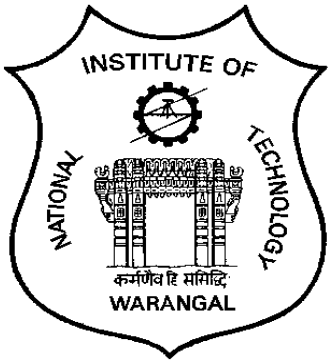
# NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL




## SCHEME OF INSTRUCTION AND SYLLABI

## FOR

## M.TECH PROGRAM IN REMOTE SENSING AND GIS

**Effective from 2016-17**

## DEPARTMENT OF CIVIL ENGINEERING

## NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

### VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

### MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

## DEPARTMENT OF CIVIL ENGINEERING

### VISION

To be a knowledge nerve centre in civil engineering education, research, entrepreneurship and industry outreach services for creating sustainable infrastructure and enhancing quality of life.

### MISSION

- Generate a specialized cadre of civil engineers by imparting quality education and training
- Attain international standards in teaching, research and consultancy with global linkages.

**GRADUATE ATTRIBUTES**

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

1. **Scholarship of Knowledge**: Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
2. **Critical Thinking**: Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
3. **Problem Solving**: Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.
4. **Research Skill**: Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
5. **Usage of modern tools**: Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.
6. **Collaborative and Multidisciplinary work**: Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
7. **Project Management and Finance**: Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.
8. **Communication**: Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
9. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
10. **Ethical Practices and Social Responsibility**: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
11. **Independent and Reflective Learning**: Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

**DEPARTMENT OF CIVIL ENGINEERING**
**M.TECH. REMOTE SENSING AND GIS**

## PROGRAM EDUCATIONAL OBJECTIVES

| | |
|---|---|
| PEO1 | Apply principles of Remote sensing and GIS to collect, map and retrieve spatial information. |
| PEO2 | Plan, assess and evaluate natural and manmade systems using geospatial models and methods |
| PEO3 | Use geospatial tools and techniques for hazard mitigation and resource planning. |
| PEO4 | Pursue research and develop capabilities to handle multi-disciplinary field projects |
| PEO5 | Work in teams and demonstrate leadership skills with professional ethics. |

**PROGRAM OUTCOMES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PO1 | Identify specific data and methodologies for effective mapping and evaluation of natural resources |
| PO2 | Develop geospatial models and tools to address the social and engineering problems |
| PO3 | Apply geospatial technologies for hazard mitigation and management |
| PO4 | Design multi-criteria geospatial systems for decision making process |
| PO5 | Work in a team using geospatial tools and environment to achieve project objectives |
| PO6 | Pursue lifelong learning for professional advancement. |

**SCHEME OF INSTRUCTION AND EVALUATION**

**M.Tech. Remote Sensing and GIS**

**I Year M. Tech. I – Semester**

| S. No. | Course code | Course Title | L | T | P | Credits | Cat. Code |
|---|---|---|---|---|---|---|---|
| 1 | CE5501 | Remote Sensing and Digital Image Processing | 3 | 1 | 0 | 4 | PCC |
| 2 | CE5502 | Geographical Information Systems | 3 | 1 | 0 | 4 | PCC |
| 3 | CE5503 | Basic Photogrammetry | 3 | 1 | 0 | 4 | PCC |
| 4 | | Elective – I | 3 | 0 | 0 | 3 | DEC |
| 5 | | Elective – II | 3 | 0 | 0 | 3 | DEC |
| 6 | | Elective – III | 3 | 0 | 0 | 3 | DEC |
| 7 | CE5504 | Remote Sensing and Photogrammetry Laboratory | 0 | 1 | 2 | 2 | PCC |
| 8 | CE5505 | Geographical Information Systems Laboratory | 0 | 1 | 2 | 2 | PCC |
| 9 | CE5541 | Seminar-I | 0 | 0 | 2 | 1 | PCC |
| | | **Total** | **18** | **5** | **6** | **26** | |

**I Year M. Tech. II – Semester**

| S.No. | Course Code | Course Title | L | T | P | C | Cat. Code |
|---|---|---|---|---|---|---|---|
| 1 | CE5551 | Advanced GIS | 3 | 1 | 0 | 4 | PCC |
| 2 | CE5552 | Advanced Digital Image Processing | 3 | 1 | 0 | 4 | PCC |
| 3 | CE5553 | Global Navigation Satellite System | 3 | 1 | 0 | 4 | PCC |
| 4 | | Elective – IV | 3 | 0 | 0 | 3 | DEC |
| 5 | | Elective – V | 3 | 0 | 0 | 3 | DEC |
| 6 | | Elective – VI | 3 | 0 | 0 | 3 | DEC |
| 7 | CE5554 | Digital Image Processing Laboratory | 0 | 1 | 2 | 2 | PCC |
| 8 | CE5555 | GPS and AGIS Laboratory | 0 | 1 | 2 | 2 | PCC |
| 9 | CE5591 | Seminar – II | 0 | 0 | 2 | 1 | PCC |
| | | **Total** | **18** | **5** | **6** | **26** | |

| **II Year M. Tech. I – Semester** | | | | |
|---|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Title** | **Credits** | **Cat. Code** |
| 1 | | Industrial Training (8-10 weeks) Optional | | |
| 2 | CE6542 | Comprehensive Viva | 2 | PCC |
| 3 | CE6549 | Dissertation Part – A | 6 | PCC |
| **II Year M. Tech. II – Semester** | | | | |
| 4 | CE6599 | Dissertation Part – B | 12 | PCC |

**LIST OF ELECTIVES**

| Sl. No. | Course Code | Course Title |
|---|---|---|
| **FOR ELECTIVES – I, II & III** | | |
| 1 | CE5511 | Advanced Statistical methods |
| 2 | CE5512 | LiDAR Technology and its Applications |
| 3 | CE5513 | Object Oriented Programming |
| 4 | CE5514 | Decision Support Systems |
| 5 | CE5515 | Principles of Geomatics |
| 6 | CE5516 | Database Management Systems |
| 7 | CE5517 | Water Resources and Environmental Systems |
| 8 | CE5312 | Environmental Impact Assessment and Management |
| 9 | CE5714 | Watershed Management |
| **FOR ELECTIVES – IV, V & VI** | | |
| 10 | CE5561 | Remote Sensing Geology |
| 11 | CE5562 | Analytical and Digital Photogrammetry |
| 12 | CE5563 | Thermal, Microwave and Hyperspectral Remote Sensing |
| 13 | CE5564 | Geospatial Techniques for Rural Development |
| 14 | CE5565 | Geospatial Techniques for Disaster Management |
| 15 | CE5566 | Geospatial Techniques for Water and Environmental Engineering |
| 16 | CE5567 | Geospatial Techniques for Transportation Engineering |
| 17 | CE5568 | Geospatial Techniques for Urban Planning |
| 18 | CE5762 | Urban Water Management |
| 19 | CE5764 | Land and Water Management |
| 20 | CE5767 | Applications of Soft Computing Techniques |
| 21 | CE5770 | Climate Systems |

**Detailed Syllabus**

| CE 5501 | REMOTE SENSING AND DIGITAL IMAGE PROCESSING | PCC | 3-1-0 | 4 Credits |
|---|---|---|---|---|

**Prerequisites**: None.

**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Select the type of remote sensing technique / data for required purpose |
| CO2 | Identify the earth surface features from satellite images |
| CO3 | Analyze the energy interactions in the atmosphere and earth surface features |
| CO4 | Perform corrections and process digital satellite data |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | | 1 |
| CO2 | 3 | 2 | 2 | 1 | | 1 |
| CO3 | 3 | 1 | | | | 1 |
| CO4 | 1 | 3 | 2 | | 2 | 1 |

**Detailed Syllabus:**

Physics of Remote Sensing: Sources of Energy, Active and Passive Radiation, Electromagnetic Radiation - Reflectance, Transmission, Absorption, Thermal Emissions, Interaction with Atmosphere, Atmospheric windows, Spectral reflectance of Earth's surface features, Multi concept of Remote Sensing.

Platforms: Various types of platforms, different types of aircraft, manned and unmanned spacecrafts used for data acquisition - characteristics of different types of platforms - airborne and spaceborne.

Data Acquisition Systems: Optical, Thermal and Microwave; Resolutions - spatial, spectral, radiometric and temporal, signal to noise ratio.

Image Processing: Data Products and Their Characteristics, Digital image formation, digital image display mechanism, image histograms, look up table data, Pre-processing – Atmospheric, Radiometric, Geometric Corrections - Basic Principles of Visual Interpretation, Equipment for Visual Interpretation, Ground Truth, Ground Truth Equipment.

Image enhancements: Linear and non-linear Contrast enhancement techniques, density slicing, pseudo colour images, spatial enhancement techniques (convolution filtering), spectral enhancement techniques, Image algebra.

Applications of Remote sensing in various Engineering and Science domains such as Agriculture, Forest, Soil, Geology, LU/LC, Water Resources, Urban etc.

**Reading:**


1. James B. Campbell & Randolph H. Wynne., Introduction to Remote Sensing, The Guilford Press, 2011.
2. Charles Elach & Jakob van Zyl., Introduction to the physics and techniques of Remote Sensing, John Wiley & Sons publications, 2006.
3. Lillesand T.M & Kiefer R.W., Remote Sensing and Image Interpretation, John Wiely and Sons, 2008.
4. Chritian Matzler., Thermal microwave radiation: Applications for remote sensing, The institution of Engineering and Technology, London, 2006.
5. Rees, W. G., Physical principles of Remote Sensing, Cambridge University Press, 2001Paul Curran P.J., Principles of Remote Sensing, ELBS Publications, 1985.

| CE 5502 | GEOGRAPHICAL INFORMATION SYSTEM | PCC | 3-1-0 | 4 Credits |
|---|---|---|---|---|

**Prerequisites:** None.

**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Analyse the basic components of GIS |
| CO2 | Classify the maps, coordinate systems and projections |
| CO3 | Process spatial and attribute data and prepare thematic maps |
| CO4 | Identify and rectify mapping inaccuracies |
| CO5 | Formulate and solve geospatial problems |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | | | 3 | | 2 | |
| CO2 | 3 | 2 | 2 | | 1 | |
| CO3 | 3 | 2 | 2 | | 1 | 2 |
| CO4 | 2 | 2 | 1 | | | 1 |
| CO5 | 3 | 2 | 2 | 2 | | |

**Detailed Syllabus:**

Map – mapping concepts, analysis with paper based maps, limitations, Computer Automated Cartography – History and Developments, GIS- Definition, advantages of digital maps, projections and coordinate systems

Fundamentals of GIS – Information Systems, Modeling Real World Features Data , Data Models – Spatial and Non-spatial, Components, Data Collection and Input, Data Conversion, Database Management – Database Structures, Files; Standard Data Formats, Compression Techniques, Hardware and Software

Topology – Types of Errors, Editing and Error Rectification, Types of Topology, Modeling topological Relationships, Tolerances.

Spatial Analysis and Interpolation – Proximity Analysis, Overlay Analysis, Buffer Analysis, Network Analysis, Spatial Auto Correlation, Gravity Modeling, DTM/DEM, Interpolation methods-Global, Local, Geostatistcial methods.

Map composition, Preparation of qualitative and quantitative maps, levels of maps, map elements and map scales

GIS Project Planning and Implementation – Understanding the Requirements, Phases of Planning, Specifications, Procedure for analysis projects and design projects.

**Reading:**


1. Paul Longley., Geographic Information systems and Science, John Wiley & Sons, 2005
2. John E. Harmon & Steven J. Anderson., The design and implementation of Geographic Information Systems, John Wiley & Sons, 2003.
3. Marble, D.F & Calkins, H.W., Basic Readings in Geographic Information System, Spad System Ltd, 1990.
4. Kang Tsung Chang., Introduction to Geographic Information Systems, Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2008.
5. Burrough, P.A., Principles of GIS for Land Resource Assessment, Oxford Publications, 2005.
6. C.P.Lo & Albert K. W.Yeung, Concepts and Techniques of Geographic Information Systems, Prentice Hall India Pvt.Ltd, 2002.

| CE 5503 | BASIC PHOTOGRAMMETRY | PCC | 3-1-0 | 4 Credits |
|---|---|---|---|---|

**Prerequisites:** None

**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Classify the photogrammetry methods and their applications |
| CO2 | Determine the scale, ground coordinates and the aerial extent of aerial photographs |
| CO3 | Demonstrate interior and exterior orientation on two overlapping aerial photographs |
| CO4 | Measure parallax and compute elevations from parallax measurements |
| CO5 | Prepare mosaics, orthophotos and photomaps for mapping of resources |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 2 | 1 | 2 |
| CO2 | 2 | 2 | 3 | 2 | 2 | 1 |
| CO3 | 1 | 2 | 2 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 2 | 1 | 2 | 1 |
| CO5 | 1 | 2 | 2 | 1 | 2 | 1 |

**Detailed Syllabus:**

Fundamentals of Aerial Photography Systems: Historical development – classification, application – aerial cameras – aerial films and processing, – geometry of vertical photographs – scale – coordinate transformation, relief displacement – titled photographs, Photographic products, Resolving power of lenses and films

Stereoscopy: Stereoscopes, stereoscopic view and its exaggeration – parallax equation – parallax measurement–parallax bar-measurement of heights and determination of slopes-stereoscopic plotting instruments.

Orientation: Concepts of orientation-interior, relative and absolute orientation of aerial photographs, Ground control

Photomaps and Mosaics: Advantages and disadvantages, Uses, Kinds of mosaics-controlled, semi-controlled, uncontrolled, Preparation, orthophotomosaics

Project Planning and Aerial Photo Interpretation: flight planning –ground control (horizontal and vertical) for aerial photogrammetry by triangulation and trilateration for ground control - image interpretation - interpretation keys – planimetric mapping applications – aerial mosaics.

**Reading:**


1. Lillesand T.M and Kiefer R.W., Remote Sensing and Image Interpretation, John Wiley and Sons, 2008.
2. Wolf P. R., Elements of Photogrammetry with Application in GIS, McGraw Hill International Book Company,2013.
3. Moffitt, Francis H. & Mikhail, Edward M., Photogrammetry, Harper and Row Publishers, 1980.
4. Hallert, B., Photogrammetry, McGraw Hill Book Company, 1960.
5. Lueder, D.R., Aerial Photographic Interpretation, Mc Graw Hill Book Company, New York, 1959.
6. Krauss, J., Photogrammetry, vol. I, Springler – Verlag Publications, 1997.

| CE 5504 | REMOTE SENSING AND PHOTOGRAMMETRY LABORATORY | PCC | 0-1-2 | 2 Credits |
|---|---|---|---|---|

**Prerequisites:** None

**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Read ancillary information of remotely sensed data |
| CO2 | Identify the different features from imageries |
| CO3 | Perform basic photogrammetry analysis |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | | 2 | | 1 |
| CO2 | 2 | 1 | 2 | 1 | | 1 |
| CO3 | 1 | 2 | 1 | 2 | 1 | 1 |

**Detailed Syllabus:**

Study of different types of satellite data products
Visual interpretation of satellite images of different resolutions.
Extraction of thematic information from satellite images
Mapping of

- Land use and land cover
- Geological and structural features
- Drainage pattern and surface water bodies
- Hydrogeomorphology for ground water potential zones
- Urban growth and transportation network
- Determination of photo scale and relief displacement
- Mirror Stereoscope and Parallax bar
- Determination of height of objects
- Determination of slopes

**Reading:**


1. Lillesand T.M and Kiefer R.W., Remote Sensing and Image Interpretation, John Wiley and Sons, 2008.
2. Lueder, D.R., Aerial Photographic Interpretation, Mc Graw Hill Book Company, New York, 1959.

| CE 5505 | GEOGRAPHICAL INFORMATION SYSTEMS LABORATORY | PCC | 0-1-2 | 2 Credits |
|---|---|---|---|---|

**Prerequisites**: None

**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Prepare the different geospatial layers |
| CO2 | Compute geometric measurements and perform spatial analysis |
| CO3 | Create high-quality maps and associated graphics |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 2 | 1 | 1 |
| CO2 | 1 | 2 | 1 | 3 | | 1 |
| CO3 | 1 | 2 | 2 | 2 | 1 | 1 |

**Detailed Syllabus:**

Digitization of Points and Lines
Editing Map Elements
Attribute Data Entry and Manipulation
Cleaning, Building and Transformation
Data Analysis – Overlay, Buffer
Map Generation with Patterns and Legends
Buffer Analysis
Network Analysis
Interpolation Methods

**Reading:**

1. ArcGIS user manuals,
2. QGIS User Manuals

| CE 5551 | ADVANCED GIS | PCC | 3-1-0 | 4 Credits |
|---|---|---|---|---|

**Prerequisites**: CE 5502: Geographical Information System

**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Conduct advanced spatial analyses using GIS tools |
| CO2 | Study GIS data with complex geospatial models |
| CO3 | Solve the geospatial problems using programming tools |
| CO4 | Develop models in GIS using Open source and Web GIS |
| CO5 | Analyse GIS data and solve problems |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 2 | 1 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 |
| CO5 | 2 | 2 | 2 | 2 | 1 | 1 |

**Detailed Syllabus:**

DTM Applications: Slope and aspect; site selection studies, viewshed and watershed analysis; Working with Open Source DEM's; GIS models: Modelling Process; Classification; Model builder tools; Python, R programming and MATLAB concepts for geoprocessing tools;

Web GIS: Definition, concept of Web GIS, History of Web GIS, components of web GIS, internet, web GIS v/s Internet GIS, users and stake holders of web GIS, advantages and limitations of web GIS, overview of Web GIS. Web mapping: static and interactive web mapping, open GIS web map server, Geographic Markup Language - principles and characteristics, commercial web mapping programs. Functions of Web GIS: Display of general information for the public, display of planning information, interactive display of spatial information, sharing and distribution of spatial data as well as management of spatial data

Mobile GIS: Location based services, Case studies on Mobile Solutions; Mobile App Development Approaches, HTML5 Geolocation; Creating a Mobile App, jQuery Mobile - Components, Event Handling, Mobile Configuration Third-party APIs; Google Maps API; ArcGIS API; Leaflet API

Open Source GIS and its components, open source GIS softwares- Q GIS, Bhuvan, Google Earth, Cloud GIS.

**Reading:**


1. Burrough, P. A and Racael A. McDonnell, Principles of Geographical Information Systems, Oxford University Publications, 1998.
2. C.P.Lo., Albert K and W.Yeung, Concepts and Techniques of Geographic Information Systems, Prentice Hall India Pvt.Ltd, New Delhi, 2002.
3. ArcGIS 10.1 User Manuals, ESRI, 2013.
4. Kraak, M. and Brown, A. Web Cartography: Development and Prospects, Taylor and Francis, London, 2001.
5. Tereshenkov, A., Web GIS Application in Local Government, VDM Verlag, 2009.
6. Pinde Fu and Jiulin Sun, Web GIS: Principles and Applications, ESRI Press, 2011
7. Maximiliano Firtman., jQuery Mobile: Up and Running, O'Reilly, 2012

| CE 5552 | ADVANCED IMAGE PROCESSING | PCC | 3-1-0 | 4 Credits |
|---|---|---|---|---|

**Prerequisites:** Remote Sensing and Image Processing (CE5501)

**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Process the remotely sensed with advanced techniques |
| CO2 | Classify the processed remote sensing data |
| CO3 | Evaluate the accuracy of image classification |
| CO4 | Apply the advanced processing methods for deriving the useful information |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | | | | 1 |
| CO2 | 1 | 3 | 2 | 3 | 2 | 2 |
| CO3 | 3 | | 3 | 1 | 2 | 1 |
| CO4 | | 2 | 1 | 1 | 2 | |

**Detailed Syllabus:**

Image Processing: Segmentation - Methods, MDL, Watershed, Mean-shift, Edge detection; Spectral indices - Vegetation indices, water related indices, indices related to cloud properties

Multiband Enhancement: Principle component transformation, Tasseled cap transformation, Data fusion techniques

Image Classification Techniques: Training set - Statistical computation, understanding feature space & scatter plots, signature purity & separability, Signature Baye's decision rule, non-parametric & parametric classification techniques, minimum distance rule, Parallelepiped algorithm, maximum like-hood method, unsupervised and hybrid classification techniques, classification analysis - confusion matrix, error analysis & kappa coefficient

Advanced classification techniques: Learning methods, Object, Texture, e-cognition, Fuzzy, ANN and SVM based classification techniques, subpixel mixture analysis

Applications: Analysis of Multi-Temporal series and change detection

R and MATLAB tools for image processing

**Reading:**


1. John R Jensen, Introductory Digital Image Processing, Prentice Hall, New Jersey,2004.
2. Robert G Reeves, Manual of Remote Sensing Vol. I & II, American Society of Photogrammetry, Falls Church, USA, 1983.
3. Florence Tupin, Jordi Inglada and Jean-Marie Nicolas, Remote Sensing Imagery, ISTE and Wiley, 2014
4. Nello Cristiani and John Shawe Taylor., An Introduction to Support Vector Machines, Cambridge University Press, 2000

| CE5553 | GLOBAL NAVIGATION SATELLITE SYSTEM | PCC | 3-1-0 | 4 Credits |
|---|---|---|---|---|

**Prerequisites:** None

**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Identify GNSS components and their functions |
| CO2 | Select GNSS survey method |
| CO3 | Interpret the navigational message and signals received by the GNSS |
| CO4 | Identify error sources in GNSS observations, and apply the corrections for accurate positioning |
| CO5 | Map the geospatial features |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | | | | |
| CO2 | 2 | | 2 | 2 | 2 | 1 |
| CO3 | 3 | 2 | 2 | | 1 | |
| CO4 | 2 | 2 | 1 | 1 | 2 | 1 |
| CO5 | 3 | 2 | | 1 | 2 | 2 |

**Detailed Syllabus:**

Geodesy:

Introduction: History of GNSS; GPS system - Services and Segments, GLONASS system- Services and Segments, Galileo System- Services and Segments, Regional Navigation Satellite Systems (RNSS), Augmentation Systems

Reference Systems and Coordinate systems: Definition and scope of Geodesy, Earth, Geoid and Ellipsoid of rotation, Reference surfaces and coordinate systems in Geodesy, Indian Geodetic System and Everest Spheroid, WGS 84, Geodetic coordinate systems, Datum transformations, Height systems, Time systems

Satellite Orbits: Orbit - Description, Determination and Dissemination

Satellite Signal: Structure of Signal, Signal processing

Satellite Observables: Pseudo range measurements, Atmospheric effects, Antenna phase center offset and variation, Multipath, system accuracy characteristics, Data formats, Error budget

Surveying with GNSS: Planning a GNSS Survey, Positioning methods – point positioning, relative positioning, Static, Differential, RTK

Data Processing: Ambiquity resolution, Post processing, real time processing, Accuracy measures, software modules, GIS and GNSS data integration
Applications of GNSS

**Reading:**


1. Bradford W. Parkinson & James Spilker., Global Positioning System: Theory and Applications, Vol I,1996
2. Hofmann-Wellenhof, Lichtennegger and Wasle., GNSS: Global Navigation Satellite Systems, Springer-Verlag Wein, New York, 2008.
3. Gunter Seeber., Satellite Geodesy Foundations-Methods and Applications,2003.
4. Shuanggen Jin, Estel Cardellach adn Feiqin Xie., GNSS Remote Sensing: Theory, Methods and Applications, Springer, London, 2014.

| CE 5554 | DIGITAL IMAGE PROCESSING LABORATORY | PCC | 0-1-2 | 2 Credits |
|---|---|---|---|---|

**Prerequisites:** None

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Analyse temporal, spectral and spatial differences of satellite data using image processing software |
| CO2 | Perform image pre-processing and post-processing techniques on a given satellite data |
| CO3 | Classify given satellite data for thematic mapping process |

**Mapping of course outcomes with program outcomes**

| Course Outcome | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 1 | 3 | 1 | 1 |
| CO2 | 2 | 1 | 2 | 3 | 1 | 1 |
| CO3 | 1 | 1 | 2 | 1 | | 1 |

**Detailed Syllabus:**

Loading, Creating Image and Display Manipulation
Image Enhancement – Linear and Nonlinear
Geometric Correction and Mosaicing
Band Ratioing
NDVI Images
Spectral Enhancement
Generation of Training Sets
Supervised Classification and Accuracy Assessment
Unsupervised Classification
Change Detection
Programs for Image Analysis
Digital Photogrammetry

**Reading:**

1. ERDAS IMAGINE 2013 user manuals
2. Leica Photogrammetry suite 2013 user guide

| CE 5555 | ADVANCED GIS AND GNSS LABORATORY | PCC | 0-1-2 | 2 Credits |
|---|---|---|---|---|

**Prerequisites**: CE 5505: Geographical Information Systems Laboratory

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**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Perform advanced geospatial analysis |
| CO2 | Collect and analyze GNSS data |
| CO3 | Map geospatial features using GNSS data |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 1 | 2 | 1 | 1 |
| CO2 | 1 | 1 | 2 | 3 | 1 | 1 |
| CO3 | 2 | 1 | 2 | 1 | 2 | 1 |

**Detailed Syllabus:**

Interpolation methods
Viewshed and watershed analysis
Modeling tools
Python and R programming geospatial tools
Study of GPS and various parts and its working
Surveying with GPS-Static and Kinematic

**Reading:**

1. DGPS manuals
2. ArcGIS and QGIS Manuals

| 5511 | ADVANCED STATISTICAL METHODS | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites**: None
**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand/(Solve the problems using) the advanced statistical approaches |
| CO2 | Identify the statistical methods for solving geospatial problems |
| CO3 | Apply the advanced statistical methods for image processing |
| CO4 | Use geo-statistics for studying spatially varying phenomena |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 1 | 3 | 1 | |
| CO2 | 3 | 2 | 1 | 3 | 2 | 1 |
| CO3 | 1 | 2 | 3 | 1 | | |
| CO4 | 1 | 3 | 2 | 2 | 2 | 1 |

**Detailed Syllabus:**

1. Basic Statistics: Sources of Data, Organization of Data, The Histogram, Measures of central tendency, Mean Deviation, Standard Deviation, Correlation, Coefficient of correlation, Rank correlation, Regression.
2. Probability: equally likely, mutually exclusive events, definitions of probability, additions & multiplication theorems of probability and problems based on them.
3. Bayesian approach, distributions; Poisson, normal, Erlang, Gamma and Weibull probability distributions
4. Multivariate Data: Random Vectors and Matrices, sample estimate of centroid, standard deviation, SSCP, dispersion, variance, covariance, correlation matrices.
5. Multivariate Regression Models, Multiple linear Regression: Multiple parameter estimation by method of least squares, tests of significance use of dummy variables, problems associated with multi co-linearity, heteroscadasticity.
6. Geostatistics- Pattern Analysis, Measures of Arrangements & dispersion, Auto Correlation, Semiveriogram, Kriging;

**Reading:**


1. Gupta, S.C. and Kapoor, V.K., “Fundamentals of Mathematics Statistics”, Sultan Chand and Sons, 2001.
2. Johnson, R.J., “Miller and Freund’s Probability and Statistics for Engineers” 6th Edition, Prentice Hall of India, 2002.
3. Jay L.Devore, “Probability and statistics for Engineering and the Sciences”, Thomson and Duxbbury, 2002.
4. Sarma, D.D. “Geostatistics with Applications in Earth Sciences”, Capital Publishing Company, 2002.
5. Cooley W.W and Lohnes P.R .- Multivariate Data Analysis**,** John Wiley and Sons,1971.

| CE5512 | LIDAR TECHNOLOGY AND ITS APPLICATIONS | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites**: None

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Identify the principles of LiDAR technology |
| CO2 | Understand the problems of LiDAR data |
| CO3 | Analyse the LiDAR data for feature extraction |
| CO4 | Extract the urban, forestry and archaeological features from LiDAR data |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 1 | |
| CO2 | 2 | 1 | 2 | | 3 | |
| CO3 | 1 | 1 | | 3 | 2 | 1 |
| CO4 | 2 | 2 | 1 | 3 | 2 | |

**Detailed Syllabus:**

Terrestrial LiDAR: Concept, Instruments, Specifications, Capabilities, Data acquisition and processing. Applications – Interior, exterior of monuments and structures, 3D visualization and analysis, generation of archives towards planning and development

Airborne LiDAR: Sampling mechanisms, Data acquisition planning and acquisition techniques, pre-processing techniques, editing and data preparation

Applications – Forest cover, archaeological features urban studies, DEM extraction, utility for disaster applications

**Reading:**


1. Takshi Fujii and Tetsuo Fukuchi (Eds.), Laser Remote Sensing, CRC Press, Taylor & Francis Group, ISBN: 0-8247-4256-7, 2005.
2. Popescu, S. C. LiDAR: Remote Sensing of Terrestrial Environments. 1st edition, CRC Press. ISBN 978-1420047639, 2012.
3. Renslow, Michael (Eds) Airborne Topographic Lidar Manual. Bethesda, MD. American Society for Photogrammetry and Remote Sensing. ISBN 1-57083-097-5, 2012.

| CE5513 | OBJECT ORIENTED PROGRAMMING | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** None
**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Prepare the algorithms and programming syntax using OOP concepts |
| Co2 | Develop programs in C++ and Java |
| C03 | Apply the concepts of data encapsulation, inheritance, and polymorphism for developing a program |
| CO4 | Design and develop programs with Graphical User Interfaces capabilities |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 2 | 3 | 1 | 2 |
| CO2 | 1 | 3 | 1 | 2 | 1 | |
| CO3 | 1 | 1 | 1 | 3 | 2 | |
| CO4 | 1 | 3 | 2 | 3 | 1 | |

**Detailed Syllabus:**
Oops concepts – Classes, Objects, Polymorphism, Inheritance, Encapsulation, Overloading. Basic elements of C++, input and output statements, decision making, functions, iterations and loops. Objects and Classes. The Big Picture. Arrays and Strings. Operator Overloading. Inheritance. Pointers. Virtual Functions and Other Subtleties; Streams and Files;
Multifile Programs, Templates and Exceptions, Object-Oriented Software Development.
Java Programming: data types, variables and arrays, operators, control statements, classes, objects, methods – Inheritance; Packages and Interfaces, Exception handling, Multithreaded programming, Strings, Input /Output.

**Reading:**

1. E. Balagurusamy - Object Oriented Programming with C++ - TMH, fourth edition, 2008.
2. Herbert Schildt - C++ The complete Reference,1999.
3. Herbert Schildt - The Java 2 : Complete Reference - Fourth edition, TMH, 2002.
4. H.M.Deitel, P.J.Deitel - Java: How to program - Fifth edition, Prentice Hall of India private limited, 2003.
5. Robert Lafore, Object Oriented Programming in C++ , 4th Edition, Pearson Pub., 2002.

| CE5514 | DECISION SUPPORT SYSTEMS | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites**: Remote Sensing, Geographical Information System.
**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Apply the concepts of decision making and modeling as a problem solving approach |
| CO2 | Identify decision support models, methods, and technologies |
| CO3 | Design and develop decision support systems |
| CO4 | Analyse and prepare the DSS for the remote sensing and GIS applications |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 3 | 1 | |
| CO2 | 2 | 2 | 1 | 3 | 1 | |
| CO3 | 1 | 2 | 1 | 3 | 1 | |
| CO4 | 3 | 2 | 1 | 2 | 2 | 1 |

**Detailed Syllabus:**

Introduction: Concepts of decision making, systems and modeling, Need for DSS, Expert Systems.

Decision Analysis and Decision Making: Decision environments, Decision making under certainty, risk and uncertainty, Concepts of multicriteria decision making, Value and utility concepts in decision making, overview of methods of multicriteria analysis

Overview of DSS: Characteristics and capabilities of DSS, Components of DSS, Data management, model management and user interface subsystems, Classification of DSS, Development of DSS, Approaches to DSS construction, DSS development tools.

Overview of Expert Systems: Concepts of AI and Expert Systems, Types of expert systems, Components of expert systems, Knowledge acquisition, Methods of knowledge acquisition, Concepts of knowledge representation and inferencing, Inference techniques.

**Reading:**


1. Efraim Turban and Jay E. Aronson, Decision Support Systems and Intelligent Systems, Prentice Hall College Div; 5 edition.,1997.
2. Harry Timmermans (Ed.), Decision Support Systems in Urban Planning, E&FN SPON, London, 1997.
3. Manuel Mora, Guisseppi A. Forgionne, JatinderN. D.Gupta, Decision Making Support Systems: Achievements, Trends and Challenges for the New Decade, Idea Group Inc, London, 2003.

| CE5516 | DATABASE MANAGEMENT SYSTEMS | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** None

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| C01 | Understand the components of Database management system and file management methods |
| CO2 | Apply the concepts of SQL and its use to manage the databases |
| CO3 | Carry out the Query, update a databases using SQL |
| CO4 | Design and build a simple database system using DBMS software |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | | 3 | | |
| CO2 | 1 | 2 | | 3 | | |
| CO3 | 2 | 3 | 1 | 2 | 2 | |
| CO4 | 1 | 2 | 1 | 3 | 2 | 1 |

**Detailed Syllabus:**

Need for Data Base Management Systems (DBMS) Components of DBMS, Records and files, Data Models, Data Associations, Entities, Attributes and Associations, Relationships among entities, Data models classification

File Organization, Constituents of file, Operations on files, Sequential files, Index- Sequential files, Direct files

Relational Database, Attributes and domains, Tuples, Relations and their schemes, Relation Representation, Relational operations, Relational algebra, Relational calculus, Implementation

Relational Database Manipulation, Structured Query Language (SQL), Query Language (QUEL) Query-by-Example (QBE), Data Manipulation and retrieval using SQL, QUEL and QBE, Concepts of Relational database design.

Introduction to Big Data Management

**Reading:**


1. Arun K. Majundar and P. Bhattacharya, Database Management Systems,2001.
2. Bipin C. Desai, An Introduction to Database Systems,1990.
3. C J Date, An Introduction to Database Systems Vol-1,1994.

| CE5517 | WATER RESOURCES AND ENVIRONMENTAL SYSTEMS | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** None.

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Analyse the components of hydrological cycle |
| CO2 | Formulate rainfall-runoff and flood routing models |
| CO3 | Plan and design water and soil conservation structures |
| CO4 | Identify sources and causes of pollution |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 2 | 1 | | |
| CO2 | 1 | 2 | 2 | 3 | | |
| CO3 | 2 | 3 | 2 | 3 | 2 | 1 |
| CO4 | 2 | 1 | 1 | 2 | | |

**Detailed Syllabus:**

Introduction – Hydrological cycle, systems concepts, lumped and distributed systems, deterministic and stochastic Systems.

Hydrograph analysis - infiltration, effective rainfall, design storm, direct runoff hydrograph, unit hydrograph theory, derivation of runoff hydrograph from unit hydrograph; Rainfall – runoff analysis, rational method, NRCS approach, derivation of UG for ungauged catchments, synthetic unit hydrograph;

Flood and drought studies – flood frequency analysis, flood plane zoning, estimation of flood for different frequencies, flood forecasting, drought assessment and monitoring.

Watershed management – soil erosion and conservation, water harvesting structures, estimation of soil loss by universal soil loss equation;

Command area studies – cropping pattern, crop condition, irrigation system performance, crop yield estimation

Environmental systems – Natural systems, Degradation of natural systems, Environmental pollution, solid waste management, treatment, wetlands, non point source pollution.

**Reading:**


1. Ven Chow & David Maidment ,Larry Mays – Applied Hydrology – Mc Graw Hill Inc., 1988.
2. Murthy V V N – Land and Water Management Engineering, Kalyani Publishers., 2008.
3. Sincero A.P and Sincero G A – Environmental Engineering, A Design Approach, Prentice Hall of India.,1996.
4. Patra K.C – Hydrology and Water Resources Engineering, Narosa Publication House., 2008.

| CE5714 | WATERSHED MANAGEMENT | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites**: None

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Identify the causes of soil erosion |
| CO2 | Plan and design soil conservation measures in a watershed |
| CO3 | Plan and design water harvesting and groundwater recharge structures |
| CO4 | Plan measures for reclamation of saline soils |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | | 1 | 2 | 3 | | 1 |
| CO2 | 1 | 2 | 3 | 2 | 1 | |
| CO3 | 1 | | 2 | 3 | 1 | 1 |
| CO4 | | 1 | 1 | 2 | 1 | 1 |

**Detailed Syllabus:**

Introduction, concept of watershed, need for watershed management, concept of sustainable development

Hydrology of small watersheds

Principles of soil erosion, causes of soil erosion, types of soil erosion, estimation of soil erosion from small watersheds

Control of soil erosion, methods of soil conservation – structural and non-structural measures

Principles of water harvesting, methods of rainwater harvesting, design of rainwater harvesting structures, artificial recharge of groundwater in small watersheds, methods of artificial recharge

Reclamation of saline soils

Micro farming, biomass management on the farm

**Reading:**


1. Chatterjee, S. N., Water Resources Conservation and Management, Atlantic Publishers, 2008.
2. Murthy, V.V.N., Land and Water Management, Khalyani Publishers, 2004.
3. Muthy, J. V. S., Watershed Management, New Age International Publishers, 1998.
4. Suresh Rao, Soil and Water Conservation Practices, Standard Publishers, 1998.

| CE5312 | ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT | DEC | 3 – 0 – 0 | 3 Credits |
|---|---|---|---|---|

**Pre-requisites**: NONE

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Identify environmental attributes for the EIA study. |
| CO2 | Identify methodology and prepare EIA reports. |
| CO3 | Specify methods for prediction of the impacts. |
| CO4 | Formulate environmental management plans. |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 |
|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 3 | - | 2 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 3 | - | 2 | 1 |
| CO3 | 2 | 2 | 3 | 1 | 3 | - | 2 | 1 |
| CO4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |

**Detailed syllabus:**

Introduction: Definitions - Environmental Inventory, Standards, Indices - Environmental attributes—Air, Water Noise, Land Economic; Cultural and detailed discussions of individual parameters of each attributes; methods for Prediction and assessment of impacts air - water - soil - noise - biological - cultural - social - economic environments - Standards and guidelines for evaluation.

EIA - EIA Terminology - Need for EIA - Evolution of EIA - Concepts of EIA - Merits and demerits of EIA - Procedures - Screening, Scoping baseline data, Impact prediction - Stake holders of EIA - Public Participation in Decision making - Projects requiring Environmental Clearance -

EIA methodologies - Criteria for Selection -Impact identification, measurement, interpretation and Evaluation - Impact Communication - Adhoc Methods, Checklists Methods, matrices , Networks and Overlays Methods - Cost-Benefit Analysis - Rapid EIA and Comprehensive EIA - General Framework for Environmental Impact Assessment, Characterization and site assessment.

EMP and Monitoring - Document Planning - Scope and Baseline conditions - Construction Stage Impacts - Environmental Management Plan - Identification of significant or Unacceptable Impacts - Environmental Mitigation Plans - Relief and rehabilitation - Environmental Legislation and Audit - Concept of Environmental Risk Analysis and Life Cycle Assessment - Legal and regulatory Aspects in India.

EIA Case Studies of Developmental Projects : Preparation of EIA for developmental projects - Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Mining, Nuclear fuel complex, Highway project,

Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry. Software for rapid EIA.

**Readings:**


1. Canter, L.W., Environmental Impact Assessment, McGraw Hill Pub. Co., 1997
2. David P. Lawrence, Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley & Sons, 2003
3. Hosetti, B. B., Kumar A, Eds, Environmental Impact Assessment & Management, Daya Publishing House, 1998
4. UNESCO, Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development, UNESCO/UNEP, Paris, 1987
5. Anjaneyulu.Y., and Manickam. V., Environmental Impact Assessment Methodologies, B.S. Publications, Hyderabad, 2007
6. Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004

| CE5561 | REMOTE SENSING GEOLOGY | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** CE5501:Remote Sensing and Digital Image Processing; CE5503: Basic Photogrammetry

**Course Outcomes:** At the end of the course the student will be able to

| | |
|---|---|
| CO1 | Interpret the satellite imageries for geological features using remote sensing principles |
| CO2 | Distinguish various structural features from satellite images |
| CO3 | Apply geophysical principles for subsurface exploration |
| CO4 | Identify ground water potential zones, landslide hazard zones and mineral resources |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 1 | |
| CO2 | 2 | 1 | 2 | 1 | | |
| CO3 | 1 | 2 | 1 | | | |
| CO4 | 3 | 1 | 2 | 2 | 1 | 1 |

**Detailed Syllabus:**

Lithology: Igneous, sedimentary and metamorphic rocks, Lithological mapping using aerial photos and satellite imagery – Elements of interpretation - Digital analysis for litho logical discrimination.

Geomorphology: Geomorphological mapping using aerial photos and satellite imagery, Landforms like denudational, structural - fluvial, marine, aeolian, glacial and volcanic landforms.

Structural Analysis: Attitude of beds, Structural mapping- lineaments, folds, faults, joints and unconformities, Structural analysis using aerial and satellite data.

Exploration Techniques: Mineral Resources, Groundwater, Engineering Geology, Hydrogeomorphological mapping, Landslide studies.

Ground Penetrating Radar: Basics and operations of GPR, Applications of GPR for geological studies, sub-surface investigations including foundation structures etc.

**Reading:**


1. Ravi P. Gupta - Remote Sensing Geology - Springer Verlag Publications, 2005.
2. Floyd F. Sabins: *Remote sensing*: Principles and Interpretation, W.H. Freeman and Company, 2007.
3. Verstappean H.T, Remote Sensing in Geomorphology,Elsevier Scientific Publications,1977.
4. Druary, S.A - Image Interpretation in Geology - Allen and Unwin Ltd,2004.
5. Lintz J and Simonett David.S, - Remote Sensing of Environment - Addission Wesley Reading,1976.

| CE5562 | ANALYTICAL AND DIGITAL PHOTOGRAMMETRY | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** CE5503: Basic Photogrammetry

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Calculate the parameters for performing relative and absolute orientation on overlapping photographs |
| CO2 | Apply analytical techniques for mapping three-dimensional information |
| CO3 | Differentiate the analytical and digital photogrammetry in analyzing the terrain |
| CO4 | Prepare DTM and orthophotos |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | | | |
| CO2 | 2 | 3 | 2 | 2 | | |
| CO3 | 3 | 1 | 2 | 1 | 1 | |
| CO4 | 2 | 1 | 1 | 2 | 2 | 1 |

**Detailed Syllabus:**

Coordinate systems: Coordinate systems-photo, model, object space, Transformation of coordinates.

Mathematical relationship between image and object space, collinearity and coplanarity conditions, orientation procedures.

Data acquisition: Analog to digital conversion, metric versus non-metric cameras, frame versus line cameras, scanners – resolution and calibration, sensor characteristics, frame grabber – digital photogrammetric work station, geometric and radiometric transformations.

Digital Photogrammetry: analog, analytical and digital photogrammetry – advantages, accuracy, representation of digital images – digital cameras, CCD cameras, spectral sensitivity of CCD sensor, geometric problems in CCD images, line scanners.

Applications: DTM generation, Image correlation, matching, orthophoto generation, DSM, DTM and derived products, fly-through models

Close Range Photogrammetry: Fundamentals of Close Range Photogrammetry, Applications in Engineering and Non-topographic fields

**Reading:**


1. Linder, Wilfried, Digital Photogrammetry- A Practical course, 2nd Edition, Springer, XIV, 214p, 53 illus, with CD-ROM and a pair of 3-D glasses, ISBN: 3-540-29152-0, 2006.
2. Zhilin Li, Qung Zhu, Chris Gold, Li, Li, Digital Terrain Modeling: Principles and Methodology, CRC Press, ISBN 0-415-32462-9, 2005.
3. Yves Egels, Michel Kasser, Digital Photogrammetry, Taylor & Francis, 2002.
4. Schenk, T., `Digital Photogrammetry-Vol. 1`, TerraScience., 1999.
5. McGlone, J.C.,'Manual of Photogrammetry-Fifth Edition', American Society for Photogrammetry and Remote Sensing, 2004.
6. Mikail, E.M., J.S. Bethel, and J.C. McGlone, 'Introduction to Modern Photogrammetry', John Wiley & Sons, Ins. 2001.
7. Greve, C., `Digital Photogrammetry-An Annendem to the Manual of Photogrammetry`. American Society for Photogrammetry and Remote Sensing, 1996.

| CE5563 | THERMAL, MICROWAVE AND HYPERSPECTRAL REMOTE SENSING | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** CE5501: Remote Sensing and Digital Image Processing

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Understand the principles of thermal and microwave remote sensing |
| CO2 | Identify the working mechanism and applications of active and passive microwave systems |
| CO3 | Interpret Hyperspectral images |
| CO4 | Classify and analyze Hyperspectral data |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | 2 | | |
| CO2 | 2 | | 2 | 1 | | |
| CO3 | 2 | 1 | 2 | 2 | | |
| CO4 | 3 | 2 | 2 | 1 | 1 | 1 |

**Detailed Syllabus:**

Brief review of thermal and microwave remote sensing, their utility, merits and demerits. Introduction to spectral characteristics of remote sensing data, optical radiation models, summary of visible to shortwave region models

**Thermal Remote Sensing:** Thermal sensors and characteristics, Interpretation of thermal images, Emmissivity conseration, Termal inertia considerations, Factors effecting analysis of thermal images. Estimation of land surface temperature, applications of thermal remote sensing for geological studies, evapotranspiration etc.

**Microwave Remote Sensing:** Microwave Remote Sensing and its advantages. Active and passive systems. Platforms and sensors.

Active Microwave systems: Basic principles of radar, radar equation, Resolution, Range, Phase and Angular measurements, Microwave scattering and its measurement, Relationships between scene and sensor parameters. Imaging systems, Imagery – their characteristics and interpretation, Applications in various fields, Land use/Land cover, Soil/ Rock, Hydrology and flood disaster applications

SAR Interferometry for DEM generation. Differential SAR Interferometry for surface displacement studies. Applications in land subsidence, landslide movements, glacier movements etc. Polarimetry in Radar Remote Sensing. Basic equations. Propagation of waves and wave polarization. HH, VV, HV and VH polarization data and their applications

**HyperSpectral Remote Sensing:**Principles of Hyperspectral Remote Sensing, Spectral Cube, Airborne and spaceborne hyperspectral sensors. Data correction – atmospheric, radiometric and geometric, Data visualization, animation, Multiple colour composites, Observing signatures of various features and comparing with spectral libraries, Comparison of PCA, MNF, ICA derived products, spectral mapping methods: Spectral Angle Mapper (SAM), Spectral Correlation mapper, spectral feature filtering (SFF), Linear Spectral Unmixing (LSU)

**Reading:**


1. Ulaby, F.T., Moore, R.K., and Fung, A.K., Microwave Remote Sensing – Active and Passive – Wesley Publishing,1986.
2. Michael T, Eismann., Hyperspectral Remote Sensing, SPIE press, USA, 2012

3. Marcus Borengasser., William S Hungate and Russel Watkins., Hyperspectral Remote Sensing: Principles and Applications, CRC Press, 2008
4. Liguo Wang and Chunhui Zhao., Hyperspectral Image Processing, Springer, 2016
5. Varshney, P. K and Arora, M. K., Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data, Springer, 2014

| CE5564 | GEOSPATIAL TECHNIQUES FOR RURAL DEVELOPMENT | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** CE5501: Remote Sensing and Digital Image Processing), CE5502: Geographical Information System

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Evaluate the contribution of sectors, policies and services for rural development |
| CO2 | Analyze geographical and socio-economic features of rural areas |
| CO3 | Plan and design the rural infrastructure |
| CO4 | Apply the geospatial concepts for rural governance |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 1 | 2 | | |
| CO2 | 2 | 2 | 1 | 2 | | |
| CO3 | 2 | 1 | 1 | 1 | 2 | 1 |
| CO4 | 3 | 2 | 2 | 1 | 1 | 1 |

**Detailed Syllabus:**

Concepts of Rural Area and Rural Development; Causes of Rural Backwardness, Need for Rural Development, Levels of Living of Rural People Poverty indicators.

Organizational Aspects of Agriculture, Alternative Occupations in Rural Areas, Assessment of Rural Energy Supply and Demand, Planning for Rural Development, Definition and Characteristics of Village Communities – Concept and Importance of Rural Industrialization.

Engineering aspects of rural infrastructure development - Education - Housing – Health - Drinking Water Supply Road Network, PURA model, Study of poverty alleviation programmes implementation.

Governance of Rural Information and Communication Technology: Opportunities and Challenges; GIS and Governance in Development in India: Trends and Strategy for Implementation; ICT Infrastructure for Rural Development: Issues and Priority for Application.

Geospatial techniques for mapping of rural resources. Spatial technologies in rural planning management administration and development.

**Reading:**


1. Jain S.C. Indigenous Resources for Rural Development, Concept Publishers, 2005.
2. Technologies for Rural Development; http://en.wikibooks.org/wiki/ Technologies for_Rural_Development, 2010.
3. Harekrishna Misra (ed.), Governance of Rural Information and Communication Technologies, Opportunities and Challenges, Academic Foundation, 2009.

| CE5565 | GEOSPATIAL TECHNIQUES FOR DISASTER MANAGEMENT | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** CE5501: Remote Sensing and Digital Image Processing), CE5502: Geographical Information System

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Evaluate the spatial data for disaster and risk management |
| CO2 | Assess and monitor the natural disasters |
| CO3 | Develop methods for early warning systems |
| CO4 | Prepare the long term disaster management plans in geospatial environment |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 3 | 2 | 1 | |
| CO2 | 2 | 2 | 3 | 2 | | |
| CO3 | 1 | 2 | 2 | 3 | 2 | |
| CO4 | 1 | 1 | 2 | 3 | 2 | 1 |

**Detailed Syllabus:**

Various types of Natural Disasters - Cyclones, Floods and Tidal waves, Earth quakes, land subsidence and Landslides, Forest fires, Droughts with most well known Indian examples, Classifications and nature of impacts.

Vulnerability factors and Risk analysis of Natural disasters and Hazard estimations. Natural disaster management plans, Shelterbelts, Special structures, Disaster preparedness and Mitigation. Information needs of Disaster management

Global Disaster Alert and Coordination System, Case studies on Earthquake Damage Assessment relief operations using space technologies Flood zone mapping and planning of relief operations using geospatial technologies.

Solving Disaster Management Challenges Using Remote Sensing, Web-GIS and Advanced Technologies, Implementation of Tsunami Information System using geospatial technologies. GIS for Emergency Management, Disaster Risk Reduction

**Reading:**


1. D.B.N. Murthy - Disaster Management - Deep & Deep Publication, 2008.
2. Babar, Md., Environmental Changes and Natural Disasters, New India Publishing Agency, 2007.
3. A. Orhan, R. Backhaus, P. Boccardo, S. Zlatanova (eds.),Geoinformation for Disaster and Risk Management Examples and Best Practices, Joint Board of Geospatial Information Societies and United Nations Office for Outer Space Affairs, Denmark, 2010.
4. GIS and Emergency Management in Indian Ocean Earthquake/Tsunami Disaster, An ESRI® White Paper, 2006.

| CE5566 | GEOSPATIAL TECHNIQUES FOR WATER AND ENVIRONMENTAL ENGINEERING | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** CE5501: Remote Sensing and Digital Image Processing), CE5502: Geographical Information System

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Use the geospatial tools in water resources and environmental models |
| CO2 | Estimate and analyze the spatio-temporal quantification of water resources |
| CO3 | Apply the geospatial methods for planning and design of water resources systems |
| CO4 | Identify the geospatial tools for understanding the environmental systems |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | | |
| CO2 | 2 | 2 | 1 | 2 | | |
| CO3 | 2 | 2 | 1 | 3 | 1 | 1 |
| CO4 | 1 | 2 | 3 | 2 | 1 | |

**Detailed Syllabus:**

Surface-Water Hydrologic Data, Spatial techniques for Surface-Water Hydrology Modeling, Surface-Water Hydrology Models, ArcSWAT model and its applications; Groundwater Data, Ground water Models and spatial techniques for Groundwater Modelling and Visualization, The ArcHydro Data Model.

Geospatial techniques for planning and design of Water-Supply and Irrigation Systems, Spatial Database Development for Wastewater and Storm water Systems, GIS-Based Wastewater Collection System Design and Management Applications, GIS-Based Decision-Support Systems for Wastewater and Storm water Systems.

Geospatial technologies for Water Resources Monitoring and Forecasting; Spatial Decision-Support Systems in River Basin Management; Spatial systems for floodplain mapping and management.

Spatial techniques for Water Quality Monitoring and Modeling, GIS for Water-Quality Database Development, GIS for Water-Quality Management Decision Support

Taxonomy of Environmental Models in the Spatial Sciences. Geographic Data for Environmental Modeling and Assessment. Applications of Remote Sensing and Geographic Information Systems in Wildlife Mapping and Modeling. Land Use Planning and Environmental Impact Assessment Using Geographic Information Systems.

**Reading:**


1. Lynn E. Johnson, Geographic Information Systems in Water Resources Engineering, CRC Press, 2008.
2. Praveen Kumar, Mike Folk, Momcilo Markus and Jay C. Alameda, Hydroinformatics: Data Integrative Approaches in Computation, Analysis, and Modeling, CRC Press, 2005.
3. Allan Brimicombe, GIS, Environmental Modeling and Engineering, Second Edition, CRC Press, 2009.
4. Andrew Skidmore (Editor, Environmental Modelling with GIS and Remote Sensing, CRC Press), 2002.

| CE5567 | GEOSPATIAL TECHNIQUES FOR TRANSPORTATION ENGINEERING | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** CE5501: Remote Sensing and Digital Image Processing), CE5502: Geographical Information System

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Identify the geospatial data and tools required for understanding the transportation systems |
| CO2 | Use geospatial methods to analyze the transportation network problems |
| CO3 | Apply the geospatial methods in transportation modelling systems |
| CO4 | Demonstrate the use of geospatial methods in transportation safety and air quality analysis |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 3 | 1 | 2 | |
| CO2 | 1 | 2 | 1 | 3 | | |
| CO3 | 1 | 2 | 1 | 3 | 2 | 1 |
| CO4 | 1 | 2 | 2 | 2 | 1 | |

**Detailed Syllabus:**

GIS – T Data Models: Data Domains and Data Modelling in GIS – T; Data Modelling Techniques; Data Modeling and Design Issues; Graph Theory and Network Analysis; Network representation of a Transportation System; Linear referencing methods and systems; Transportation Data Models for ITS and related Applications.

Transportation Data Sources And Integration: Basic Mapping Concepts; Transportation Data Capture and Data Products; Transportation Data Integration; Spatial Data Quality; Spatial and Network aggregation.

Shortest Paths And Routing: Fundamental Network Properties; Fundamental Properties of Algorithms; Shortest Path Algorithms; Routing Vehicles with in Networks.

Network Flows And Facility Location: Flow through Uncongested Networks; Flow through Congested Network; Facility location within Networks; Spatial Aggregation in Network Routing and location problems.

GIS based Spatial Ananlysis and Modeling: GIS and spatial Analysis; Urban sprawl; GIS Analytical functions; Coupling Transportation Analysis and Modelling with GIS; Customising GIS; Supporting Advanced Transportation Analysis in GIS.

Transportation Planning:: Transportation Analysis Zone Design; Travel demand Analysis; Landuse – Transportation Modelling; Route Planning; Decision support for Transportation Planning.

Intelligent Transportation Systems: ITS Applications; ITS Architectures and Geographic Information; Integrating GIS and ITS.

Transportation, Environment and Hazards: Mapping sensitive Environmental features; GIS and Transportation related Air Quality; Accidents and Safety Analysis; Transportation of hazardous Materials.

**Reading:**


1. Miller HJ and Shaw SL, Geographic Information Systems for Transportation: Principles and Applications, Oxford University Press,2001.
2. Implementation of GIS in State DOTs, NCHRP Report No:180.

3. Simlowitz HJ. GIS Support Transportation System Planning. International GIS Sources Book.
4. Scholton HJ and Stillwell JCH, Geographical Information Systems for Urban and Regional Planning, Kluwer Acedemic Publishers,2010.
5. Hill JC, GIS in Transportation, Transportation Research Part C & 2000.

| CE5568 | GEOSPATIAL TECHNIQUES FOR URBAN PLANNING | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** CE5501: Remote Sensing and Digital Image Processing), CE5502: Geographical Information System

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Identify the geospatial data and tools required for understanding the transportation systems |
| CO2 | Use geospatial methods to analyze the transportation network problems |
| CO3 | Apply the geospatial methods in transportation modelling systems |
| CO4 | Demonstrate the use of geospatial methods in transportation safety and air quality analysis |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 3 | 1 | 2 | |
| CO2 | 1 | 2 | 1 | 3 | | |
| CO3 | 1 | 2 | 1 | 3 | 2 | 1 |
| CO4 | 1 | 2 | 2 | 2 | 1 | |

**Detailed Syllabus:**

Urban Planning: Challenges and Opportunities in Present Context, Smart City and AMRUT: Mission Guidelines, Challenges and Opportunities, GIS Concepts and Spatial Database for Urban Planning, GPS Concepts, Mobile Mapping and Application in Urban Utility Mapping

Remote Sensing Overview and Earth Observation Data for Urban Planning, Urban Land use/ Land cover Classification, Urban/ Regional Features Extraction Using Remote Sensing Data

GeospatialData and Services on Bhuvan Geoport, Open Source Tools and Datasets for Urban Planning, Crowd sourcing and Mobile Apps for Citizen-centric services, National Urban Information System (NUIS) and Bhuvan-NUIS

Urban Sprawl and Urban Growth Modeling, Urban Green Spaces, Land Surface Temperature Studies in Urban Areas, Urban Seismic Risk Assessment, 3D City Modeling for Urban Planning; Disaster Risk Reduction.

**Reading:**


1. Xiaojun Yang., Urban Remote Sensing: Monitoring, Synthesis and Modeling in the Urban Environment, Wiley-Blackwell, 2011
2. Zhenjiang Shen., Geospatial Techniques in Urban Planning, Springer-Verlag, Berlin Heidelberg, 2012.
3. Henk J. Scholten John C. H. Stillwell (Eds.), Geographical Information Systems for Urban and Regional Planning, Springer, Dorddrecht, 1990.
4. Harry Timmermans (Ed.), Decision Support Systems in Urban Planning, E&FN SPON, London, 1997.
5. Carol L. Stimmel, Building Smart Cities: Analytics, ICT, and Design Thinking, CRC Press, New York, 2016.
6. http://smartcities.gov.in/

| CE5767 | APPLICATIONS OF SOFT COMPUTING TECHNIQUES | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites**: None.
**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Understand the characteristics of Soft Computing Techniques |
| CO2 | Develop neural network models for pattern classification, function approximation, pattern association, prediction and control problems |
| CO3 | Apply fuzzy logic and fuzzy reasoning for decision making |
| CO4 | Formulate genetic algorithm for simple objective optimization problems. |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 2 | 3 | 1 | 1 |
| CO2 | 1 | 2 | 2 | 3 | | |
| CO3 | 1 | 2 | 2 | 3 | 1 | |
| CO4 | 2 | 1 | 2 | 3 | | |

**Detailed Syllabus:**

Introduction, need for soft computing techniques, components of soft computing
Artificial Neural Networks (ANN), types of ANN and learning algorithms, tasks performed by ANN
Basic concepts of feed forward neural networks, perceptron learning rule, back propagation learning algorithm, application of feed forward ANN for function approximation and prediction, limitations of feed forward neural networks, applications of feed forward neural networks in Hydrology, Water Resources and Environmental Engineering
Hebbian learning and Hopfield networks, pattern association, radial basis function networks, Kohonen networks and self organisation maps, applications of ANN in pattern classification

Information and uncertainty, Chance versus ambiguity, Classical sets and fuzzy sets, Logic and reasoning, Fuzzy set operations and fuzzy relations, Membership Functions, fuzzy numbers and fuzzy arithmetic
Fuzzy Systems, fuzzy relations, fuzzy inference systems, Decision Making with Fuzzy Information, Fuzzy Classification and Pattern Recognition, Neuro-Fuzzy Systems
Evolutionary computing, concepts of genetic algorithm, components of genetic algorithm, Hybrid soft computing techniques, Applications in Civil Engineering.

**Reading:**


1. Haykin, Neural Networks: A Comprehensive Foundation, Prentice Hall India, New Delhi, 2008.
2. Jang, J.R, Sun Chuen-tsai, and Mizutani Eiji, Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, PHI Learning, 2009.
3. Rajasekaran, S., and Vijayalakshmi Pai, G.A., Neural Networks, Fuzzy Logic and Genetic Algorithms – Synthesis and Applications, Prentice-Hall India, New Delhi, 2003.
4. Sivanandam, S N and S N Deepa, Principles of Soft Computing, Wiley India, 2013.
5. Karray, Fakhreddin O. and Clarence De Silva, Soft Computing and Intelligent Systems Design – Theory, Tools and Applications, Pearson Education Ltd., 2013.

| CE5764 | URBAN WATER MANAGEMENT | DEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites**: None.

**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Identify factors affecting urban hydrological cycle |
| CO2 | Estimate urban water demand and urban storm water quantity |
| CO3 | Plan and design storm water control and disposal systems |
| CO4 | Develop integrated urban water management system |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | | 1 | | |
| CO2 | 2 | 2 | 1 | 2 | | |
| CO3 | 2 | 2 | 1 | 3 | 1 | 1 |
| CO4 | 1 | 2 | 1 | 3 | 1 | 1 |

**Detailed Syllabus**

General introduction to urbanisation and its effect on water cycle – urban hydrological cycle – trends in urbanisation – Effect of urbanisation on hydrology.

Urban Hydrological cycle – time of concentration – importance of short duration of rainfall and runoff data – methods of estimation of time of concentration for design of urban drainage systems.

Master drainage plans – issues to be concentrated upon – typical content of an urban drainage master plan – interrelation between water resources investigation and urban planning processes – planning objectives – comprehensive planning – use of models in planning.

Basic approaches to urban drainage – runoff quantity and quality – wastewater and stormwater reuse – major and minor systems.

Elements of drainage systems – open channel – underground drains – appurtenances – pumping – source control.

Stormwater Analysis Calculation of runoff and peak – Design of stormwater network systems.

Best Management Practices – Detention and retention facilities – Swales-constructed wetlands.

Operation and maintenance of urban drainage system – interaction between stormwater management and solid waste management, Various model available for stormwater management. Legal aspects

**Reading:**


1. Geiger W. F., J Marsalek, W. J. Rawls and F. C. Zuidema, “Manual on Drainage in Urbanised area” – 2 volumes, UNESCO, 1987.
2. Hall M J , Urban Hydrology, Elsevier Applied Science Publisher,1984.
3. Stahre P and Urbonas B , “Stormwater Detention for Drainage”, Water Quality and CSO Management, Prentice Hall, 1990.
4. Wanielista M P and Eaglin ,“Hydrology – Quantity and Quality Analysis”, Wiley and Sons, 1997.
5. Marsalek et al “Urban water cycle processes and interactions”, Publication No. 78, UNESCO, Paris(http://www.bvsde.paho.org/bvsacd/cd63/149460E.pdf), 1997.
6. Maksimovic C and J A Tejadxa-Guibert “Frontiers in Urban Water Management – Deadlock or Hope”, IWA Publishing,2001.
7. http://www.water.ca.gov/urbanwatermanagement/
8. http://www.adb.org/publications/good-practices-urban-water-management

| CE5770 | CLIMATE SYSTEMS | DEC | 3 – 0 – 0 | 3 Credits |
|---|---|---|---|---|

**Pre-requisites:** None
**Course Outcomes:** At the end of the course the student will be able to:

| | |
|---|---|
| CO1 | Identify factors influencing the global climate systems |
| CO2 | Assess impacts of climate change on global, regional and local scales |
| CO3 | Develop strategies for adaptation and mitigation measures |
| CO4 | Identify clean technologies for sustainable development |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 2 | 1 | 1 | 2 |
| CO2 | - | 2 | 1 | 1 | 2 | 1 |
| CO3 | 1 | - | 3 | 1 | 2 | 2 |
| CO4 | 1 | 1 | - | 1 | 2 | 2 |

**Detailed syllabus**

Earth's climate system: introduction-climate in the spotlight - the earth's climate machine – climate classification - global wind systems – trade winds and the hadley cell – the westerlies - cloud formation and monsoon rains – storms and hurricanes – the hydrological cycle – global ocean circulation – el nino and its effect - solar radiation –the earth's natural green house effect – green house gases and global warming – carbon cycle.

Observed changes and its causes: observation of climate change – changes in patterns of temperature, precipitation and sea level rise – observed effects of climate changes – patterns of large scale variability – drivers of climate change – climate sensitivity and feedbacks – the montreal protocol – unfccc – ipcc –evidences of changes in climate and environment – on a global scale and in india – climate change modeling.

Impacts of climate change: impacts of climate change on various sectors – agriculture, forestry and ecosystem – water resources – human health – industry, settlement and society – methods and scenarios – projected impacts for different regions– uncertainties in the projected impacts of climate change – risk of irreversible changes.

Climate change adaptation and mitigation measures: adaptation strategy/options in various sectors – water – agriculture –- infrastructure and settlement including coastal zones – human health – tourism – transport – energy – key mitigation technologies and practices – energy supply – transport – buildings – industry – agriculture – forestry - carbon sequestration – carbon capture and storage (ccs)- waste (msw & bio waste, biomedical, industrial waste – international and regional cooperation.

Clean technology and energy: clean development mechanism –carbon trading- examples of future clean technology – biodiesel – natural compost – eco-friendly plastic – alternate energy – hydrogen – bio-fuels – solar energy – wind – hydropower – mitigation efforts in india and adaptation funding.

**Reading:**


1. Anil Markandya , Climate Change and Sustainable Development: Prospects for Developing Countries, Routledge, 2002
2. Heal, G. M., Interpreting Sustainability, in Sustainability: Dynamics and Uncertainty, Kluwer Academic Publ., 1998
3. Jepma, C.J., and Munasinghe, M., Climate Change Policy – Facts, Issues and Analysis, Cambridge University Press, 1998
4. Munasinghe, M., Sustainable Energy Development: Issues and Policy in Energy, Environment and Economy: Asian Perspective, Kleindorfor P. R. et. al (ed.), Edward Elgar, 1996
5. Dash Sushil Kumar, “Climate Change – An Indian Perspective”, Cambridge University Press India Pvt. Ltd, 2007

| CE5541 & CE5591 | Seminar – I & Seminar – II | PCC | 0-0-2 | 1 Credits |
|---|---|---|---|---|

**Prerequisites**: None.

**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Select a topic relevant to geospatial technologies |
| CO2 | Undertake a critical review of the literature on the chosen topic |
| CO3 | Prepare and present a technical report |

**Mapping of course outcomes with program outcomes**

| Course outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | | | | 2 | |
| CO2 | 2 | | | | 2 | |
| CO3 | 1 | 1 | 1 | 1 | 2 | 2 |

**Detailed Syllabus:**

The student can choose any topic, of his choice, pertaining to Remote Sensing and GIS technologies. Topic should be a relevant and currently researched one. Students are advised to refer articles published in current journals in the area of geospatial applications for choosing their seminar topics. Student should review minimum of 5 to 6 research papers relevant to the topic chosen, in addition to standard textbooks, handbooks, etc. Students are required to prepare a seminar report, in the standard format and give presentation to the Seminar Assessment Committee (SAC) in the presence of their classmates.

**Reading:**

1. Remote sensing, GIS and Photogrammetry Journals, Conference Proceedings
2. Research Articles / Reports available on Internet
3. Remote sensing and GIS Textbooks and Handbooks

| CE6549 & CE6599 | Dissertation Part – A & Dissertation Part – B | PCC | 0-0-0 | 18 Credits (6 + 12) |
|---|---|---|---|---|

**Prerequisites**: None.

**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Identify a topic related to social and engineering problems, hazard mitigation and decision support systems which can be addressed geospatial environment |
| CO2 | Make a critical review of the available literature on the topic |
| CO3 | Conduct independent research to formulate and solve the chosen problem |
| CO4 | Prepare technical report on the study carried out |

**Mapping of course outcomes with program outcomes**

| Course outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 2 | 1 | 2 | 2 |
| CO2 | 1 | 1 | 1 | 1 | 2 | |
| CO3 | 3 | 3 | 3 | 3 | 2 | 3 |
| CO4 | | | | | 2 | 2 |

**Detailed Syllabus:**

Students are required to search, collect and review various research articles published in chosen area of research. A student has to select a topic for his dissertation, based on his/her interest. A student shall be required to submit a dissertation report on the research work carried out by him/her.

**Reading:**

1. Journal Publications
2. Conference / Seminar Proceedings
3. Handbooks / Research Digests
4. Research articles on internet

| CE6542 | Comprehensive Viva Voce | PCC | 0-0-0 | 1 Credits |
|---|---|---|---|---|

**Prerequisites**: None.

**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Assimilate knowledge of different courses studied |
| CO2 | Develop overall comprehension about remote sensing and GIS |
| CO3 | Analyse real life geospatial problems with theoretical knowledge learned |
| CO4 | Interpret and articulate solutions to real life geospatial problems |

**Mapping of course outcomes with program outcomes**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | | |
| CO2 | 2 | 2 | 2 | 2 | | |
| CO3 | 3 | 2 | | | 2 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 2 | 2 |

**Detailed Syllabus:**

All the subjects studied in I year I semester and II semesters.

**Reading:**

1. Reading Material of all the courses
2. Case Studies