

2. A) There shall be a written examination at the end of each of the first two semesters in the subjects offered in the respective semesters.

B) The candidates are required to submit, at the end of the fourth semester, three copies (as prescribed) of the dissertation or before a date to be notified by the University from time to time, accompanied by three copies of a short summary, all of which will be retained by the University.

C) At the end of the fourth semester, there shall be (1) an evaluation of the dissertation, and (2) a viva voce on the dissertation and related subjects.

D) Marks for sessional work shall be allotted by the Teaching Staff of the college on the basis of class work, slip tests, practical works, etc., and the list of marks shall be sent to the Registrar, before the commencement of the written examination.

E) For taking the examination in the theory in any subject candidates shall be required to obtain a minimum of 50 per cent insessional work in that subject, failing which, they shall be required to repeat the course in that subject in the semester in which it is offered again for study.

F) Candidates who fail to secure the minimum prescribed marks in that subject will be permitted to continue the studies in the next semester. They shall, however, be required to pass the examination in the subjects in which they have failed in the subsequent examination.

G) Candidates who have secured not less than 40 per cent in any of the theory papers and not less than 50 per cent of the total maximum marks of the theory paper and sessional put together shall be declared to have passed the examination in that subject. In the case of subjects in which no written examination is prescribed, candidates should secure 50 percent of the marks allotted to each of these subjects.

3. A) The evaluation of project work / Research work will be done by conducting viva voce examination
at the end of fourth semester by a Board of Examiners consisting of:
1. Head of the Department
2. Chairman, Board of Studies
3. The Internal Research Director
4. One or two experts from outside the Department/University nominated by the Vice-Chancellor.

The dissertation shall be either “recommended” (with grades A, B, C), or “Not recommended” (with grade F stands for failed).

4. Candidates who have passed all the subjects of the course and secured not less than 60 per cent of the aggregate of marks, shall be declared to have passed in first class.

All the remainingsuccessful candidates shall be declared to have passed in second class.

5. Candidates who fail in the subjects of any semester will be deemed to have been conditionally promoted. They shall however, have to appear and pass only in the subjects in which they have failed. Candidates have to take the examination in the subjects in which they have failed during these semesters, when the University conductsthe examinations in those subjects.

6. Themarksobtained will be converted to grades on a 10-point scale and then to Semester Grade Point Average (SGPA) and subsequently Cumulative grade point average is awarded at the end of the course by University.

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### M.Tech. Geo-Engineering

**Scheme of Instructions and examination**

(with effect from 2018-2019 academic year)

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Course Title</th>
<th>Scheme of Instructions</th>
<th>Scheme of Examinations</th>
<th>Total</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>GE1.1</td>
<td>Mathematics and Statistics</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>70</td>
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<tr>
<td>GE1.2</td>
<td>Principles of Remote Sensing</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>70</td>
</tr>
<tr>
<td>GE1.3</td>
<td>Principles of Photogrammetry and Photointerpretation</td>
<td>4</td>
<td>4</td>
<td>3</td>
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<tr>
<td>GE1.4</td>
<td>Earth Systems</td>
<td>4</td>
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<tr>
<td>GE1.5</td>
<td>Elective 1</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>70</td>
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<td></td>
<td>A. Coastal Zone Management</td>
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<td></td>
<td>B. Natural Disaster Management</td>
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<td></td>
<td>C. Satellite Meteorology, Agriculture and Oceanography</td>
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<tr>
<td>GE2.1</td>
<td>Geo-ExplorationTechniques</td>
<td>Lec. 4, Lab. 0, Total 4</td>
<td>Duration of Exam. (hrs) 3</td>
<td>Theory/Lab/Viva 70 Sessional 30</td>
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<td>Geo-Engineering Investigations</td>
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<td>Duration of Exam. (hrs) 3</td>
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<td>Geographic InformationSystems</td>
<td>Lec. 4, Lab. 0, Total 4</td>
<td>Duration of Exam. (hrs) 3</td>
<td>Theory/Lab/Viva 70 Sessional 30</td>
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<td>GE 2.4</td>
<td>EnvironmentalStudies</td>
<td>Lec. 4, Lab. 0, Total 4</td>
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II SEMESTER

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### IIIrd-SEMESTER

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<th>Credits</th>
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<td>GE3.1</td>
<td>Dissertation (Preliminary)</td>
<td>Viva-Voce</td>
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### IVth-SEMESTER

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<th>Scheme of Examination</th>
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<th>Credits</th>
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<tr>
<td>GE4.1</td>
<td>Dissertation (Final)</td>
<td>Viva-Voce</td>
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<td>12</td>
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</tbody>
</table>

**PROGRAM OUTCOMES**

Upon successful completion of the program the student will gain

- **PO1.** Understanding of the principles and techniques of remote sensing and GIS their application in geospatial data analysis and management.

- **PO2.** Ability to analyze and interpret remote sensing data using various software and tools for image processing, classification, and visualization.
PO3. Knowledge of the applications of remote sensing and GIS in various fields of geo engineering, such as geohazards, natural resource management, and infrastructure planning

PO4. Ability to design and conduct independent research projects in geo engineering and remote sensing, including the formulation of research questions, data collection, analysis, and interpretation.

**PROGRAM SPECIFIC OUTCOMES**

PSO1. Awareness of the ethical, legal, and societal implications of remote sensing, including privacy and security issues, data access and ownership, and the responsible use of remote sensing data.

PSO2. Preparation for careers in geo engineering and related fields, including government agencies, private companies, and research institutions, and the acquisition of the skills and knowledge needed for lifelong learning and professional development.

**SEMESTER I**

**GE1.1-Mathematics and Statistics**

**COURSE OBJECTIVES:**
- To familiarize the students with the foundations of probability and statistical methods.
- To explain the concepts in random variables and several distributions in engineering applications.
- To teach the concepts of correlation, regression and estimations and their properties.
  - To explain the concept of testing of hypothesis for large samples.
  - To impart knowledge on small sample tests

**COURSE OUTCOMES:**

After completion of the course, the student will be able to
- classify the concepts of Data Science and its importance(L2)
- apply discrete and continuous probability distributions
- explain the association of characteristics through correlation and regression tools
- identify the components of a classical hypothesis test
Use the statistical inferential methods based on small and large sampling tests

**Unit-1** Fundamentals: Sets and Subsets, Sequences, Operations on Sets; Counting sequences, and subsets (permutations and combinations) Algorithms and Pseudocode: Induction and Recursion: Division in the integers; Matrices

**Unit-2** Relations and Digraphs; Product sets & Paths in Relations & Digraphs; Properties of Relations; Equivalence Relations; Computer Representation and Digraphs; Manipulation of Relations; Transitive closure and Warshall’s Algorithm.

**Unit-3** a) Functions; Functions - The Pigeonhole principle; Permutations b) Trees & Languages Trees; Labeled Trees; Language; Context free languages and derivation trees. Ambiguity in context free grammar.

**Unit-4** Measurement of Central Tendency, Mean, Mode, Median, Geometric mean and Harmonic Mean.

2) Measures of variations Range, Quintile deviations, Mean deviation, Standard deviation and variance, Coefficient of variations.

3) Probability concepts - Additions and multiplication laws, Basic problems on these laws. Concept of random variables and probability distribution.

**Unit-5** Theoretical distribution; Binomial, Poisson and normal with application.

2) Correlation Analysis - Introduction, Karl Pearson’s Coefficient of Correlation, Auto Correlation.

3) Regression Analysis - Linear regression analysis; Curve fitting concept of multiple regression analysis.


**TextBooks:**

1) Statistics by S.P. Gupta

2) Statistical theory and methods by SANCHETI C and Kapoor

3) Statistics by S.C. Gupta
GE1.2 Principles of Remote Sensing

COURSE OBJECTIVES
The Objective of the course is to
- Introduce the concept of remote sensing and its principles.
- Expose the various remote sensing platforms and sensors and to introduce the elements of data interpretation.
- Impart knowledge on data reception and corrections.
- Introduce thermal and microwave remote sensing techniques and their applications.

COURSE OUTCOMES
After completion of the course the student will be able to understand
- The characteristics of electromagnetic radiation and its interaction with earth features.
- The types and configuration of various satellites and sensors.
- The elements of data interpretation.
- Gain knowledge in Thermal and microwave remote sensing techniques.

andtarget, Atmospheric Widows, imaging spectrometry, Spectral signature of various land cover features

a) PLATFORMS AND SENSORS

* **Platforms:** Types of platforms, ground, airborne, and space born platforms, Orbit of satellites, Kepler’s Law, satellite characteristics, satellites for Earth observations studies, and planetary missions (Chandrayana)

* **Sensors:** Types and classification of sensors, imaging modes, Characteristics of optical sensors, sensor resolution - spectral, radiometric and temporal, Characteristics of detectors,

**Learning Outcomes:**
- Summarize the basic concepts of remote sensing and electromagnetic radiation
- Identify different platforms and sensors use in remote sensing

**Unit-II**

a) Data reception, Data processing & Data generation: * Ground station, Data generation, Data processing & correction
b) Radiometric and Geometric corrections
- Radiometric corrections
- Random noise correction
- Atmospheric correction, Geometric errors and corrections,
- Distortion evaluated from tracking data, distortion evaluated from ground control Image correction.
c) Ground Investigation in support of Remote sensing
- Uses of ground data, calibration correction, Interpretation of properties, Training sets, Accuracy evaluation, test sites
- Ground truth
- Instruments and spectral signature
- * Sources of RS data: Global and Indian data products

**Learning Outcomes:**
- After completion of this unit the student will be able to
  - Explain the concept of data generation and processing
  - Explain various errors and corresponding corrections of satellite data

**Unit-III:**

- Visual Image Interpretation: * Introduction to Visual Interpretation, Basic principles of Visual Interpretation
- Elements of Visual Interpretation, Techniques of Visual Interpretation
- Interpretation Keys, Methods of searching and sequence of Interpretation
- Methods of analysis and Reference levels
- Computer compatible tapes – Band sequential format, Band interleaved by Line format, Run-length encoding format.
- Hardcopy outputs – Generation of B/W and False Color Composites
- Generally supported scales of the data products, Information about annotation of the products.

**Learning Outcomes:**
- After completion of this unit the student will be able to
  - Explain basic principles of image interpretation
  - Identify band formats and various data products

**Unit-4**

- Thermal Imaging system:
- Radiation principles (Plank’s Law, Stephen Boltzman law), Interaction of EMR with earth surface, Wien’s displacement law, Kirchoff’s Law)
- * IR - radiometers, Airborne and Satellite TTR scanner system
- Characteristics of IR images
  - i) Scanner distortion, ii) image irregularities, iii) Film density and recorded
  - iv) Temperature ranges
- Effects of weather on images i) Clouds,
ii) Surface winds, iii) Penetration of smoke plumes * Interpretation of thermal imagery * Advantages of Thermal imagery

Learning Outcomes:
After completion of this unit the student will be able to

- Outline the concept of thermal remote sensing and related physical principles
- Identify various applications of thermal remote sensing


Learning Outcomes:
After completion of this unit the student will be able to

- Explain principles of microwave remote sensing and its applications
- Explain the concept of LIDAR and its components

List of Textbooks
GE1.3 Principles of Photogrammetry and Photointerpretation

COURSE OBJECTIVES
The Objective of the course is to
- Introduce basic concepts of Photogrammetry.
- Impart knowledge on aerial photographic measurements.
- Introduce elements of image interpretation.
- Impart knowledge on digital photogrammetry, DEMs and contours.

COURSE OUTCOMES
At the end of the course the student will be able to understand
- Photographic process and characteristics of tools used in photogrammetry.
- Concepts of stereoscopy and geometry of various types of photographs.
- The process of Planning photogrammetric operations.

UNIT- I Fundamentals of Photogrammetry and Photointerpretation – types of photographs; Vertical photographs – principal point; scale; Stereoscopy; Vertical exaggeration–factors involved and determination; Overlap, sidetand flight planning
Learning Outcomes:
After completion of this unit the student will be able to
- Explain fundamentals of photogrammetry
- Identify different parameters of aerial photographs

UNIT-II Geometric elements of vertical aerial photographs; Relief Displacement on vertical aerial photographs; Parallax and parallax measurement—monoscopic and stereoscopic methods; Determination of horizontal ground length, direction and angles from photo coordinates;

Learning Outcomes:
After completion of this unit the student will be able to
- Measure parallax from vertical photograph
- Determine ground length, directions and angles from photo coordinates.

UNIT-III Aerial mosaics: comparison with maps; Elements of aerial photo interpretation—(a) landforms; (b) surface drainage patterns; (c) erosion features, (d) gray tones; (e) miscellaneous elements.

Learning Outcomes:
After completion of this unit the student will be able to
- Compare aerial mosaics with maps
- Interpret earth surface features from photographs

UNIT-IV Digital photogrammetry: definition and scope; Photographs and images; Geo-referencing—Interior orientation, exterior orientation; Aerotriangulation—singleframe and block triangulation—pass points, tie points; ground control points; Satellite photogrammetry

Learning Outcomes:
After completion of this unit the student will be able to
- Define digital and satellite photogrammetry
- Explain the concept of geo referencing and triangulation

UNIT -V3 Surface modeling—DEMs, DSMs and DTMs; Triangulated irregular networks; Gridded surfaces; interpolation methods; Contour representation; Terrain visualization; DEM user applications.

Learning Outcomes:
After completion of this unit the student will be able to
- Explain DEMs, DSMs and DTMs
- Identify applications of DEMs

Textbooks
2. Elements of Photogrammetry, Paul R. Wolf, McGraw-Hill, 2000

GE1.4-Earth Systems

COURSE OBJECTIVES
The objective of the course is to
- Introduce concept of Oceans, climate.
- Impart knowledge on meteorological parameters and their measurement.
- Give fundamental knowledge on Geomorphology.
- Impart knowledge on different landforms of earth.

COURSE OUTCOMES
At the end of the course the student will be able to
- Understand about ocean parameters and composition of atmosphere.
- Understand and measure meteorological parameters.
- Explain the concept of monsoon in Indian context.
- Identify different landforms.
- Understand soil forming process and classification of India soils.

Unit-1
a) Earth - Orbit, Rotation, Time
b) Oceans - Depth, Bottom relief
c) Oceans - Temperature, Salinity, Density of seawater
d) Oceans - Waves, Tides, Currents
e) Climate
and the atmosphere – Origin, nature, composition and vertical division of the atmosphere.

**Learning Outcomes:**
After completion of this unit the student will be able to
- Understand basic concepts of Earth, oceans
- Explain origin and composition of atmosphere


**Learning Outcomes:**
After completion of this unit the student will be able to
- Explain seasonal, geographical variations in temperature, wind and precipitation
- Identify different weather disturbances and weather forecasting methods


**Learning Outcomes:**
After completion of this unit the student will be able to
- Explain causes and impacts of climate change
- Summarize the concept of geomorphology

**Unit-4** a) Wind and associated land forms b) Seas and associated land forms c) Land forms associated with faults and folds d) Rivers and associated landform e) Glaciers associated land forms

**Learning Outcomes:**
After completion of this unit the student will be able to
- Identify landforms associated with wind, seas, rivers and glaciers

**Unit-5** a) Soil forming processes, Soil profile, Soil components. b) Pedogenic regimes. c) Classification of soils d) Soil of India

**Learning Outcomes:**
After completion of this unit the student will be able to
• Explain the concept of soil profile and soil forming process
• Recognize soils in Indian context

List of Text Books
1. Structural Geology by Billings, M. 1984
2. Earth History & Plate Tectonics by Carl K. Seyfert, Leslie A. Sirkin
4. General Climatology by H. J. Critchfield
5. Physical Geology by Arthur Holmes
6. Physical Geography by Stahler
7. The Atmosphere by Frederick K. Lutgens and Edward J. Tarbuck
Syllabus for Elective Subjects  
GE.1.5.Elective1
(Choose any one of the following)

A. Coastal Zone Management
B. Natural Disaster Management
C. Satellite Meteorology, Agriculture and Oceanography

A. Coastal Zone Management

COURSE OBJECTIVE
The objective of the course is to
- Introduce the importance of Coastal zone management.
- Impart knowledge on coastal landforms and river deltas.
- Give knowledge on coastal wetlands and sea level changes.
- Impart knowledge on different coastal hazards.

COURSE OUTCOMES
At the end of the course student will be able to
- Understand the importance of coastal zone management.
- Gain knowledge on deltas and other coastal landforms.
- Identify different coastal wetlands.
- Understand sea level changes and different coastal hazards.
- Gain knowledge on remote sensing application in coastal zone management.

Unit 1 Coastal and littoral zones – definitions and scope of study Shore zone processes – waves, tides and currents Coastal landforms; River deltas: types of deltas and their morphological variations Human activities and their impact on the delta-fringe coasts

Learning Outcomes:
After completion of this unit the student will be able to
- Define coastal and littoral zones
- Identify types of river deltas and coastal landforms

Unit 2 Coastal wetlands – Mangrove swamps, marshes, lagoons, tidal channels/creeks and their significance in coastal stability and economic importance Continental margins – forms and processes; territorial waters and Exclusive Economic Zone Sea level changes – factors involved; effects of sea level oscillations on coastal zones; Sea-level rise and coastal vulnerability; Role of geoinformatics in assessment of coastal vulnerability to sea-level rise

Learning Outcomes:
After completion of this unit the student will be able to
- Identify different types of coastal wetlands
- Explain the effects of sea level on coastal zones
- Describe the role of geoinformatics in coastal vulnerability studies

Unit 3 Coastal Hazards: Storm surges and Tsunamis; Origin, propagation and run-up of tsunamis; Tsunami impact – role of coastal topography and vegetation; Global warming and Sea-level rise - impact on coastal zones; coastal vulnerability assessment Coastal hazard preparedness – coastal
Learning Outcomes:
After completion of this unit the student will be able to
- Explain coastal hazards like Tsunamis and storm surges
- Recognize the effect of global warming on coastal zones

Unit 4 Human activity and coastal environment – deforestation, agriculture/aquaculture, pollution and coastal structures, and their effect on coastal zones; Coastal vegetation; shelter belts; coastal aquifers; freshwater-seawater interface
Morphology of Indian coasts
Learning Outcomes:
After completion of this unit the student will be able to
- Infer the impact of human activities on coastal zones
- Understand the freshwater-seawater morphology in Indian coasts.

Unit 5 Coastal zone management– concepts, models and information systems
Coastal Regulations Zones (CRZ) and Coastal Management Zones (CMZ): Indian context
Application of remote sensing in coastal zone studies; Role of Geographic Information Systems in coastal zone studies
Learning Outcomes:
After completion of this unit the student will be able to
- Explain the concept of coastal zone management
- Summarize the applications of RS & GIS coastal zone studies

Textbooks
2. Deltas, Coleman, J.M., Continuing Education Publication Co. Inc., 1976
5. Introduction to Marine Geology and Geomorphology, King, C.A.M., Edward Arnold, 1974
GE.1.5. Elective1
Natural Disaster Management

COURSE OBJECTIVES
The objective of the course is to
- Introduce the concept of disasters and their classification.
- Impart knowledge on cyclones, earthquakes, Landsides.
- Explain the Components of disaster relief, disaster management policies.
- Impart knowledge on remote sensing and GIS applications in disaster management.

COURSE OUTCOMES
After the completion of the course, the student will be able to
- Classify various types of disasters and explain disaster management cycle.
- Explain the vulnerability scenario of India with respect to various disasters.
- Demonstrate the significance of disaster relief components, institutional arrangements.
- Apply the knowledge of geo-informatics, communication system in disaster Management.

Unit-1 Various types of Natural Disasters - Cyclones, Floods and Tidal waves with most well known Indian examples, Classification of Disasters and nature of Impacts.

Learning Outcomes:
- Classify various types of disasters
- Explain cyclones and floods with Indian examples

Unit-2 Various types of Natural Disasters - Earthquakes, land subsidence and Landslides, Forest fires, Drought with most well known Indian examples, Classification and nature of impacts.

Learning Outcomes:
- Explain about earthquakes, landslides and droughts

Unit-3 Vulnerability factors and Risk analysis of Natural disasters and Hazardestimations.

Learning Outcomes:
- Classify vulnerability factors of natural disaster
- Analyze the risk factor of natural disasters.

Unit-
4 Natural disaster management plans, Shelter belts, Special structures, Disaster preparedness and Mitigation.

Learning Outcomes:
- After completion of this unit the student will be able to
- Explain disaster management cycle
- Identify different disaster management activities

**Unit-5 Information needs**

of Disaster management, Remote Sensing Applications, GIS applications.

**Learning Outcomes:**

After completion of this unit the student will be able to

- Explain the role of Remote sensing and GIS applications in disaster management

**References**

1. Krishna Prem & Bhanfari, N.M. (1967): Risk assessment due to strong Wing storms/Cyclones and preventive measures for Habitat Buildings; Proceedings volume 1 of International Conference on Habitat and sustainable Development, December 1-2-1997 organized by Institute of Engineers (India) and World Federation of Engineering Organisations.


COURSE OBJECTIVES
The objective of the course is to
- Introduce the basic concepts of Remote Sensing of atmosphere and satellite meteorology.
- Gain the knowledge on meteorological applications in weather forecasting aviation and trade applications.
- Familiarize the Indian Meteorological satellites and sensors.
- Impart knowledge on crop identification and assessment techniques.
- Introduce ocean remote sensing concept.

COURSE OUTCOMES
At the end of the course the student will be able to understand
- Concepts of satellite meteorology and satellite sensors useful for the same.
- The applications of meteorological studies in resource management, disaster management.
- Interpret meteorological satellites images for weather systems and clouds.
- Monitor ocean parameters through satellite images.

Unit-1
1. Fundamentals of Remote Sensing in Meteorology
2. Meteorological satellite characteristics and their orbits, TIROS, NIMBUS, NOAA, TIROS N, SEASAT, GOES, METEOSAT, INSAT, OCEAN SAT. Role of LANDSAT, SPOT and IRS in collecting meteorological, agricultural andeanographic data.
4. Atmospheric temperature retrieval techniques and surfaceradiationstudies.
5. Windmeasuring techniquesfromsatellitedata.

Learning Outcomes:
After completion of this unit the student will be able to
- Explain fundamentals of meteorological remote sensing
- List out different meteorological satellite and their characteristics
- Measure Atmospheric temperature and wind from satellite data

Unit-2
1. Cloud classification techniques.
3. Interpretation of Satellite meteorological images for weather systems and cyclones.
5. SpectralbehaviorofdifferentcropsandvegetationinVIS,NIR,MIR,TIRandMicro-waveregions.

Learning Outcomes:
After completion of this unit the student will be able to
- Describe various cloud classification techniques and rainfall monitoring methods
- Estimate soil moisture and evapotranspiration from remote sensing techniques


**Learning Outcomes:**
After completion of this unit the student will be able to
- List out various principles of crop identification and yield monitoring using RS
- Explain the remote sensing applications in water resource monitoring

**Unit-4** 1. Principles of Remote Sensing of Sea 2. Visible wavelength ocean-color sensors: introduction to color sensors on Landsat, Coast zone color scanner (CZCS) on Nimbus, application and oceanographic uses of Landsat and CZCS data. 3. Introduction to infrared scanning radiometers, atmospheric correction and Sea - Surface temperature calibration techniques, interpretation and uses of SST data from satellites. 4. Passive microwave radiometers: Physical principles of passive microwave radiometry - microwave radiometer design and oceanographic interpretation of microwave data.

**Learning Outcomes:**
After completion of this unit the student will be able to
- Explain remote sensing principles of oceans
- List out different ocean monitoring satellites


**Learning Outcomes:**
After completion of this unit the student will be able to
- Explain the concept of satellite altimetry and its applications
- Define SAR and identify its applications in ocean related studies

**List of Text Books**
4. Remote Sensing in water management in command areas, Govardhan, V.
Reference Books

5. Environmental Satellites; Systems Data Interpretation and Applications. Jimmie D. Johnson, Frances C. Parme nter, Ralph Anderson, Department of Commerce, NOAA.
GE.1.6. Elective 2
(Choose any one of the following)
A. Mathematical Morphology in Image Processing
B. Water Resources Management
C. Geoinformatics for Earth Science Applications

A. Mathematical Morphology in Image Processing

COURSE OBJECTIVES
The objective of the course is to
- Impart knowledge on the basics of mathematical morphology
- Introduce morphology transformations and algorithm for image processing
- Impart knowledge on morphology based classification and segmentation techniques
- Discuss recent advances in mathematical morphology and its applications

COURSE OUTCOMES
After completion of the course student will be able to
- Explain basics of mathematical morphology
- Gain knowledge in morphological algorithms for image processing
- Performs morphology based image classification and segmentation


Unit 3: Morphology based Image Classification & Applications Binary and Grey level image segmentation-Skeletization by Zone of Influence Technique-Watershed segmentation technique- Watersnakes and PDE based-Textural segmentation-Applications of segmentation techniques in remotely sensed data classification-Segmentation of SPOT, RADARSAT, ERS SAR, and IRS data- Morphology based noise removal techniques for Microwave remote sensing data analysis-Granulometries for feature analysis Morphology for DEM analysis and terrain characterization

Unit 4: Shape Representation by morphology and shape description Exact dilations-Distance transformations-Exact distance transforms through exact dilations-Voronoi Diagrams (Graph Theory)- Scale-space skeletonization-Multi-scale morphological transformations-Shape Characterization-Perimeter-area-
Centroid- Maximal and minimal distances to centroid- Distance to the boundary-Diameter- Maximum chord-Polygonal approximation based shape decomposition-Patternspectrumprocedure.

**Unit 5:** Recent Advances in Mathematical Morphology in Image processing and analysis Fuzzy Morphology-Watersnakes and PDE based morphology, Energy minimization concepts-Theoretical grayscale morphology-Lattice theory-Discrete topology and metrics for image processing-nonlinear image filtering-connected operators-geometrical scale space-topographical segmentation-random sets and geometrical probability-integral geometry and geometrical measures-morphology applications in imagesciences.

**References:**

**Suggested Reading**
1. Gonzalez, *Digital Image Processing*
GE.1.6. Elective 2
Water Resources Management

COURSE OBJECTIVES
The objective of the course is to
- Expose student to different issues in water shed management.
- Impart knowledge on soil related studies.
- Impart knowledge on rainfall and run-off.
- Impart knowledge on integrated water management in Agriculture.

COURSE OUTCOMES
After completion of the course the student will be able to
- Understand importance of watershed management and characteristics.
- Estimate rainfall and runoff in catchments.
- Gain knowledge on integrated water management in Agriculture.

Unit-1 (Watershed Concept)
- a) Issues in watershed management - land degradation, agricultural productivity, reservoirs sedimentation, depletion of bioresources, floods and droughts. Principles and approaches - principles of watershed management, different approaches in watershed management; Problem-oriented approach, three-dimensional approaches, integrated approach, steps in watershed management.
- b) Watershed characteristics - size, shape, physiography, slope, climate, drainage, landuse, vegetation, geology, soils, hydrology, hydrogeology, socio-economics. Linear aspects of channel systems - Aerial aspects of drainage basins.

Learning Outcomes:
- After completion of this unit the student will be able to
  - Explain the principles of watershed management
  - Describe watershed characteristics

Unit-2 (Land Management)
- b) Land capability classification, land degradation and problem soils. Reclamation of saline soils, alkaline soils, saline soils, acid soils, sulphide soils; sediment yield modeling and watershed prioritization. The universal soil losses equation, sediment yield index method, statistical regression model, the European soil erosion model; Site selection from conservation measures.

Learning Outcomes:
- After completion of this unit the student will be able to
  - Explain basic soil surveying techniques
Describe land degradation problem and its mitigation

**Unit-3 (Water Management)**

- a) Surface water - Study of rainfall, estimation of run-off at micro catchments, stream gauging; Rainwater harvesting; catchment, harvesting, harvesting structures, groundwater exploration of canal command areas, potential areas; integrated water resources management, conjunctive use.
- b) Dry land Agriculture - Runoff agriculture, micro catchment forming, irrigation with saline water, reusing water, conserving water, sprinkler irrigation, drip irrigation, pot irrigation, others systems, reducing crop land percolation losses, reducing transpiration losses, selection of water use efficiency crops.

**Learning Outcomes:**

After completion of this unit the student will be able to
- Estimate rainfall and run-off in micro catchments
- Explain dry land agriculture methods

**Unit-4 (Integrated Management)**

- a) Agriculture - Crop husbandry, soil enrichment, inter mixed and strip cropping, cropping pattern; sustainable agriculture, hybrid and improved seeds; Biomass management, crop rotation, legumes, organic fertilization, spider farming, pastures and silvopastures; horticulture, treeculture, form forestry; bund utilization, boundary plantation; social forestry; Energy - Renewable resource, water power, solar energy wind power; biomass, firewood, synthetic fuels, burning of municipal / garbage, ocean tides and waves.
- b) Appropriate Technology - farm equipment; Contour methods; check dams, water catchment and harvesting; kunds, depression harvesting, harvesting below ground level, harvesting below stream bed level, ground water harvesting; low cost technology, water conservation, utilization of wasted natural resources, Novelities; Rural technological delivery systems, cultivating wasted lands, tree culture, farm forestry, silvopastures, horticulture, social forestry, afforestation, wonder ways.

**Learning Outcomes:**

After completion of this unit the student will be able to
- List out different farming techniques

**Unit-5 (Monitoring and Evaluation)**

- a) People’s Part - awareness, participation, Response; State and integrated approach, appreciation of the concept, training, transfer of technology, resource and development, Agro-industrial infrastructure; sustainable society, livestock, small animal farming, pisciculture, sericulture, Health and hygiene education, transport, cues.
- b) Monitoring and Evaluation - purpose of monitoring and evaluation, nature of monitoring and evaluation - an interative dynamic process, design of monitoring programs; determining information needs, setting information need priorities, determining means of collecting information, Information management in monitoring programs; monitoring biophysical data, monitoring socio-economic data, monitoring project activities and outputs, design of evaluation procedures, types of evaluation, focus of evaluation, reporting evaluation results, insuring use of monitoring and evaluation information, a final word of caution.

**Learning Outcomes:**

After completion of this unit the student will be able to
- Realize the importance of people’s participation in water resources management
- Collect information and prepare evaluation reports
TextBooksandReferences


GE.1.6. Elective 2
B. Geoinformatics for Earth Science Applications

COURSE OBJECTIVES
The objective of the course is to
- Impart knowledge on Remote sensing applications in Lithological studies.
- Gain knowledge in remote sensing applications in Geological structures.
- Familiarize with geospatial applications in Geomorphology.
- Impart knowledge on RS & GIS techniques in Geological investigations.

COURSE OUTCOMES
After completion of the course the student will be able to
- Explain remote sensing applications in Lithological studies.
- Understand the importance of Remote sensing in Geomorphological studies.
- Explain Remote sensing applications in Geological investigations.
- Gain knowledge on remote sensing application in disaster management.

Unit – I: Remotesensing applications in lithological studies
Introduction: Scope for Geological applications in multispectral data, Thermal Data, Microwave data Mapping of Broad scale Lithological Units in General, Igneous, sedimentary and metamorphic rock, Identification of Mineral Assemblage, their physical properties mode of origin and mode of occurrence; Lithological mapping using aerial photos and satellite imagery, Digital analysis for lithological discrimination

Learning Outcomes:
After completion of this unit the student will be able to
- Identify the scope of remote sensing data in geological studies
- Prepare lithological maps using aerial and satellite imagery


Learning Outcomes:
After completion of this unit the student will be able to
- Explain remote sensing application in study of folds and faults
- Prepare structural analysis through aerial and satellite imagery.

Unit – III: Remotesensing application in geomorphology Nature and type of landforms like denudational, structural, fluvial, marine, Aeolian, glacial and volcanic
Learning Outcomes: After completion of this unit the student will be able to

- Explain remote sensing applications in Geomorphological studies
- Interpret satellite and aerial imagery to identify aeolian, volcanic and marine landforms.


Learning Outcomes: After completion of this unit the student will be able to

- Explain remote sensing applications in Geological investigations and mineral exploration
- Describe the importance of RS & GIS in Disaster management

Unit-V: Engineering and Sub-surface exploration & Disaster Assessment

Engineering geological Investigations: river valley projects, dams and reservoirs, route location (high ways and Rail ways) canal and pipeline alignments; neotectonism, seismic hazard and damage assessment, local ground condition, disaster assessment, volcanic and geothermal Energy applications, volcanic mapping and monitoring, identification of coal fires; environmental geology Resistivity, aeromagnetic and electromagnetic survey for subsurface explorations

Learning Outcomes: After completion of this unit the student will be able to

- Explain the importance of geospatial technologies in sub surface exploration
- Explain application of RS & GIS in various civil engineering projects

Textbooks

Ravi P. Gupta, Remotesensing Geology-Springer Publisher, A1 Books Co.in.
GE1.7Lab.1: Photogrammetry and PhotoInterpretation
Practical

COURSE OBJECTIVES
The objective of the course is to
- Familiarize student in calculation of height, scale etc from aerial photographs.
- Impart knowledge on identification of features from aerial photographs.
- Train student in preparing aerial mosaics.
- Train student in extracting contours, drainage etc from DTMs.

COURSE OUTCOMES
After completion of the course the student will be able to
- Determine vertical exaggeration from aerial photograph.
- Calculate height, scale from aerial photos.
- Interpret aerial photographs to identify different landforms.
- Construct digital terrain models.
- Extract contours, watershed and drainages from DTMs.

PG.1. Testing stereovision
PG.2. Use of Lens stereoscope and Mirror stereoscope
PG.3. Determination of vertical exaggeration
PG.4. Use of Parallax Bar for height calculation from aerial photographs
PG.5. Calculation of scale of photographs, Marking principal point and conjugate principal point on the stereopairs
PG.6. Preparation of aerial mosaics
PG.7. Interpretation of aerial photographs for identification of landforms, fluvial, Aeolian, glacial, coastal, volcanic and arid processes
PG.8. Identification of tectonic elements from aerial photographs
Digital photogrammetry—digital image matching and collection of masspoints
Construction of digital terrain models
Application of DTMs—contour generation, fill, fly-through, slope and aspect, viewshed analysis, watershed and drainage extraction, volumetric analysis, preparation of orthoimages.
GE1.8Lab. 2: Remote Sensing & Image Interpretation

COURSE OBJECTIVES
The objective of the course is
- Train student in satellite image annotation
- Impart knowledge on different spectral response patterns.
- Train student in studying and interpretation of optical, thermal and RADAR imagery.
- Train student in interpreting high resolution imagery.
- Impart knowledge on ground data validation.

COURSE OUTCOMES
After completion of the course the student will be able to
- Study and understand annotation of satellite images.
- Understand spectral response pattern of different land cover features.
- Understand and Interpret Optical, Thermal and RADAR imagery.
- Interpret high resolution satellite imagery.

RS.P1 Study of Satellite Image Annotation (information) LANDSAT, SPOT and IRS and Referencing Scheme (Analog)
RS.P2 Study of Digital Referencing Scheme (NRSC/Digital Globe/space imaging etc).
RS.P3 Understanding of Spectral Response Pattern of different Land cover objects 1 & 4
RS.P4 Study of Given Area in B/W, Colour and IR Colour Photographs (IKONOS AU area)
RS. P5 Study of Satellite Imagery (B/W) in Different bands and Visual Interpretation (Landsat 6 band data for Visakhapatnam)
RS.P6 Study of Thermal Image, Interpretation of Various Features-
RS.P7 Study of Radar (Microwave) Imagery and Interpretation of Features
RS.P8 Study of Radar And SAR (Microwave) Imagery And Interpretation of Features-
RS.P9 Interpretation of Cultural Details From high resolution imagery
RS.P10 Digital Interpretation and preparation of Land use Map at 1:50,000 scale
RS.P11 Field exercise on visual Image interpretation and validation using ground data
II\textsuperscript{nd} Semester
GE2.1-Geo-ExplorationTechniques

COURSE OBJECTIVES
The objective of the course is to
- Impart knowledge in different geo exploration techniques.
- Impart knowledge on Electrical and seismic methods of Geo-Exploration.
- Impart knowledge on soil classification techniques.

COURSE OUTCOMES
After completion of the course the student will be able to
- Gain knowledge in concept of Geo-exploration.
- Understand electrical and seismic methods.
- Classify different minerals and soils.
- Performs laboratory soil tests and make feasibility reports.

Unit-
Directcurrent-Resistivitymethod

Learning Outcomes:
After completion of this unit student will be able to
- List different geo exploration techniques
- Explain electrical resistivity method

Unit-
2a)Seismicmethod:i.FundamentalsofPrinciplesii.TheoryofRefractionsshooting.iii.ReductionofSeismicobser-
vationsiv.Seismicoperationsv.
Seismicfieldoperationandinterpretationvi.Acquisitionofseismicdatainwatercoveredareas

Learning Outcomes:
After completion of this unit student will be able to
- Discuss various seismic methods of geo-exploration
- Perform seismic analysis in the field and interpret data

Unit-
3i.Fundamentalsofquantitativeinterpretation.ii.Spontaneouspotentialcurveiii.Resistivityloggingiv.Gamma-
rayloggingv.Determinationoflithologyand porosityvi. Determinationof ResistivityandPermeability

Learning Outcomes:
After completion of this unit student will be able to
- Explain various logging methods
- Determine resistivity and permeability of soil

Unit-4 a) Geological Techniques b) Geomorphological Techniques c)
Geohydrological Techniques d) Hydrological Techniques

**Learning Outcomes:**
After completion of this unit student will be able to

- Explain geomorphological techniques

**Unit-5a)** Soil Mechanics b) Clay Minerals and Soils c) Laboratory and in-situ tests of soil Drilling Techniques d) Feasibility report

**Learning Outcomes:**
After completion of this unit student will be able to

- Analyze soils in laboratory and field.
- Prepare feasibility reports of soil tests.

**List of Textbooks**
1. Application of surface geophysic stogroundwater investigations by A.A.R. Zhody.
3. Log Interpretation by Schlumberger.
GE2.2-Geo-Engineering Investigations

COURSE OBJECTIVES
The objective of the course is to

- Introduce the concept of Geo-Engineering investigations for different civil engineering structures.
- Impart knowledge in rock classification.
- Teach the importance of geo-engineering investigations with case studies.

COURSE OUTCOMES
After completion of the course the student will be able to

- Understand the importance of Geo-Engineering investigations.
- Gain knowledge in different investigations techniques of civil structures.
- Identify different rock based on their compositions.
- Enhance knowledge with case studies.

Unit-1 Introduction: Geo-Engineering investigations for dams and reservoirs; Geo-Engineering investigations for tunnels; Geo-Engineering investigations for Airfields; Geo-Engineering investigations for Highways and Railway lines

Learning Outcomes:
After completion of this unit student will be able to

- Understand basic concepts of Geo-engineering investigations for construction of dams, reservoirs, Tunnels, air fields and highway
- Understand use of different types methods/aspects/surveys

Unit-2 Geo-Engineering investigations for coastal and offshore structures; Geo-Engineering investigations for canals and bridges; Geo-Engineering investigations for major industries, Thermal and Nuclear Power stations

Learning Outcomes:
After completion of this unit student will be able to

- Understand basic concepts of coastal offshore structure and their functionality.
- Explain the investigations and the importance of canals bridges and major industries.

Unit-3 Introduction to Rock Mechanics Physical properties of rocks: Mineral composition, rock structure, texture Classification of rocks: Litho logical classification, engineering classification, R Q D and core recovery of rock. Theoretical basis of rock mechanics- elasticity and plasticity Methods of rock exploration- geological, geophysical and drill
Learning Outcomes:
After completion of this unit student will be able to
- Understand basic concepts of Earths rock compositions and different testing analysis
- Explain origin and composition and classification of different geological rock formations and Methods of rock exploration, geological exploration, geophysical exploration

Unit-4 Geo-Engineering Case Studies; D.B.K. Railway tunnel alignment; Visakha Steel Plant site investigations; Geophysical Techniques for Terrain Evaluation; Terrain Evaluation for Urban Planning

Learning Outcomes:
After completion of this unit student will be able to
- Understand basic concepts and importance of case studies for the future projects and management of present structures.
- Explain the urban planning, terrain evaluation and development of rural to urban areas.

Unit-5 Geo-Engineering Investigations for river valley projects: case studies of Nagarjunasagar Dam, Srisailam Dam and Farakka Barrage project. Dam-failure investigations

Learning Outcomes:
After completion of this unit student will be able to
- Understand the case study for future references of dams and barrage construction.
- Explain and to justify the advantages and disadvantages of the Dam-failure Investigations.

List of Text Books
GE2.3-Geographic Information Systems

COURSE OBJECTIVES
The Objective of the course is to

- Familiarize about the concept of GIS, its components, along with its advantages.
- Focus about different available data formats in GIS.
- Impart knowledge on spatial data structures details and input, management and output processes.
- Explain different data analysis techniques.
- Impart knowledge on latest technological trends in the field.

COURSE OUTCOMES
After completion of the course the student will be able to

- Gain knowledge in the basics of GIS and its components.
- Learn about types of GIS data, data imputing and errors.
- Gain knowledge in raster and vector based spatial data analysis in GIS.
- Learn about latest technological developments in GIS.

Unit-1: Fundamentals of GIS
a) Introduction to GIS: Understand the difference between GIS and information system in general, GIS components and function of GIS: hardware software requirement of GIS, data types and spatial data models, idea of conceptual, logical and physical models, RDBMS, data basenormalization. Representation of real world via vector and raster representation model.
b) Definition of a map Geographic data in the computer. File and dataprocessing, database structures, perceived structures and computer representation and geographical data. Raster data structure, Vector data structures for geographical entities.

Learning Outcomes:
After completion of this unit the student will be able to

- Define terms and concepts related to GIS.
- Classify and explain different components of GIS

Unit-2: Data input and Quality verification
a) Data input, verification, storage and output: Data input, data verification, and correction and storage data output; data user interfaces.
b) Data Quality, Errors and Natural Variation: Sources of error, Errors resulting from natural variation of from original measurements. Errors arising through processing, problem; and errors arising from overlay and boundary intersections. Errors resulting room rasterizing a vector map. Errors associated with overlaying two or more polygon networks. Thenature of boundaries. Thestatistical nature of boundaries. Combining attributes from overlaid maps.

Learning Outcomes:
After completion of this unit the student will be able to

- Explain about data imputing in GIS.
- Identify different errors in GIS data to improve data quality

Unit-3: DEM & Map Projections
a) Digital Elevation Models: The need of DEMs, methods of representing DEMs. Image methods, data sources and sampling methods for DEMs. Productsthat can be derivedfrom DEM. Automated landform delineation from DEMs.
b) Map projections in GIS
Learning Outcomes:
After completion of this unit the student will be able to

- Explain about map projections in GIS.
- Extract data products from DEM’s

Unit-4

Learning Outcomes:
After completion of this unit the student will be able to

- Learn about spatial data analysis in GIS.
- Explain raster and vector data analysis.

Unit-5
Technological trends in GIS a) Tools for Map analysis: Single maps, Map reclassification, operations and attribute tables, spatial topological and geometric modeling and operations on spatial Neighborhood. Tools for map Analysis: Map pairs, map overlay and map modeling correlation between two maps. Tools for map analysis: Multiple maps, types of models, Boolean logic models, Index overlay models, Fuzzy logic methods. b) GIS customization, Data warehousing, cloud GIS, data mining, OLAP, SDSS, distributed, parallel and GPU, spatial data infrastructure, (i.e. integration and standards etc.) Free and opensource tools and web resources, Introduction to spatial decision problems, GIS and decision support system, overview of Internet GIS, Location based services.

Learning Outcomes:
After completion of this unit the student will be able to

- Identify different GIS based tools for map analysis.
- Explain about Internet GIS and latest technological developments in GIS.

List of Textbooks
1. http://www.gespatialworld.net;
2. www.earthmapping.com/;
GE2.4-Environmental Studies

COURSE OBJECTIVES
The objectives of the Environmental Science course are to

- Familiarize the fundamental aspects of environment and the environmental management.
- Make realize the importance of natural resources management for the sustenance of the life and the society.
- Apprise the impact of pollution getting generated through the anthropogenic activities on the environment.
- Impart knowledge on RS & GIS application in Environmental Analysis.

COURSE OUTCOMES
After completion of the course the student will be able to

- Understand fundamental aspects of environment and the environmental management.
- Understand of the importance of natural resources management for the sustenance of the life and the society.
- Familiarity on various forms of pollution and its impact on the environment.
- Learn concept of environmental impact assessment.
- Gain knowledge in RS & GIS application in Environmental analysis.

UNIT1 - Environmental Concepts
1) Environment– meaning, scope, components of environments
2) Ecosystems– Concept, components, evolution and development. Types and classification of ecosystems
3) Primary and Secondary production, food chains, food pyramid and energy flow
4) Biogeochemical and nutrient cycles - hydrological and material cycles

UNIT II - Environmental Pollution
1) Air pollution– Sources of pollution, effects on humans. Global effects- green house effect, acid Rain, global warming and heat island effect. Effects on vegetation and materials, air pollution control
2) Water pollution – Sources of water pollution, water as an ecological factor and its role in the biosphere, water pollution control
3) Soil pollution– Sources of soil pollution, effects of soil pollution, soil pollution control

UNIT III – Human Activities and Environmental Degradation
1) Human population and environment
2) Impact of human land use practices on environment
3) Deforestation and environmental change
4) Urbanization and industrialization. Urban environmental problems- air, water, noise, nuclear, thermal pollution and human health hazards

UNIT IV - Environmental Impact Assessment (EIA)
1) Need of EIA, EIA procedure, Environmental impact statement and procedure
2) EIA methodologies- Adhoc method, Check list method, Matrix method, Overlay method, Network method and Benefit-cost ratio method
3) Environmental impact assessment for Irrigation, Industrial, Airport, Transport and Thermal projects
4) Assessment of impacts on socioeconomic environment

UNIT V – Environmental Analysis Application of Remote Sensing and GIS in Environmental analysis
1) Change detection and mapping- vegetation change, erosion and deposition
2) Detection of air and water pollution
3) Encroachment and wetland degradation
4) Disaster management- cyclones, floods and droughts, earthquakes and volcanic eruptions
List of Textbooks

1) Ecology and Environment, P. D. Sharma, Rastogi Publications
2) Environmental Science, M. Chandra Sekhar, The Hi-TECH Publishers
3) Environmental Studies, R. Rajagopalan, Oxford University Press
7) Pollution Control and Conservation, Kovacs, M. (ed), Ellis Horwood Ltd., Budapest, 1985
9) Preventive and Social Medicine, Park & Park, Banarasidas
Choose any one of the following
A-Water Resources Evaluation
B. Integrated Watershed Management

A-Water Resources Evaluation.

COURSE OBJECTIVES
The objective of the course is to
- Impart knowledge on drainage basin analysis
- Familiarize student in hydrological aspects of forest, Agricultural lands
- Impart knowledge on Groundwater sources and aquifer properties
- Teach the negative aspects of groundwater pollution
- Impart knowledge on water resource development

COURSE EVALUATION
After completion of the course the student will be able to
- Gain knowledge in Geomorphology analysis of drainage basins
- Understand aquifers and well hydraulics
- Gain knowledge in concepts of seawater intrusion in coastal areas
- Understand the importance of water resource development activities.

Unit-1 Quantitative geomorphology of drainage basins and channel networks. Runoff hydrology of urban areas

Learning Outcomes:
- Conduct quantitative geomorphological study of a drainage basin
- Explain runoff hydrology of urban areas.

Unit-2 Hydrology of Agricultural lands Hydrology of Forest lands and Range lands Hydrology of arid and Semi-arid regions, Floods

Learning Outcomes:
- Understand the hydrological aspects of Agriculture and forest lands.
- Explain hydrology of arid and semiarid regions.

Unit-3 Groundwater potential areas in India Aquifer Properties and groundwater flow Well hydraulics

Learning Outcomes:
- Define aquifer and summarize various aquifer properties
- Solve problems related to well hydraulics

Unit-4 Seawater intrusion Groundwater basin management and conjunctive use Groundwater pollution and legislation
Learning Outcomes:
After completion of this unit student will be able to
- Summarize impacts of seawater intrusion and its mitigation measures
- Explain the effects of groundwater pollution on water resources

Unit 5
Planning for water resources development in Rural and Urban areas with reference to Indian continent. Water balance studies

Learning Outcomes:
After completion of this unit student will be able to
- Perform water balance study for a catchment
- Plan various water resource development activities in rural and urban areas

List of Text Books
Handbook of Applied Hydrology by VenTe Chow
Groundwater by H.M. Raghunath
Water Resources Engineering by R.K. Linsely & J.B. Franzini
B. Integrated Watershed Management.

COURSE OBJECTIVES

The objective of the course is to
- Expose student to different issues in water shed management.
- Impart knowledge on soil related studies.
- Impart knowledge on rainfall and run-off.
- Impart knowledge on integrated water management in Agriculture.

COURSE OUTCOMES

After completion of the course the student will be able to
- Understand importance of watershed management and characteristics.
- Estimate rainfall and runoff in catchments.
- Gain knowledge on integrated water management in Agriculture.

Unit-1 (Watershed Concept)

Issues in watershed management - land degradation, agricultural productivity, reservoirs sedimentation, depletion of bioresources, floods and droughts. Principles and approaches - principles of watershed management, different approaches in watershed management; Problem oriented approach, three dimensional approaches, integrated approach, steps in watershed management. Watershed characteristics - size, shape physiography, slope, climate, drainage, landuse, vegetation, geology, soils, hydrology, hydrogeology, socio-economics. Linear aspects of channel systems - Aerial aspects of drainage basins.

Learning Outcomes:
After completion of this unit the student will be able to
- Explain the principles of watershed management
- Describe watershed characteristics

Unit-2 (Land Management)


Learning Outcomes:
After completion of this unit the student will be able to
- Explain basic soil surveying techniques
- Describe land degradation problem and its mitigation
Unit-3 (Water Management) Surface water - Study of rainfall, estimation of run-off at micro catchments, stream gauging; Rainwater harvesting; catchment, harvesting, harvesting structures, Ground water - exploration of canal command areas, potential areas; integrated water resources management, conjunctive use. Dry land Agriculture - Runoff agriculture, micro catchment forming, irrigation with saline water, reusing water, conserving water, sprinkler irrigation, drip irrigation, pot irrigation, other systems, reducing crop land percolation losses, reducing transpiration losses, selection of water use efficiency crops.

Learning Outcomes:
After completion of this unit the student will be able to
- Estimate rainfall and run-off in micro catchments
- Explain dry land agriculture methods

Unit-4 (Integrated Management) Agriculture - Crop husbandry, soil enrichment, inter mixed and strip cropping, cropping pattern; sustainable agriculture, Hybrid and improved seeds; Biomass management, crop rotation, legumes, organic fertilization, spider farming, pastures and silvipastures; horticulture; tree culture; form forestry; bund utilization, boundary plantation; social forestry; Energy - Renewable resource, water power, solar energy wind power; biomass, firewood, synthetic fuels, burning of municipal / garbage, ocean tides and waves. Appropriate Technology - farm equipment; Contour methods; check dams, water catchment and harvesting; kunds, depression harvesting, harvesting below ground level, harvesting below stream bed level, ground water harvesting; low cost technology, water conservation, utilization of wasted natural resources, Novelities; Rural technological delivery systems, cultivating wasted lands, tree culture, farm forestry, silvipastures, horticulture, social forestry, afforestation, wonder ways.

Learning Outcomes:
- List out different farming techniques
- Gain knowledge on groundwater harvesting techniques

Unit-5 (Monitoring and Evaluation) People’s Part - awareness, participation, Response; State and integrated approach, appreciation of the concept, training, transfer of technology, resource and development, Agro-industrial infrastructure; sustainable society, livestock, small animal farming, pisciculture, sericulture, Health and hygiene education, transport, cues. Monitoring and Evaluation - purpose of monitoring and evaluation, nature of monitoring and evaluation - an interactive dynamic Process, design of monitoring programs - determining information needs, setting information-need priorities, determining means of collecting information, Information management in monitoring programs; monitoring biophysical data, monitoring socio-economic data, monitoring project activities and outputs, design of evaluation procedures, types of evaluation, focus of evaluation, reporting evaluation results, insuring use of monitoring and evaluation information, a final word of caution.

Learning Outcomes:
- Realize the importance of peoples participation in water resources management
- Collect information and prepare evaluation reports
TextBooks and References

   Program. University of Minnesota, College of Natural Resources, St. Paul Minnesota, U.S.A.
A. Urban Planning and Information Systems

COURSE OBJECTIVES
The objective of the course is to
• Introduce the concept of urban planning and its history in Indian context.
• Impart knowledge in urban planning components.
• Familiarize with geospatial application in urban planning.
• Impart knowledge on aspect of transportation planning.

COURSE OUTCOMES
After completion of the course the student will be able to
• Gain knowledge in Urban planning and its history.
• Understand the concepts of zoning, masterplans etc.
• Use different GIS techniques and data types to assess urban planning problems.
• Gain knowledge in transportation studies in urban context.

Unit I
IntroductionPlanning: background and principles; Need for planning; Urbanisation and its impact, Distribution of landuse/landcover; Town planning in ancient India and new towns of India; Requirements and possible types of development of towns; Geoinformatics application in Urban Planning

Learning Outcomes:
After completion of this unit student will be able to
• Understand the principles of urban planning.
• Summarize distribution of land use/landcover in urban planning.

Unit II
Formulation of Plans Objectives and contents; Regional plan; Perspective plan; Master plan; Development plan; Project (scheme) plan; Delineation of planning area; Trend analysis; Land suitability analysis; Land use planning; Zoning and principles of zoning; Building Bye-laws and its principles; Requirement of urban & regional planners; Remotesensing for different levels of development planning

Learning Outcomes:
After completion of this unit student will be able to
• Formulate different plans in urban context.
• Classify different zones and building bylaws.

Unit III
HousingImportance of housing; urban housing demand and production; Slums and squatters; Housing problem in India; National Housing policy; Site analysis - Layout design; Housing projects/Slum housing; Urban renewal projects; Urban infrastructure planning

Learning Outcomes:
After completion of this unit student will be able to
- Recognize the importance of housing and its related problems.
- Conduct site analysis and design layouts.

**Unit – IV** Transportation planning Classification of urban roads; Traffic surveys: speed, time, delay surveys; Use of speed, journey time and delay studies; Traffic volume; Origin Destinations surveys; Parking surveys; Utility of remote sensing in traffic and transportation studies

**Learning Outcomes:**
After completion of this unit student will be able to
- Conduct traffic surveys for solving transportation problems.
- Apply remote sensing technology to traffic and transportation studies

**Unit – V** Urban Information System Information system: Land; Housing; Transportation; Infrastructure; Trends in mapping using remote sensing, GIS and GPS; Database creation for Infrastructure development; Decision support system for urban and regional management.

**Learning Outcomes:**
After completion of this unit student will be able to
- Create database for urban information system.
- Develop decision support system for urban management
GE.2.6 Elective-2

Choose any one of the following
A. Digital photogrammetry and mapping
B. Geoinformatics for Resources Studies and Disaster management
C. Spatial Database Modeling

A. Digital photogrammetry and mapping

COURSE OBJECTIVES
The objective of the course is to
- Impart knowledge on basics of Geodesy.
- Teach fundamentals of GPS, GNSS.
- Impart knowledge on Aerial and satellite photogrammetry.
- Introduce fundamental of cartography and geo data base organization.

COURSE OUTCOMES
At the end of the course the student will be able to
- Understand Fundamentals of Geodesy, Techniques involved in establishment of geodetic control.
- Concepts of geoid, ellipsoid and their interrelationship.
- Gain knowledge in Aerial and satellite photogrammetric techniques.
- Understand different cartography techniques and Geodesy.

Unit 1: Geodesy and Surveying Fundamentals of geodesy, Geodetic reference systems: ICRE, ITRF, Geoid and geoidal heights and undulations, Geodetic datum and datum transformation, Map projection and transformation. Techniques of ground survey (horizontal and vertical control, triangulation, traversing, leveling, GPS and Total Station surveying). Data integration from different sources (GPS, Total Station, High resolution satellites) for large scale mapping and cadastral surveys.

Learning Outcomes:
After completion of this unit the student will be able to
- Explain fundamentals of Geodesy and map projection.
- Integrate data from different sources for mapping projects.

Unit-II: GNNS: Carrier phase measurements, Signal structure, GNSS Errors and biases, Differential Positioning – concepts and principles, IGS station-finalephemeris, differential corrections, accuracy in differential satellite positioning system PS, local area DGPS, wide area DGPS, LAAS, WAAS, GAGAN, Mapping methods with GPS – rapid static method, semi-kinematic method, kinematic method. Real time DGPS, GNSS, GLONASS, IRNSS, GALILEO, Beidou, and future prospects of navigational satellites

Learning Outcomes:
After completion of this unit the student will be able to
- Explain concept of differential positioning.
- Discuss various GPS methods and their advantages.
- Identify various GPS satellite systems

Unit-III: Aerial and Satellite Photogrammetry Photogrammetric camera (digital), Imaging systems- Asynchronous imaging, multiline scanners, multiplexcamera/multisensors, areascanners, panoramic lineararrayscanners, widefieldcamera, Imaging properties, Theory of orientation: (IO, RO and AO).

Photogrammetric Triangulation: Single image, Stereo-pair (two overlapping images), Strip triangulation, Block Adjustment of Independent Models (BAIM), Bundle Block Adjustment, Special cases
Satellite Photogrammetry: Orbital Parameters, Orbital Modeling, Data Processing for stereo generation (block triangulation, optimum control requirement), Space Resection and Intersection, Solutions and differences in different sensor models for photogrammetric processing. Processing of IRS IC/ID, CARTOSAT, ASTER, ALOS PRISM, SPOT, IKONOS, QuickBird etc.

Learning Outcomes:
After completion of this unit the student will be able to
- Compare Aerial and satellite photogrammetry techniques.
- Generate stereopairs from photographs.


Learning Outcomes:
After completion of this unit the student will be able to
- Acquire and process Photogrammetric data.
- Validate the accuracy of data.

Unit V: Digital Cartography and Visualization: Geo Spatial Data Base organization, Digital Cartography, Web Cartography, 3D Simulation and Visualization, Digital earth models and data dissemination services: contemporary approaches (Bhuvan and Google Earth) and future prospects.

Learning Outcomes:
After completion of this unit the student will be able to
- Acquire and process Photogrammetric data.
- Validate the accuracy of data.

Suggested Readings:
6. Wolfgang Torge, W., Geodesy, 3rd edition.
Textbooks

- Rangwala, TownPlanning, Charotar Publishing House, Anand, India
B. Geoinformatics for Disaster management

COURSE OBJECTIVES
The Objectives of the course is to
- Introduce basic concepts and importance of Natural resources management.
- Impart knowledge on geospatial applications in managing resources like water, soils and minerals.
- Teach the concept of disaster management.
- Introduce role of geoinformatics in managing different disasters.

COURSE OUTCOMES
After completion of the course the student will be able to
- Understand the importance of natural resource management.
- Explain the role of geoinformatics in managing resources like water, soils and minerals.
- Gain knowledge in concept of disaster management.
- Summarize the application of geoinformatics in different disasters.

Unit I Natural Resources Development: Introduction and Scope: role of geoinformatics technologies – aerial photographs; satellite remote sensing; GPS; and GIS in resource evaluation. Water resources – surface water and groundwater resources: mapping and monitoring of watersheds, tanks and reservoirs; hydrogeomorphic mapping and identification of groundwater potential zones. Ocean resources: estimation of sea-surface temperature; primary productivity and potential fishing zones

Learning Outcomes:
After completion of this unit the student will be able to
- Understand the scope of geoinformatics in natural resource management.
- Identify groundwater potential zones.
- Analyze satellite data and measure sea surface temperature

Unit II Soil and agricultural resources: Spectral behavior of soils; Mapping of soils using multispectral images; Evaluation of soil erosion prone zones through GIS; Remotesensing in Landuse/landcover mapping; Crop area estimations; monitoring of crop vigour; Yield estimations.

Forest resources: mapping of forest types; estimations of timber volume; monitoring of forest health – forest pests, forest fires, Trends in deforestation and afforestation.

Learning Outcomes:
After completion of this unit the student will be able to
- Prepare soil maps from multispectral images.
- Estimate crop area and yield from satellite data.
- Identify trends in deforestation and afforestation.

Unit III Remote sensing techniques for identification of rocks and minerals; mapping of geological structures; surface manifestation of minerals and their identification; spectral properties of minerals; role of thermal and hyperspectral remote sensing in mineral exploration. Casestudies

Learning Outcomes:
After completion of this unit the student will be able to
- Identify rocks and minerals from remote sensing data.
- Summarize the role of hyperspectral and thermal remote sensing in mineral exploration.

Unit IV Geoinformatics in Disaster Management: introduction and scope. Coastal Hazards: Storm
surges and Tsunamis: Origin, propagation and run-up; Role of coastal topography, bathymetry and vegetation; Coastal hazard preparedness – Role of geoinformatics in coastal hazard mapping, risk and vulnerability assessment and evacuation analysis; coastal protection, education and awareness of coastal communities

**Learning Outcomes:**
After completion of this unit the student will be able to
- Discuss the scope of geoinformatics in disaster management.
- Prepare coastal hazard and vulnerability maps.

**Unit V** Geoinformatics applications in disaster mapping and mitigation; Risk zone mapping: earthquakes – identification of geological structures like faults; volcanic activity – thermal imaging for monitoring temperature changes; Geoinformatics analysis of potential zones for landslides; avalanches; and floods. Mapping of disaster affected areas for rescue and mitigation; damage assessment; GIS-based decision support systems for disaster management

**Learning Outcomes:**
After completion of this unit the student will be able to
- Identify geological folds and faults from satellite data.
- Prepare maps of disaster affected areas for rescue and mitigation.

**Books and References:**
- Geomatics solutions for Disaster Management, Li, Zlatanova and Fabbri (ed), Springer, 2007
- Applications of Remote Sensing in Agriculture, M.D. Steven and J.A. Clark, Butterworths, 1990
- Tsunamis to survive from tsunami, Susumu Murata et al., 2009 World Scientific Books

**Reference**
C: Spatial Database Modeling

Unit I: Spatial Database Management System: Database overview, attributed data model, Spatial Database, spatial data type and structures. **Spatial Database Design:** Conceptual data modelling, concepts of UML, UML use case, Spatial data topological relationship.

**Learning Outcomes:**
- After completion of this unit the student will be able to
  - Explain the fundamentals of database management in geospatial context.
  - Describe the concepts of database modelling

Unit II: Spatial Database: Storage and Retrieval Concepts of spatial data storage, spatial indexing, Basic of relational algebra, Data normalization, Spatial Query languages using extended SQL, spatial query processing and optimization.

**Learning Outcomes:**
- After completion of this unit the student will be able to
  - Explain database storage and retrieval concepts.
  - Understand the fundamentals of spatial query process.

Unit III: GIS Implementing Architectures: GIS Implementation architectures (desktop, client-server, enterprise, mobile, web/cloud, web services from mobile platforms, spatial data acquisition/supply in distributed environment and security issues).

**Learning Outcomes:**
- After completion of this unit the student will be able to
  - Explain GIS architecture.
  - Identify various GIS related platforms.

Unit IV: Spatial Data Modelling 05: Spatial data modelling and its classification, spatial decision support system, spatial decision modelling concepts, AHP based modelling with case study, Agent based modelling with case study.

**Learning Outcomes:**
- After completion of this unit the student will be able to
  - Discuss spatial data modelling.
  - Interpret various case studies to understand data modelling

Unit V: Spatial Data Mining: Overview of data mining, Concepts of Decision tree based approach with case study, Concept based image retrieval concept with case study.

**Learning Outcomes:**
- After completion of this unit the student will be able to
  - Explain concept of data mining.
**SuggestedReadings:**

**BooksandReports**


**JournalArticles**

GE2.7Lab.1.Geo-EngineeringPracticals

COURSE OBJECTIVES:
The objective of the course is to
- Familiarize student with various geo engineering survey techniques
- Impart knowledge on Sesimicrefraction testing
- Train the student in various soil tests in Laboratory
- Impart knowledge on Well monitoring techniques

COURSE OUTCOMES:
After completion of the course student will be able to
- Conduct Electric resistivity and seismic refraction studies
- Determine specific gravity, aAttenberg limits of soil in laboratory
- Determine permeability, bulk density of soil in laboratory
- Determine safe yield of a well in the field

Geoelectricalsurveyandcomputations
a) Seismicrefractionandreflectiondatacomputations.

Laboratorydeterminationofsoilclassification
a) Attenberglimits b) Specificgravity

Lab, permeability by constant and failing head methods;
Direct Shear and triaxial shear test;
Compaction and bulk density;
Consolidation test;

Field work and data analysis
Ground water exploration & Management;
Well monitoring;
Well/bore well pumping tests;
Selection of pumps;
Safe yield determination;
Identification of gray areas;
Design of rain water harvesting structures;
Geotechnical exploration;
Subsurface lithology;
Bed rock mapping;
Identification of buried pipes;
Location of infiltration wells in the river bed;
Mobile mapping through GPS;
point mapping; line mapping; polygon mapping
GE2.8Lab.2.GeoInformation\hspace{1cm} Systems \hspace{1cm} Practical

COURSE OBJECTIVES
The objective of the course is to
- Familiarize with different GIS software.
- Train student in creating spatial layers in GIS.
- Train student in performing basic GIS tasks.
- Teach Map analysis.

COURSE OUTCOMES
After completion of the course the student will be able to
- Understand basic GIS data concepts.
- to perform basic GIS analysis of concepts.
- Demonstrated a practical application of GIS.
- gain practical experience in spatial analysis in GIS.

1. Familiarity\hspace{1cm}with\hspace{1cm}DBase\hspace{1cm}Commands\hspace{1cm}including\hspace{1cm}record\hspace{1cm}updating\hspace{1cm}and\hspace{1cm}processing.
2. Themerepresentation\hspace{1cm}by\hspace{1cm}usage\hspace{1cm}of\hspace{1cm}graphics\hspace{1cm}command\hspace{1cm}resources\hspace{1cm}data\hspace{1cm}maintenance - Theme\hspace{1cm}filling\hspace{1cm}and\hspace{1cm}retrieval\hspace{1cm}and\hspace{1cm}usage.

Exercise: Development\hspace{1cm} updating\hspace{1cm} of\hspace{1cm} data\hspace{1cm} base\hspace{1cm} management\hspace{1cm} software\hspace{1cm} packages\hspace{1cm} for\hspace{1cm} a selected\hspace{1cm} practical\hspace{1cm} problem\hspace{1cm} using\hspace{1cm} available\hspace{1cm} GIS\hspace{1cm} package.\hspace{1cm}Arc\hspace{-0.5cm}-\hspace{-0.5cm}info,\hspace{1cm}Arc\hspace{-0.5cm}-\hspace{-0.5cm}Viewpractice\hspace{-0.5cm}and\hspace{1cm}ILWIS\hspace{1cm}software\hspace{1cm} packages Creation\hspace{1cm} of different spatial layers.\hspace{1cm}Mapanalysis.
SEMESTERS III & IV

Dissertation and Viva Voce

A) Dissertation:
The student for the fulfillment of M.Tech Degree in Remote Sensing must carry out individual dissertation work. Candidates can do their work in the department or in any industry/research organization for two semesters (i.e., 3rd and 4th semesters).

B) Evaluation procedure:
Progress of the dissertation/thesis work at the end of 3rd Semester will be evaluated by a committee consisting of Chairman, Board of Studies, Head of the Department, and Thesis guide.

The Final thesis at the end of 4th Semester is evaluated through defence and Viva Voce examination will be conducted to the student by the external examiner and the internal research guide along with the Head of the Department and Chairman Board of Studies, on the topic of the dissertation carried out by the student. The candidate may be recommended for award of grades such as A (=Excellent); B (=Very Good); C (=Good); or F (=Not Accepted / Failed).

The prerequisite for submission of the M.Tech. thesis is that one should communicate his/her work to any referred journal or publication in a conference.

For final result, the dissertation credits are not added for CGPA.