Department of Remote Sensing

Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

- To educate students at Undergraduate, Post Graduate Doctoral and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

Be a centre of excellence in the field of Geo-spatial Technology education and research to meet the needs of ever increasing requirement of human resources in these fields and to cater to the larger interest of the Society and Nation.

Department Mission

- Impart quality education and equip the students with strong foundation that could make them capable of handling challenges of the ever advancing geo-spatial technologies.
- Maintain state-of-the-art in research and outreach facilities in phase with the premier institutions for sustained improvement in the quality of education and research.

Programme Educational Objectives (PEOs) – Remote Sensing

PEO 1: To prepare the students in identifying, analysing and solving geospatial problems.

PEO 2: To train the students in developing practical and executable solutions to the challenges of growing field of Remote Sensing and GIS.

PEO 3: To impart the students with strong base of knowledge that makes them suitable both for industries as well as for teaching and research.

PEO 4: To inculcate the students with the sensitivity towards ethics, public policies and their responsibilities towards the society.

PROGRAM OUTCOMES (POs)
M. Tech. in Electrical Engineering (CONTROL SYSTEM)

PO1: An ability to independently carry out research /investigation and development work to solve real life geospatial problems.

PO2: An ability to write and present a substantial technical report/document and publish international level research articles.

PO3: Students should be able to demonstrate a degree of mastery over the areas of Remote Sensing and GIS technology. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: An ability to share theoretical and practical knowledge in both teaching and research as well as in industries.

PO5: An ability to apply professional ethics, accountability and equity.

COURSE INFORMATION SHEET

Course code: RS 501
Course title: PRINCIPLES OF REMOTE SENSING & DIGITAL SATELLITE IMAGE PROCESSING

Pre-requisite(s): Basic Physics/Science
Co- requisite(s): Computer Knowledge

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03
Class: M. TECH
Semester / Level: 01/05 (Monsoon)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to:

1.	Disseminate basic concepts and applications of Electromagnetic Spectrum in Remote Sensing, Energy Balance and Data acquisition platforms, sensors and their characterstics
2.	Enhance student's knowledge about optical, thermal and microwaves based Remote Sensing and Applications for solving real life problems
3.	Introduce students to digital image processing tools and techniques.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Explain physical principles and sensing process in remote sensing.
CO2	Explain different type of sensors (optical, microwave, thermal and LIDAR) and their characteristics.
CO3	Describe preprocessing requirements and discuss various Digital Image Processing techniques.
CO4	Rationalise statistical outlook of satellite images and different classification approaches with respect to diverse applications.
CO5	Apply the knowledge of remote sensing in various thematic studies

SYLLABUS

MODULE 1: BASIC CONCEPTS (8L)

Remote Sensing: History, Development, Definition, Concept & Principles, Electromagnetic Radiation (EMR) and Its Characteristics, Wavelength Regions and their Significance, Interaction of EMR with Atmosphere and Earth's Surface: Absorption, Reflectance and Scattering, Atmospheric Windows, Energy Balance Equation, Spectral Response and Spectral Signature, Spectral, Spatial, Temporal and Radiometric resolutions.

MODULE 2: DATA ACQUISITION (8L)

Platform: Balloon, Rocket, Helicopter, Aircraft and Spacecraft, Aerial vs. Satellite Remote Sensing, Satellites and their Specifications: LANDSAT, SPOT, ENVISAT, RADARSAT, IRS, IKONOS, Sensors and their Specifications: MSS, TM, LISS(I,II,III,IV), PAN, WiFS, AWiFS, MODIS, Weather & Communication Satellites.

MODULE 3: OPTICAL, THERMAL AND MICROWAVE REMOTE SENSING (8L)

Imaging and Non-Imaging, Active and Passive, Multispectral, Superspectral and Hyperspectral Sensors, Electro-Optical Systems, Opto-Mechanical Scanners, Infrared Scanners, Scatterometer,

Thermal Properties of Terrain, Thermal IR Environmental Considerations, Thermal Infrared and Thermal Scanners, Microwave Remote sensing concepts:, Backscattering, Range Direction, Azimuth Direction, Incident Angle, Depression Angle, Polarization, Dielectric Properties, Surface Roughness and Interpretation, Speckle and Its Reduction, Applications of optical, thermal and microwave remote sensing.

MODULE 4: IMAGE ENHANCEMENT AND FILTERING TECHNIQUES (8L)

Concepts about digital image and its characteristics, Sources of image degradation - Image restoration and Noise Abatement , Radiometric and Geometric correction technique, linear and non linear transformation for geometric corrections, Look-up Tables (LUT) and Types of image displays and FCC, Radiometric enhancement techniques, Spatial enhancement techniques, Contrast stretching: Linear and non-linear methods, Low Pass Filtering: Image smoothing, High Pass Filtering: Edge enhancement and Edge detection, Gradient filters, Directional and non-directional filtering.

MODULE 5: PATTERN RECOGNITION (8L)

Concept of Pattern Recognition, Multi-spectral pattern recognition, Spectral discrimination, Signature bank, Parametric and Non-Parametric classifiers, Unsupervised classification methods, Supervised classification techniques, Limitations of standard classifiers.

TEXT BOOKS:

1. Joseph,George and Jeganathan, C. (2017). "Fundamentals of Remote Sensing", 3rd Edition, Universities press (India) Pvt. Ltd., Hyderabad.
2. Jensen, J.R. (2006). "Remote Sensing of the Environment – An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi.
3. Jensen, J.R. (1996). Introductory Digital Image Processing A remote sensing perspective. Prentice Hall Seies in GIS , USA
4. Lillesand, Thomas M. and Kiefer, Ralph, W. (2007). "Remote Sensing and Image Interpretation", 4th Edition, John Wiley and Sons, New York

REFERENCE BOOKS:

1. Sabins, F.F. Jr. (2007). 'Remote Sensing – Principles and Interpretation", W.H. Freeman & Co.
2. Reeves, Robert G. (1991), "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/institutional visits/field visit
CD6	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	3	-
CO2	2	1	3	3	-
CO3	2	1	3	3	1
CO4	3	1	3	3	1
CO5	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6
CO2	CD1, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3, CD6
CO5	CD1,CD2,CD3,CD4,CD5, CD6

Course code: RS 502
Course title: GEOGRAPHIC INFORMATION SYSTEM AND SATELLITE NAVIGATION SYSTEMS
Pre-requisite(s): Basic Sciences
Co- requisite(s): Basic Computing

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 3
Class: M. TECH
Semester / Level: 01/05 (Monsoon)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives:

This course aims to:

1.	Introduce the students to the basic concepts of GIS and making the students familiar with the spatial data and spatial analysis techniques
2.	Introduce the satellite based positioning system, concept of geodesy and augmentation systems
3.	Impart concepts about reference surfaces (Datum), coordinate transformation models and surveying methods.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Describe various GIS and Navigation tools and techniques within spatial analytical framework and handle spatial and non-spatial database.
CO2	Carry out spatial data analysis to solve natural, environmental and societal problems and challenges.
CO3	Explain various datums, coordinate systems, Differential positioning concepts and associated surveying techniques.
CO4	Elucidate integrated geospatial techniques and apply them in solving real world problems.

SYLLABUS

MODULE 1: BASIC CONCEPTS OF GIS (8L)

Definition, Philosophy & Historical evolution of GIS, Spatial vs. non-spatial data, Components of GIS, Spatial data models – Raster and Vector; advantages & disadvantages, Raster Data & its Representation: Data Structure& File format, Data Compression (block code, chain code, run length code, quadtree, MrSID), Vector data representation: Data Structure& File format,Topology, Advantage of DBMS in Context of GIS, Relational and Object Oriented DBMS.

MODULE 2: DATA INPUTANDGEO-CORRECTION (8L)

Sources of Spatial Data (Raster and Vector), Data Acquisition Through Scanners and on-screen Digitisation, Projections, Geometric Transformations of Raster and Vector Data (Affine Transformation and Transformation Coefficients), RMS Error, Types of Co-ordinate Systems, Spheroid and Datums, Sources of Errors, Spatial Data Quality: Accuracy, Precision, Error and uncertainty.

MODULE 3: SPATIAL ANALYSIS AND VISUALIZATION (8L)

Spatial Analysis: Definition, Steps and classification, Raster Data Analysis Tools – Local, Focal, Zonal and Global, Vector Data Analysis – Buffering, Distance Measurements, Analyzing Geographic Relationship, Overlay Analysis, Quantifying Change, Spatial Interpolation: Introduction, DEM Generation Surface Representation & Analysis, Network Analysis, Linkage Between Spatial and Non-Spatial Data, Basics of Geodatabase Model, Difference between 2D,2.5D, 3D and 4D GIS, Current issues and trends in GIS.

MODULE 4: SATELLITE POSITIONING SYSTEM - AN OVERVIEW (8L)

Introduction to Global Navigation Positioning System, Various Global/Regional Satellite constellations, NAVSTAR GPS signals, Geopositioning - Basic Concepts, Pseudo Range Measurement, Phase Difference Measurement, Sources of GNSS errors, DOP, Geoid, Datum/Ellipsoid - definition and basic concepts, Global Datum vs. Indian Geodetic Datum, Coordinate Systems, Transformation of coordinates, GNSS Remote Sensing.

MODULE 5: POSITIONING AUGMENTATION AND GNSS APPLICATIONS (8L)

Differential positioning concept, Various Differential survey Methods, GNSS Survey Planning, Data Processing, Site characteristics of Reference Station, Reference Station Equipment, Augmentation Systems (IRNSS, GAGAN, WAAS, LAAS, etc.) Basic concepts, Applications.

TEXT BOOKS:

1. Burrough, Peter A. and Rachael McDonnell (1998). 'Principles of Geographical Information Systems' Oxford University Press, New York.
2. George Joseph & C. Jeganathan (2018). Fundamentals of Remote Sensing 3rd edition, Universities Press, India.
3. C.P.Lo and Albert K.W.Yeung (2006). Concepts and Techniques of Geographic Information Systems. Prentice Hall of India,New Delhi.
4. Kang-tsung Chang (2007). Introduction to Geographic Information Systems, Tata McGraw Hill, New Delhi.
5. Satheesh Gopi (2005). Global Positioning System: Principles and Applications. McGraw Hill Publishers.
6. N. Madhu, R. Sathikumar, Satheesh Gopi (2006). Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson India Publisher.

REFERENCE BOOKS:

1. Magwire, D. J., Goodchild, M.F. and Rhind, D. M. (2005). Geographical Information Systems: Principles and Applications', Longman Group, U.K.
2. Paul Longley, Michael Goodchild, David Maguire and David Rhind (2005). Geographical Information Systems. Principles, Techniques, Applications and Management. John Wiley & Sons.
3. Laurini, Robert and Derek Thompson (1992). Fundamentals of Spatial Information Systems. Academic Pr., London
4. Kluwer Fotheringham A S, O'Kelly M E. (1998). Spatial Interaction Models: Formulations and Applications.
5. Thanappan Subash (2011). Geographical Information System,Lambert Academic Publishing.
6. John E. Harmon & Steven J. Anderson (2003). The design and implementation of Geographic Information Systems, John Wiley &Sons,.
7. ArcGIS 10.1 Manuals, 2016.
8. N.K.Agrawal (2004). Essentials of GPS, Spatial Network Pvt. Ltd
9. Leica. A. (2003). GPS Satellite Surveying, John Wiley & Sons. New York
10. Terry-Karen Steede (2002). Integrating GIS and the Global Positioning System, ESRI Press
11. Hofmann W.B &Lichtenegger, H. Collins (2001). Global Positioning System – Theoryand Practice, Springer-Verlag Wein, New York,.
12. Gunter Seeber (2003). Satellite Geodesy Foundations-Methods and Applications,Gruyter, Walter de GmbH.

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/institutional visits/field visit
CD6	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	3	3	2
CO2	3	2	1	2	2
CO3	2	-	3	3	2
CO4	3	2	3	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD4, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3, CD4, CD6

SEMESTER II

Course code: RS 511
Course title: AERIAL AND SATELLITE PHOTOGRAMMETRY & IMAGE INTERPRETATION

Pre-requisite(s): Student must have the knowledge of Remote Sensing, GIS & GNSS
Co- requisite(s): Basic understanding of various satellite data

Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to make the students:

1.	Learn fundamental aspects of Aerial Photogrammetry, Satellite/Aerial Photo interpretation and its applications in various thematic domains.
2.	Learn analogue and digital based approaches in photogrammetry.
3.	Understand the recent developments and role of satellite and UAV in terrain modelling and mapping.

Course Outcomes (COs)

On completion of this course, students should be able to :

CO1	Explain the historic developments in the field of Photogrammetry, and image interpretation concepts.
CO2	Carry out plannimetric measurements and principles with reference to Aerial and Satellite High Resolution Images.
CO3	Use Stereoscopes, anaglyph glasses and digital workstations for Photogrammetric purposes.
CO4	Explain the limitations and flight planning requirements for various natural resources and thematic mapping/management.
CO5	Explain the role of UAV in terrain mapping and apply photogrammetric principles.

SYLLABUS

MODULE 1: ENVIRONMENTAL MAPPING & INTERPRETATION (8L)

Importance of Image Interpretation, Image interpretation for delineation of lithology (Rocks), minerals and their characteristics, Geological structures - Folds, Faults and Joints and their field characteristics, Various important land forms, Image characteristics of geological structures and major land forms, Visual and Digital Satellite Image Interpretation, Elements of image interpretation, development of interpretation keys, Image interpretation for LU/LC and Vegetation mapping, Image interpretation for ocean and coastal monitoring.

MODULE 2: GEOMETRY OF AERIAL PHOTOGRAPHS (8L)

Need for Photogrammetry, Historical developments in Photogrammetry, Fundamental concepts and Importance of flight planning, End Lap, Side Lap, Scale, Ground Coverage, Weather Conditions, Purpose, Flying Height, Projection, Tilt, Swing, Scale, Image Displacement due to relief, due to lens distortion, due to tilt, Parallax, stereoscopic depth perception, overlaps in stereo pairs, principles of floating marks, Parallax bar and types, measurement of absolute and differential parallax, Parallax

height measurement, correction to measure parallaxes – contouring from stereometric heights., Types of photographs, Vertical and Tilted photographs.

MODULE 3: ANALYTICALPHOTOGRAMMETRY (8L)

Co-ordinate system, air base components, degree of freedom, Elements of interior and exterior orientation of an aerial photographs, Numerical Derivations for Height based on relief displacement, coordinates, parallax, Orientation Procedures, Coordinate Transformation concepts, Epi-polar Geometry, Photo-triangularion: Pass-points for Aerotriangulation, semi-analytical aero-triangulation, analytical aero-triangulation, bundle adjustment with GNSS, Aero-triangulation with Satellite images, strategies for aero-triangulation.

MODULE 4: DIGITAL PHOTOGRAMMETRY (8L)

Analogue to Digital conversion, Image measurements, colour balancing, Image matching, Feature extraction- points, lines and regions, Planimetric Measurements, GCPs and Ortho-Rectification, Ortho-photographs, Digital Terrain Model derivationfrom Satellite images, Limitations, Quality checks and interactive control.

MODULE 5: TERRAIN MODELING WITH UAV (8L)

Digital Photogrammetric Images from UAV and associated concepts, UAV flight planning, coverage types, processing methods., Recent trends in its application, automated aerial triangulation: concepts, solutions, analysis, Photogrammetry work-stations, Review of available software.

TEXT BOOKS:

1. Wolf, P.R. (2000). Elements of Photogrammetry with Applications in GIS, McGraw Hill Ins, Singapore.
2. Rampal, K.K. (2004). Textbook of Photogrammetry, John-Wiley & Sons.
3. Moffit, F.M. (1980). Photogrammetry, International Text Book Co.

REFERENCE BOOKS:

1. McGlone J.C. (2013). Manual of Photogrammetry. 6th edition. American Society for Photogrammetry and Remote Sensing.
2. Drury, S.A. (2004). "Image Interpretation in Geology, Publisher: - Chapman and Hall, London, UK.
3. Panday, S.N. (1987). Principles and Application of Photogeology, Parentice Hall Inc.
4. Ray, R. (2012). An Introduction to photogrammetry, MITRAM publications, Kolkata.ISBN:978-93-80036-41-0.
5. Beginners Guide to UAV: https://www.digitaltrends.com/opinion/start-serious-drone-habit/

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/institutional visits/field visit
CD6	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	-	1	2	3	1
CO2	3	1	3	3	2
CO3	-	-	3	3	2
CO4	3	3	2	3	1
CO5	3	1	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD3, CD6
CO4	CD1, CD2, CD3, CD6
CO5	CD1, CD2, CD3, CD4, CD6

Course code: RS 512
Course title: ADVANCED REMOTE SENSING AND GEOSPATIAL MODELLING
Pre-requisite(s): (i) Basic knowledge of Remote Sesning, GIS, and GNSS
(ii) Student must have undergone RS 501 and RS 502
Co- requisite(s):

Credits: 4 L:3 T:1 P:0
Class schedule per week: 4
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to make the students:

1.	Understand Thermal, Microwave and Hyperspectral Remote Sensing techniques and its application areas.
2.	Learn advanced pattern and process modelling techniques associated with spatial problems.
3.	Realize the importance of uncertainty and errors associated with various spatial processes, and to quantify those errors.
4.	Learn techniques of Time Series Analysis and Web GIS.

Course Outcomes (COs)

On completion of this course, students should be able to:

CO1	Describe various advanced RS & GIS tools and techniques within spatial analytical framework to solve natural, environmental and societal problems and challenges.

CO2	Relate backscattering signals from different surfaces to physical processes, and understand SAR processing techniques.
CO3	Make use of thermal and hyperspectral data for real world applications (analysing Urban Heat Island problem, estimation of surface composition, forest species identification etc.).
CO4	Utilise sampling concepts, point pattern analysis, time-series analysis for various real life problems and associated uncertainty and errors.
CO5	Explain WebGIS concepts and able to use various scripting languages, web tools in implementing GIS functions on web.

SYLLABUS

MODULE 1: Advances in Thermal and Microwave Remote sensing (8L)

Determination of Emissivity and Land surface Temperature (LST) using thermal band, Microwave sensor technology, platforms and data types, Basic and advanced processing techniques such as InSAR, differential InSAR or polarimetric InSAR, Applications of active and passive microwave remote sensing data in areas of geology, Hydrology, Agriculture and environmental sciences, etc., Application of LST in analysing Urban Heat Island effect, Coalfire extent, Energy balance, etc.

MODULE 2: Hyperspectral and LASER Remote sensing (8L)

Basic principle of hyperspectral image creation and spectral radiometry concepts, Processing and information extraction techniques in hyperspectral images, Spectral mixture analysis, feature extraction, classification and spectral library creation, Applications of hyperspectral remote sensing, Physics of Lidar and its application.

MODULE 3: Spatial Patterns, Processes and Uncertainty Modelling (8L)

Kriging and Spatial Autocorrelation, Points and Pattern Analysis: Nearest Neighbour Analysis, Quadrat Analysis, Poisson Processes, Uncertainty, Spatial resolution induced error, Positional Uncertainty, Attributed Uncertainty, Error Propagation Analysis, Taylor Series Approximation.

MODULE 4: Geo-spatial Modelling and TimeSeries Analysis (8L)

SDSS, General Suitability & Multicriteria Modelling, AHP, Logistic modelling, Geographically Weighted Regression, Land Cover Change Modelling, Markov Chain Modelling, Advantages and difficulties in Time-series satellite data, Time-Composite Techniques, Temporal Smoothing Techniques - Fourier, Double Logistic, Gaussian, Seasonal Trend, Information Extraction Algorithms, Applications from Time-series.

MODULE 5: Web GIS (8L)

Roles of Clients & Servers, Basics of web GIS, Architecture, Datawarehouse and geospatial web services, OGC, Open source and proprietary web-based scripting and mapping environments, KML, GeoJSON, and other formats for drawing vector data in the browser, Application Programming Interfaces (APIs),GeoServer, NSDI, Census GIS, BHUVAN, Crowd Sourcing.

TEXT BOOKS:

1. Floyd M. Henderson et.al.(1998). Imaging Radar (Manual of Remote Sensing, Volume 2) 3rd Edition , Wiley.
2. Dale A. Quattrochi et.al. (2004). Thermal Remote Sensing in Land Surface Processing.CRC Press.
3. Marcus Borengasser et.al. (2007). Hyperspectral Remote Sensing: Principles and Applications ,*CRC Press.*
4. Mitchell, Andy (2012). The Esri Guide to GIS Analysis, Volume 3: Modeling Suitability, Movement, and Interaction. Redlands, CA, Esri Press.

5. Yue-hong Chou (1997). Exploring Spatial Analysis in Geographical Information System. Onword Press. Thomson Learning.
6. Devillers, R. and Jeansoulin, R. (2006). Fundamentals of Spatial Data Quality. ISTE Ltd., USA.

REFERENCE MATERIALS:

1. ArcGIS Resource Center Web APIs, http://resources.arcgis.com/content/web/web-apis
2. ArcGIS JavaScript APIs, http://help.arcgis.com/en/webapi/javascript/arcgis/
3. ArcGIS JavaScript API Samples, https://developers.arcgis.com/en/javascript/jssamples/
4. Parker, D.C., Manson, S.M., Janssen, A., Hoffmann, M. and Deadman, P. (2003). Multi-agent systems for the simulation of land use and land cover change. A Review. Annals of the Association of American Geographer, 93(2).
5. Parker, D.C. (2005). Integration of GIS and Agent-based Models of Land use: Challenges and Prospects in D.J. Maguire, M.F. Goodchild, and M. Batty, eds. GIS, Spatial Analysis and Modelling. ESRI Press, Redlands, CA
6. Goodchild et. al. (1996). GIS and Environmental Modeling: Progress and Research Issues. GIS world, Inc.
7. Berners-Lee, T. (1996). The world wide web: past, present and future. Cambridge, MA: Massachusetts Institute of Technology, Laboratory for Computer Science. http://www.w3.org/People/Berners-Lee/1996/ppf.html.
8. Jones, C. B., and R.S. Purves (2008). Web-based GIS. In The Handbook of Geographical Information Science, eds. J. P. Wilson and A. S. Fotheringham, 559-580. Oxford: WileyBlackwell.
9. Sheather, S. (2009). Spatial Modelling Principles in Earth Sciences. Springer.
10. Maguire, Batty, & Goodchild (2005). GIS, Spatial Analysis, and Modeling. ESRI Press.
11. ArcGIS Resource Center Web APIs, http://resources.arcgis.com/content/web/web-apis
12. ArcGIS JavaScript APIs, http://help.arcgis.com/en/webapi/javascript/arcgis/
13. ArcGIS JavaScript API Samples, https://developers.arcgis.com/en/javascript/jssamples/

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/institutional visits/field visit
CD6	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	3	1	2	3	3
CO2	2	2	3	3	2
CO3	3	-	2	3	3
CO4	3	1	2	3	3
CO5	2	2	3	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD4, CD6
CO3	CD1, CD2, CD3, CD4, CD6
CO4	CD1, CD2, CD3, CD4, CD6
CO5	CD1, CD2, CD3, CD6

ELECTIVES

Course code: RS 505
Course title: REMOTE SENSING IN AGRICULTURE AND FORESTRY

Pre-requisite(s): (i) Knowledge of Basic Sciences
(ii) Computer Knowledge
Co- requisite(s):
Credits: 3 L:3 T:0 P:0
Class schedule per week: 3
Class: M. TECH
Semester / Level: 01/05 (Monsoon)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to:

1.	Enhance the student's understanding about role of remote sensing for agriculture and forestry applications.
2.	Make the student assess various situations of agriculture damages and land degradation, and to detect and quantify those problems using remote sensing.
3.	Learn various forestry, ecological and wildlife related concepts, and to use remote sensing in those fields.

Course Outcomes (CO)

On completion of this course, students should be able to:

CO1	Map and quantify various agricultural features, yield, and identify the difference between healthy crop and affected crop using remote sensing data.
CO2	Identify and visually interpret various land features and its degradation on the satellite imagery and importance of secondary data in the field of agriculture.
CO3	Able to identify different types of forests features and associated problems (such as forest fire, degradation, deforestation etc) with the help of satellite data.
CO4	Able to model landscape ecological metrics, anthropogenic disturbances and wildlife site suitability using RS&GIS.

SYLLABUS

MODULE 1: INTRODUCTION (8L)

Spectral Properties of Vegetation: Natural and Man-made, Crop Yield and Acreage Estimation, Discriminate Analysis, Agricultural Applications: Sensor Requirements.

MODULE 2: DAMAGE ASSESSMENT (8L)

Plant Stress, Disease and Change Detection, Various Vegetation and Climatic Indices for Drought Damage assessment and Monitoring, Pest Control and Monitoring, Salt Affected land Mapping and Monitoring., Land degradation (water logging, salinization, erosion) assessment using RS & GIS.

MODULE 3: LAND USE/LAND COVER (8L)

Basic Concept and Criteria of Land Use / Land Cover Classification, Methodology, Classification System, Level of Classification, Land Capability Assessment.

MODULE 4: FORESTRY CONCEPTS (8L)

Conventional/Recent Remote Sensing Classification and Forest Inventory, Climatic, Altitudinal and Topographical Zones and Vegetation Relation, Forest Types Classification and Retrieval of Biophysical Parameters, Sensor Requirements, Landscape Ecology Concepts.

MODULE 5: VISUAL AND DIGITAL ANALYSIS: (8L)

Forest Cover, Canopy Density, Biomass Assessment, Forest Fire and Burnt Area Identification, Indian Forest Fire Alarm, Geospatial Modelling of Forest Fire Risk Zones, Sustainable Management, Criteria & Indicators based Decision Framework., Wildlife and Landscape Relationship, Habitat Assessment and Suitability Modelling, Disturbance Index and Analysis.

TEXT BOOKS:

1. Nicolas Baghdadi and Meherez Zribi (2016). Land Surface Remote Sensing in Agriculture and Forest, ISTE Press and Elsevier, UK.ISBN:978-1-78548-103-1
2. Roy, P.S., Dwivedi, and Vijayan, D. (2010). Remote Sensing Applications. NRSC, ISRO, Hyderabad. ISBN 978-81-909460-0-1.
3. NDMA (2010). National Disaster Management Guidelines: Management of Drought. A publication of National Disaster Management Authority Government of India, New Delhi. ISBN: 978-93-80440-08-8
4. Fortin, M.S. and Dale, M. (2005). Spatial Analysis for Ecologist, Cambridge University Press, Cambridge. ISBN- 9780521804345.

REFERENCE MATERIALS:

1. Boyd, D.S. and Danson, F.M. (2005). Satellite remote sensing of forest resources: Three decades of research development. Prog. Phys.Geogr., 29, 1-26.
2. Kogan, F.N. (2001). Operational Space Technology for Global Vegetation Assessment. Bulletin of the American Meteorological Society, 82:1949-1964.
3. Thornthwaite, C.W. (1948). An Approach toward a rational classification of climate, Geographical Review, 21: 633-655.
4. Sinha, A.K. (1986). Spectral Reflectance characteristics of Soils and its correlation with soils properties and surface conditions, Journal of Indian Soceity of Remote Sensing, 14(1), 1-9.
5. Nagendra, H. and Gadgil, M. (1999). Satellite imagery as a tool for monitoring species diversity: An assessment, Journal of Applied Ecology, 36: 388-397.
6. Muller, D. and Ellenberg, D.H. (1974). Aims and Methods of Vegetation Ecology, John Wiley and Sons,New York.
7. Franklin, S.E. (2001). Remote Sensing for Sustainable Forest Management, Lewis Publishers, Washington, D.C.

8. Behera, M.D. and Roy, P.S. (2002). Lidar Remote Sensing for Forestry Applications: The Indian Context, Current Science, 83(11):1320-1327.
9. Delcourt H.R. and Delcourt, P.A. (1988), Quaternary Landscape Ecology: Relevant Scales in Spce and Time, Landscape Ecology, 2: 23-44.
10. Farina, A. (2008). Principles and Methods in Landscape Ecology, Chapman & Hall Publication, London. ISBN – 9780412730405.
11. Digby, P.G.N. and Kempton, R.A. (1996). Multivariate Analysis of Ecological Communities. Chapman & Hall Publication. London. ISBN – 0412246406.
12. Environmental Education Media Films: http://www.eempc.org/
13. Environmental Development related: www.kosmosjournal.org

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/institutional visits/field visit
CD6	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	3
CO2	2	2	2	3	2
CO3	2	2	2	3	3
CO4	3	2	2	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD4, CD6
CO3	CD1, CD2, CD3, CD4, CD6
CO4	CD1, CD2, CD3, CD4, CD5, CD6

Course code: RS 506
Course title: REMOTE SENSING IN DISASTER MANAGEMENT
Pre-requisite(s): (i) Knowledge of Basic Sciences
(ii) Computer Knowledge
Co- requisite(s):
Credits: 3 L:3 T:0 P:0
Class schedule per week: 3
Class: M. TECH
Semester / Level: 01/05 (Monsoon)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to:

1.	Impart basic concepts of disaster, its causes and its historial background
2.	Enhance student's knowledge about disaster management planning
3.	Make the students learn Geoinformatics approaches to deal with disaster risk reduction and management.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Explain various types of disasters and responsible factors.
CO2	Interpret and discriminate different stages of disaster management planning and utility of geomatics tools in every stage.
CO3	Understand administrative structure of disaster management in India.
CO4	Understand the ethical and humanitarian values.
CO5	Apply integrated geospatial techniques in disaster management and disaster risk reduction.

SYLLABUS

MODULE 1: INTRODUCTION (8L)

Natural and human induced disasters, Fundamental concept of Disaster Management, Various natural disasters and their characterization: Cyclones, Floods, Earth quakes, land subsidence and Landslides, Forest fires, Droughts., Disasters and National losses, Historical perspective of disasters in India., Existing organizational structure for managing disasters in India, NGOs and people participation in disaster management.

MODULE 2: RS & GIS FOR HAZARD, RISK AND DAMAGE ASSESSMENT (8L)

Hazard evaluation – Zonation – Risk assessment and vulnerability, Damage assessment – Land use planning and regulation for sustainable development, Potential of GIS application in disaster mapping – Disaster management plan.

MODULE 3: LONG TERM MITIGATION MEASURES (8L)

Needs and approach towards prevention, principles and components of mitigation, Disaster legislation and policy – Insurance – Cost effective analysis – Utilisation of resource, Training – Education – Public awareness –Role of media.

MODULE 4: DISASTER MANAGEMENT PLANNING (8L)

Spatial and non-spatial data bank creation, Natural disaster management plans, Shelterbelts, Special structures, Disaster preparedness and Mitigation. Information needs of Disaster management, Operational emergency management – Vulnerability analysis of infrastructures, Settlements and

population, Pre-disaster and post disaster planning for relief operations, Satellite communications during disasters: networks, use of Internets, Warning system - rehabilitation - Post disaster review, Global Disaster Alert and Coordination System.

MODULE 5: DISASTER MODELING AND CASE STUDIES (8L)

Known/Generic Models in managing various disasters, Earthquakes in India, Tsunami Impact Assessment, Floods in Indo Gangetic plains, Landslides in Himalayan region, Drought in Indian plateau regions, Glacial lake outburst floods.

TEXT BOOKS:

1. Roy, P.S. (2000). Natural Disaster and their mitigation. Published by Indian Institute of Remote Sensing (IIRS).
2. Sdidmore, A. (2002). Environmental Modeling with GIS and Remote Sensing, Taylor & Francis.
3. Anji Reddy, M. (2004) Geoinformatics for environmental Management. B. S. Publication.
4. Murthy, D.B.N. (2008) - Disaster Management - Deep & Deep Publication.

REFERENCE BOOKS:

1. Bhattacharya, Tushar (2012). Disaster Science and Management, McGraw Hill Education (India) Pvt. Ltd. ISBN-10: 1259061302; ISBN-13: 978-1259061301
2. UN (2015). Disasters without boarders United Nations Publications Sales No: E15.II.F.13, ISBN: 978-92-1-120699-9
3. Gupta, H. K. (2012). Disaster Management, Universities press India , e-ISBN 9788173718663
4. Hyndman, Donald and Hyndman, David (2018). Natural Hazards and Disasters, ISBN - 13:0538737524
5. Pandey, Mrinalini (2014). Disaster Management, Willey India Pvt.Ltd ISBN 10: 8126549246 / ISBN 13: 9788126549245
6. Shukla, Shailesh,and Hussain, Shamna (2013) Biodiversity, Environment and Disaster Management Unique Publications, ISBN: 9788183577670, 8183577679
7. Babar, Md. (2007). Environmental Changes and Natural Disasters, New India Publishing Agency.
8. Orhan, R. Backhaus, P. Boccardo, S. Zlatanova (2010). 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.
9. Liu Y. & Baas S. (2001). Strengthening pastoral institutions in North-West China pastoral area to access improved extension services for risk management and poverty alleviation. (www.fao.org/sd/2001/IN0601_en.htm).
10. Swift, J. & Baas, S. (2003). Managing Pastoral Risk in Mongolia - A Plan of Action. ProjectTCP/FAO/MON0066.FAO.Rome. (available at www.fao.org/docrep/009/ ah828e/ ah828e00.htm).
11. Tearfund (2005). Mainstreaming disaster risk reduction: a tool for development organisations by S. La Trobe and I. Davis. Teddington, Middlesex. UN/ISDR. 2004.
12. UN/ISDR. (2004). Living with Risk: A global review of disaster reduction initiatives. 2004 Version, Volume II Annexes. Geneva.
13. ESRI (2006). GIS and Emergency Management in Indian Ocean Earthquake/Tsunami Disaster, An ESRI® White Paper.

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/institutional visits/field visit
CD6	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	2	3	3
CO2	3	2	3	3	3
CO3	2	-	2	2	2
CO4	3	-	-	-	3
CO5	3	3	2	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD6
CO4	CD1, CD5, CD6
CO5	CD1, CD2, CD3, CD4, CD5, CD6

Course code: RS 507
Course title: REMOTE SENSING IN HYDROLOGY & WATER RESOURCES
Pre-requisite(s): (i) Knowledge of Basic Sciences
(ii) Student must have computer knowledge
Co- requisite(s):
Credits: 3 L:3 T:0 P:0
Class schedule per week: 3
Class: M. TECH
Semester / Level: 01/05 (Monsoon)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to:

1.	Introduce students about hydrologic cycle, Precipitation, Aquifer & Aquifer coefficients, ground water movement and understand the data required for various hydrological studies.
2.	Make them understand river basin and watershed concepts, parameters and management strategies.
3.	Disseminate knowledge about water resource estimation, evaluation, and modelling.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Describe hydrologic cycle, data requirement for hydrological studies and characterise aquifers and ground water movement.
CO2	Evaluate basins and drainages to infer surface and near surface characteristics of the area.
CO3	Describe ground water regimes of India and determine water quality and ground water prospects zones with the use of satellite data.
CO4	Design suitable watershed management strategy by characterising watersheds for sustainable development of water resources including site suitability analysis for water recharge structures and reservoir sediment estimation.
CO5	Estimate and model surface runoff, flood, drought, snowmelt runoff and soil erosion .

SYLLABUS

MODULE 1: Basic Concepts (8L)
Hydrologic cycle, Forms of precipitation, Precipitation measurement - conventional vs satellite data based, Data for hydrological studies., Aquifers, Geological materials as aquifers and Aquifer parameters - Porosity, Specific yield, Storage coefficient., Ground water movement - Darcy's Law, Permeability, Hydraulic Conductivity, Transmissivity.

MODULE 2: Ground-water exploration and evaluation (8L)
Ground water regimes in India, Geophysical techniques for groundwater prospecting, Remote sensing in hydro-geomorphology and ground water prospect mapping, Remote sensing in water quality mapping and monitoring.

MODULE 3: River Basins (8L)
Classification of streams and rivers, Drainage pattern, Delineation of Drainage basin and catchment, Interlinking of river basins, Remote sensing based site selection for river valley projects.

MODULE 4: Watershed management (8L)

Watershed characterization using remote sensing, Morphometric parameters and analysis, Watershed problems and management strategy, Ground water recharge structures and their site suitability analysis.

MODULE 5: Operational applications in Water Resources (8L)

Satellite image based surface runoff modeling, Flood and drought- mapping and modeling, Reservoir sediment estimation, Snow and Glacier Hydrology, Snowmelt runoff modeling, Soil erosion modeling.

TEXT BOOKS:

1. Murthy, J. V. S. (1994). Watershed Management in India. Wiley Eastern Ltd., New Delhi.
2. David Keith Todd (2005). Groundwater Hydrology, John Wiley & Sons, New York, Second Edition.
3. H. M. Raghunath (2000). Hydrology- principles, Analysis, Design, New Age International, New Delhi.
4. P. Singh, Vijay P. Singh (2000). "Snow and Glacier Hydrology".

REFERENCE BOOKS:

1. P. Singh (2001). "Snow and Glacier Hydrology", Springer.
2. Schultz, G. A. and Engman, E. T. (2000). Remote Sensing in Hydrology and Water Management, Springer-Verlag, Berlin, Germany.

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/institutional visits/field visit
CD6	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	3	2
CO2	3	1	2	3	2
CO3	3	-	3	3	3
CO4	3	1	3	3	3
CO5	3	2	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD6
CO2	CD1, CD3, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3, CD5, CD6
CO5	CD1, CD2, CD3, CD4, CD5, CD6

Course code: RS 516
Course title: REMOTE SENSING IN SNOW AND GLACIER HYDROLOGY
Pre-requisite(s): (i) Knowledge of Basic Sciences
(ii) Student must have undergone RS 501, RS 502
Co- requisite(s):
Credits: 3 L:3 T:0 P:0
Class schedule per week: 3
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to:

1.	Teach the concepts and role of Snow and Glacier components of the Cryosphere.
2.	Make the student understand periglacial and hydrological implications of glaciers using remote sensing.
3.	Make students learn various global initiatives and techniques of snowmelt-runoff modelling using remote geospatial techniques.

Course Outcomes (Cos)

On completion of this course, students should be able to:

CO1	Explain differences between snow and glaciers, types of glaciers and glacial landforms and its formation.
CO2	Identify and visually interpret snow and glacier extent on the satellite images and analyse in terms of changes, and quantify relationship between glacial geomorphology and glacier hydrology.
CO3	Able to measure depth of snow cover, snow water equivalent and snow response to microwave.
CO4	Explain snowmelt models including inferences on their efficacy to derive global climate change phenomena and able to generate report.

SYLLABUS

MODULE 1: GLACIAL GEOMORPHOLOGY (8L)

Ice and related phenomenon, Types of glaciers, Movement of glaciers, Erosional work of glaciers , Transportation and depositional work of glaciers, Glacier depositional landforms, Glacio-fluvial deposits and landforms, Glacial geomorphic cycle. Meaning and concept of Periglacial climate, Periglacial areas, Permafrost, Mechanism of Periglacial processes, Genetic classification of Periglacial landforms, Periglacial cycle of erosion.

MODULE 2: HYDROLOGICAL ASPECTS OF GLACIERS (8L)

Classification of glaciers and its mapping using Satellite Data, Inventory of glaciers, Spatial characteristics of a glacier, Mass balance of a glacier and its measurement, Depth of a glacier and its measurement.

MODULE 3: SPATIAL SNOW, ICE AND GLACIERS (8L)

Scope and importance of snow and glaciers, Properties of snow and ice - Thermal and Optical, Water Inventory, snow and ice on the earth - snow covered areas on the Globe, the records of glacier retreat and advancement in centuries with spatial distribution.

MODULE 4: MEASUREMENT OF DEPTH, WATER EQUIVALENT AND AREA OF SNOW COVER (8L)

Depth of snow cover, Snow cover water equivalent, Areal extent of snow cover, satellite sensors for snow related studies, Microwave response of snow, Metamorphism of snow.

MODULE 5: REMOTE SENSING BASED SNOWMELT ESTIMATION, SNOWMELT RUNOFF MODELING AND FORCASTING (8L)

Remote Sensing in estimating Snowmelt indices, Comparison of energy balance and index approach, Observed maximum snowmelt rates, Modeling of snowmelt runoff, Storage potential, Time delay in runoff generation, Forecasting of snowmelt runoff, Simulation accuracy, Snowmelt Runoff Model SRM, Precipitation Runoff Modeling System PRMS, HBV MODEL University of British Columbia Watershed Model UBC.

TEXT BOOKS:

1. Tedesco, M. (2015). Remote SEsning of the Cryosphere, Wiley Blackwell Publisher, ISBN: 978-1-118-36885-5.
2. Arthur Homes (1993). Principles of Physical Geology, Thomas Nelson & Sons Ltd. Edinburgh.
3. P. Singh, Vijay P. Singh (2000). Snow and Glacier Hydrology. Water Science and Technology, Springer.

REFERENCE BOOKS:

1. Douglas I Benn, David, J. A. Evans (2010). Glaciers and Glaciation, Hodder Education.
2. Kurt M. Cuffey and W. S. B. Paterson (2010). The Physics of Glaciers, Fourth Edition.
3. P. McL. D. Duff and Arthur Holmes (1999). Himalayan Glaciers.
4. P. Singh (2001). Snow and Glacier Hydrology, Springer.

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/institutional visits/field visit
CD6	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	3	-
CO2	3	2	3	3	1
CO3	3	2	3	3	2
CO4	3	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3, CD4, CD5, CD6

Course code: RS 517
Course title: REMOTE SENSING IN CLIMATE CHANGE AND ENVIRONMENTAL IMPACT ASSESSMENT
Pre-requisite(s): (i) Knowledge of Basic Sciences
(ii) Student must have undergone RS 501, RS 502
Co- requisite(s):
Credits: 3 L:3 T:0 P:0
Class schedule per week: 3
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to:

1.	Enhance student's understanding about climatic system of earth and its changes over time.
2.	Teach the fundamental concepts about global warming, climatic dependence of various ecosystems (agriculture, forest and glaciers) and associated mapping methods using remote sensing.
3.	Disseminate information about various global initiatives, environmental impact assessment methods and modelling using remote sensing and GIS.

Course Outcomes (Cos)

On completion of this course, students should be able to:

CO1	Understand and explain the differences between weather and climate, local to global climatic variations, and Elnino vs Lanino.
CO2	Quantify relationship between ecosystmes (forest, agriculture and glacier) and rainfall, temperature, and map/model the impact of global warming on these systems using RS & GIS.
CO3	Able to identify/map different types of surface waterbodies, glaciers, and drought impact from satellite imageries.
CO4	Describe global policies and EIA methods, and link them with local, regional and national developmental initiatives and generate report.

SYLLABUS

MODULE 1: INTRODUCTION TO WEATHER AND CLIMATE (8L)

Fundamentals of Weather and Climate; Greenhouse effect and Global Warming; Local, Regional, Continental and global weather Pattern; Global bio-geo-Climatic conditions; Weather variations and associated effects - Elnino, LaNino, Southern Oscillation, Drought and Flood Scenario; Mapping weather parameters with a focus on rainfall, temperature and wind. Remote Sensing missions for weather monitoring.

MODULE 2: AGRICULTURE, FOREST AND CLIMATE (8L)

Vegetation growth rhythm and climatic interaction; Food security, Drought monitoring and forecast; Weather dependence of Agriculture; Climate change impact on agriculture economy. Carbon accounting with climate change scenario; Time-Series Satellite data; space-time dynamics; Phenology of Vegetation; Global changes in phenology; Droughts in Amazon and monitoring mechanism; Forest Fire and climate change.

MODULE 3: SNOW, GLACIER WATER AND CLIMATE (8L)

Surface water mapping and monitoring; snow cover mapping; snowmelt runoff forecasting; Glaciers Inventory; Glacial Mass Balance and Glacial retreat with changing climate.

MODULE 4: ENVIRONMENTAL IMPACT ASSESSMENT (8L)

Scope of EIA; EIA Methods and Mitigation; Criteria and Indicators; Certification; Ecological, Economical and Demographic impact assessment.

MODULE 5: GLOBAL POLICIES (8L)

United Nations Framework Convention on Climate Change (UNFCCC); Kyoto Protocol; Intergovernmental Panel on Climate Change (IPCC); Reducing Emissions from Deforestation and forest Degradation (REDD); Convention of Biological Diversity (CBD); Committee on World Food Security.

TEXT BOOKS:

1. Roy, P.S., Dwivedi, R.S., and Vijayan, D. (2010). Book on Remote Sensing Applications. National Remote Sensing Centre, ISRO, Hyderabad. ISBN: 9788190946001.
2. FAO (2011). Climate Change, Water and Food Security. Compiled by Hugh Turral, Jacob Burke and Jean-Marc Faures, Rome. ISBN: 9789251067956
3. Morris, P. and Therivel, R. (2001). Methods of Environmental Impact Assessment, 2nd edition, Spon Press, London (2008 reprint).
4. Thenkabail, P.S., J.G. Lyon, H. Turral and C. Biradar (2009). Remote Sensing of Croplands for Food Security. 476p. CRC Press. Taylor and Francis, New York. ISBN 978-1-4200-9009-3.

REFERENCE MATERIALS:

1. ECA (Economics of Climate Adaptation) (2009). Shaping climate resilient development: a framework for decision making. ClimateWorks Foundation, Global Environment Facility, European Commission, McKinsey & Company, The Rockefeller Foundation, Standard Chartered Bank and Swiss Re. 164pp.
2. FAO (2015). Booklet on FAO's work on Climate Change. Job Number 15165.
3. FAO (2016). Planning, implementing and evaluating Climate-Smart Agriculture in Smallholder Farming Systems. Job Number 15805. Report under Mitigation of Climate Change in Agriculture (MICCA) Programme of FAO. ISBN: 978925109305.

4. IPCC (2014). IPCC Assessment Report. UNFCCC.
5. Kulkarni, A., I.M. Bahuguna, B.P. Rathore, S.K. Singh, S.S. Randhawa, R.K. Sood and S. Dhar (2007). Glacial retreat in Himalaya using Indian Remote Sensing satellite data. Current Science, Vol. 92, No. 1.
6. Lal, M., T. Nozawa, S. Emori, H. Harasawa, K. Taka, A. Abe-Ouchi, T. Nakajima, T. Takemura and A. Numaguti (2001). Future climate change: Implications for Indian summer monsoon and its variability. Current Science, Vol. 81, No. 9, 10.
7. Milly, P.C.D., R.T. Wetherald, K.A. Dunne and T.L. Delworth (2002). Increasing risk of great floods in a changing climate. Nature Vol 415: 514–517.
8. Rees, H.G. and D.N. Collins (2006). Regional differences in response of flow in glacier-fed Himalayan rivers to climatic warming. Hydrological Processes, 20 (10). 2157–2169. 10.5002/hyp.6209.
9. Schmidhuber, J. and F. Tubiello (2007). Global food security under climate change. PNAS 104 (50) 19703–19708.
10. Tubiello, F. and G. Fischer (2007). Reducing climate change impacts on agriculture: Global and regional effects of mitigation, 2000–2080 Technological Forecasting & Social Change 74 1030–1056.
11. USDA (ed Walsh, M) (2008). The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States. U.S. Climate Change Science Program Synthesis and Assessment Product 4.3.
12. WWF (2005). An Overview of Glaciers, Glacier Retreat, and Subsequent Impacts in Nepal, India and China. Kathmandu. Nepal.
13. World Bank (2010). Economics of Adaptation to Climate Change: Synthesis Report. Washington DC. 100pp.
14. World Bank (2009b). Water and Climate Change: Impacts on groundwater resources and adaptation options. Water Unit Energy, Transport, and Water Department. Washington DC. 98pp.

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/institutional visits/field visit
CD6	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	1	1	2	3	2
CO2	3	2	3	3	2
CO3	3	2	3	3	3
CO4	1	3	1	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD3, CD4, CD5, CD6
CO3	CD1, CD3, CD5, CD6
CO4	CD1, CD2, CD4, CD6

Course code: RS 602
Course title: DATA SOURCES, STATISTICS AND RESEARCH METHODS IN GEOSPATIAL DOMAIN
Pre-requisite(s): Knowledge of statistics
Co- requisite(s): Knowledge of RS & GIS

Credits: 4 L:3 T:1 P:0
Class schedule per week: 4
Class: M.Sc.
Semester / Level: 03/06 (Monsoon)
Branch: Geoinformatics
Name of Teacher:

Course Objectives

This course aims to make the students:

1.	Learn about various geo-spatial data providers at global and national level.
2.	Understand various steps and important components involved in project management, field report preparation, and sampling statistics.
3.	Gain knowledge about importance of quality, ethics, and different research methods being used in the geo-spatial domain.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1.	Explain the formulation of various schemes in Geoinformatics domain
CO2.	Write Project reports and project proposals
CO3.	Apply research methods quantitatively and qualitatively
CO4.	Use the National/Global standards of research

SYLLABUS

MODULE 1: GEO-SPATIAL RESEARCH & DATA SOURCES (8L)

Geo-spatial Research Problems., National and International Projects: Past and Recent, Different types of Geo-spatial data requirement, USGS Global Visualization Viewer (GloVis), NASA Earth Observation (NEO), USGS Earth Explorer, ESA's Sentinel data, NOAA, IPPMUS Terra, LANCE, VITO Vision, Bhuvan, MOSDAC, India-WRIS, Identification of problems at regional and Local level.

MODULE 2: FIELD AND PROJECT REQUIREMENTS (8L)

Need for Field Visit and Preparation of field reports, Research proposal, Literature review, Project/Report Writing, Components of Research Thesis/Project Report, Project Administrator and project management, Classification of Projects/thesis, Problems and opportunities in Projects.

MODULE 3: SAMPLING AND STATISTICS (8L)

Statistical Concepts: Population, Sample, Random, Bias, Percentile, Standard Score, Distribution, Correlation, Regression (logistic, linear), Analysis of variance, Need for sampling, types of sampling, sample size estimation and accuracy evaluation., Hypotheses and its testing, chi-square test, t-test, Calculation and Evaluation of Confidence Intervals.

MODULE 4: METHODS IN GEOINFORMATICS (8L)

Types of Research Methods: Quantitative and Qualitative, Research Techniques and Tools: Questionnaire, Interview, Observation, etc., Analytical methods in Geoinformatics, Different models in various Natural Resources Monitoring.

MODULE 5: TOOLS, QUALITY AND ETHICS (8L)

Tools & Methods: Project Communications and Presentation, Intellectual property Right, Plagiarism and associated softwares, Evaluating Quality of Research paper/journal: Citation Index, Impact Factor, National/Global standards, SCI, SCOPUS, etc., Referencing/Citation methods, Reference management software.

TEXT BOOKS:

1. Deborah Rumsey (2003). Statistics for Dummies, Wiley Publishing, Inc., New Jersey.
2. Huxold, W.E. and Levinsohn A.G. (1995). Managing Geographic Information Projects. Oxford University Press, New York.
3. Earickson, R. and Harlin, J. (1994). Geographic Measurement & Quantitative Analysis, Macmillan, New York

REFERENCE BOOKS:

1. Bennet P. Lientz & Kathryn P., (2001) Project Management for the 21st Century Academic Press, California.
2. Miguel Roig (2015). Avoiding plagiarism, self-plagiarism, and other questionable writing practices: A guide to ethical writing. (https://ori.hhs.gov/sites/default/files/plagiarism.pdf)

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/institutional visits/field visit
CD6	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	-	-	2	3	-
CO2	2	3	-	-	3
CO3	3	2	-	2	1
CO4	3	3	-	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD4, CD6

LABORATORIES

Course code: RS 503
Course title: REMOTE SENSING & DIGITAL SATELLITE IMAGE PROCESSING LAB

Credits: 2 L:0 T:0 P:4
Class schedule per week: 4
Class: M. TECH
Semester / Level: 01/05 (Monsoon)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to make the student learn practical aspects related to:

1.	Usage of diverse remote sensing data for extracting needed geo-spatial information.
2.	Executioin of various analogue and digital information extraction techniques, both manuallay and using computers..

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Interpret Satellite Hard copy FCC images and Survey of India Toposheets.
CO2	Collect Field Spectra for various land cover featuers.
CO3	Execute various radiometric and spatial enhancement techniques and create land cover map using different clustering techniques using DIP methods.

LAB EXERCISES

Lab 1 Understanding Remote Sensing Data and Visual Interpretation

Lab 2 Import / Export of Satellite Data, Display, Analysis, and Digital interpretation of earth surface featuresin Standard FCC

Lab 3 Radiometric and atmospheric corrections

Lab 4 Geo-referencingand Geocoding

Lab 5 Field Spectra Collection: vegetation, bare soil, and concreteusing Spectro Radiometer

Lab 6 Analysis of satellite derived spectral response and field spectra

Lab 7 Study of the various contrast enhancement techniques

Lab 8 Spectral Enhancement (Ratio images and PCA)Techniques

Lab 9 Spatial Enhancement: Low Pass Filtering & High Pass Filtering Techniques

Lab 10 Multi-Resolution (Fusion) Analysis

Lab 11 Unsupervised Classification

Lab 12 Supervised Classification & Accuracy Evaluation

Lab 13 Advance Classification

Course Evaluation:
Individual Experiment, Lab Quiz, Lab Record, End Sem Lab Examination and Viva

Course Delivery Methods

CD1	Laboratory experiments

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	1	-	3	2	1
CO2	1	-	3	3	1
CO3	3	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Course code: RS 504
Course title: GEOGRAPHIC INFORMATION SYSTEMS & NAVIGATION SYSTEMS LABORATORIES
Pre-requisite(s): Basic physics
Co- requisite(s):

Credits: 2 L:0 T:0 P:4
Class schedule per week: 4
Class: M. TECH
Semester / Level: 01/05 (Monsoon)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to impart practical knowledge related to :

1.	Creation of spatially coherent Geo-database containing vector and raster.
2.	Solving real life spatial problems involving various analytical techniques for both vector and raster data.
3.	Collection of GPS data, execution of processing techniques and integrate with other spatial layers.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Describe various GIS techniques within spatial analytical framework and handle huge spatial and non-spatial database.
CO2	Apply spatial analysis techniques of ArcGIS software to solve environmental and societal problems and challenges.
CO3	Collect GNSS data in different survey modes and post process them to generate output to be integrated in GIS environment.
CO4	Handle integrated geospatial techniques and apply them in solving real world problems.

LAB EXERCISES

Lab 1 Basics of Geodatabase, Vector, Raster, Catalogue and Georeferencing

Lab 2 Topology creation and correcting topological errors & Non-topological editing.

Lab 3 Linking spatial with non-spatial data.

Lab 4 Layout generation (designing a map, cartographic elements, thematic mapping).

Lab 5 Vector analysis I (Query, Overlay, Clip, Dissolve and Merge Functions).

Lab 6 Raster analysis I (Arithmatic, Logical and Global functions)

Lab 7 Raster Analysis II (Local, Focal and Zonal functions)

Lab 8 Introduction to GNSS receivers ,initial settings and creating codes and attribute table in GNSS receiver

Lab 9 Understanding different projection, coordinate system and Datums &Standardisation

Lab 10 Point, Line and Polygon Data collection using GNSS for Planimetric Measurements

Lab 11 GNSS Data collection in differential mode positioning

Lab 12 Post processing of the GNSS data and Export functions

Lab 13 GNSS and GIS integrations output preparation

Course Evaluation:
Individual Experiment, Lab Quiz, Lab Record, End Sem Lab Examination and Viva

Course Delivery Methods

CD1	Laboratory experiments

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	1	-	3	3	1
CO2	3	2	3	3	2
CO3	1	-	3	3	2
CO4	3	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Course code: RS 508
Course title: REMOTE SENSING IN AGRICULTURE AND FORESTRY LABORATORY
Pre-requisite(s): Basic physics
Co- requisite(s):
Credits: 2 L:0 T:0 P:4
Class schedule per week: 4
Class: M. TECH
Semester / Level: 01/05 (Monsoon)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to make the student:

1.	Utilise diverse remote sensind data for extracting vegetation related spatial information.
2.	Execute appropriate digital image processing and modelling techniques for diverse agriculture and forestry applications.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Visually and Digitally differentiate various agriculture and forestry features from satellite data.
CO2	Use various remote sensing and GIS tools for extracting land cover, land capability, degradation, waterlogging, and model acreage, lifezones and fire risk.
CO3	Execute spatial models related to landscape metrics, biodiversity, wild life habitat suitability , and environmental problems.

LAB EXERCISES

Lab 1 Visual Interpretation of different types of forests and crops.

Lab 2 On-Screen Land Degradation Mapping

Lab 3 Digital classification of Agriculture and Foresty Types

Lab 4 Detection of Plant Stress, Change Detection and Salt Affected Areas.

Lab 5 Desertification, Waterlooging and Flood Damage Assessment using RS & GIS.

Lab 6 Land Cover Mapping using multi-temporal RS data.

Lab 7 Acreage and Land Capability Modelling using RS & GIS.

Lab 8 Climatic, Altitudinal and Topographic relation with Life Zones and its Modelling.

Lab 9 Landscape Metrics Modelling.

Lab 10 Anthropogenic Disturbance Modelling using RS & GIS

Lab 11 Biodiversity Modelling using RS & GIS

Lab 12 Wildlife Habitat Modelling using RS& GIS

Lab 13 Forest Fire Risk Modelling using RS & GIS

Course Evaluation:

Individual Experiment, Lab Quiz, Lab Record, End Sem Lab Examination and Viva

Course Delivery Methods

CD1	Laboratory experiments

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	1	1	3	2	1
CO2	2	2	3	3	3
CO3	3	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Course code: RS 509
Course title: REMOTE SENSING IN DISASTER MANAGEMENT LABORATORY
Pre-requisite(s): Basic physics
Co- requisite(s):

Credits: 2 L:0 T:0 P:4
Class schedule per week: 4
Class: M. TECH
Semester / Level: 01/05 (Monsoon)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to make the student:

1.	Utilise diverse remote sensind data for extracting spatial information associated with Disasters.
2.	Execute various information extraction and modelling techniques to assess vulnerability and risk associated with different disasters.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Take help from Bhuvan Disaster services and other online web portal for data collection related to disasters and causing factors of disaster.
CO2	Prepare map of different natural and man-made disasterprone areas.
CO3	Apply integrated geospatial techniques in disaster management and disaster risk reduction.

LAB EXERCISES

Lab 1-2 Explore Bhuvan& Google Earth etc. in general, and specifically for Disaster services and analyse the situation in your state

Lab 3 Mapping flood inundated area using satellite data

Lab 4 Download MODIS Fire data and TRMM rainfall data, and analyse.

Lab 5 Download MODIS Snow related data and analyse.

Lab 6 Identify the drought prone region using vegetation indices derived from satellite data

Lab 7 Identify and map landslides from satellite images and compare the same with high resolution Google-earth image

Lab 8 Delineate forest fire regions in the given study area with the help of MODIS LST product for a particular date and compare your result with Bhuvan site

Lab 9 Mapping lightning incidence location

Lab 10 Water sample collection from different location and its analysis for assessing different water quality parameters and comparison with the BIS standards

Lab 11 Download Air quality data from CPCB website for your city and find out the trend of different air quality parameters for last few years

Lab 12 Compare the Air quality parameters for metro cities (Before Diwali and after Diwali)

Lab 13 Modelling Hazard Zonation (flood/earthquake/landslide).

Course Evaluation:

Individual Experiment, Lab Quiz, Lab Record, End Sem Lab Examination and Viva

Course Delivery Methods

CD1	Laboratory experiments

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	1	-	3	2	-
CO2	2	2	2	2	2
CO3	3	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Course code: RS 510
Course title: REMOTE SENSING IN HYDROLOGY AND WATER RESOURCES LABORATORY
Pre-requisite(s): Basic physics
Co- requisite(s):

Credits: L:0 T:0 P:4
Class schedule per week: 4
Class: M. TECH
Semester / Level: 01/05 (Monsoon)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to make the student:

1.	Map Hydrology related information using ground observation as well as satellite data.
2.	Model rainfall, ground water and snow related parameters.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Map Rainfall from various data sources.
CO2	Delineate and characterise watershed by computing morphometric parameters.
CO3	Assess groundwater potential and water quality.
CO4	Model Snow melt run off, flood and soil erosion.

LAB EXERCISES

Lab 1 Downloading of Satellite Rainfall data (TRMM) and Generating Spatial Rainfall Map.

Lab 2 Downloading of Rainfall point data and generating spatial rainfall map using interpolation techniques.

Lab 3 Delineation of watershed map using DEM and topographic maps.

Lab 4 Calculation of various morphometric parameters and characterise watershed.

Lab 5 Mapping of various land forms with the help of satellite data.

Lab 6 Interpretation of Lineaments and analysis.

Lab 7&8 Mapping of Hydrogeomorphology and Ground water prospects.

Lab 9 Estimation of Water quality and Reservoir sedimentation.

Lab 10 Estimation of USLE parameters for soil erosion modelling.

Lab 11 Conducting Geo-electric Resistivity for ground water exploration.

Lab 12 Mapping of Snow and Glaciers using digital techniques.

Lab 13 Interpreting flood plains and mapping flood hazard zones using RS & GIS.

Course Evaluation:

Individual Experiment, Lab Quiz, Lab Record, End Sem Lab Examination and Viva

Course Delivery Methods

CD1	Laboratory experiments

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	-	2	2	1
CO2	2	1	2	2	1
CO3	2	2	3	3	2
CO4	3	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Course code: RS 513
Course title: AERIAL AND SATELLITE PHOTOGRAMMETRY & IMAGE INTERPRETATION LABORATORIES

Credits: 2 L:0 T:0 P:4
Class schedule per week: 4
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to make the student learn practical skills related to :

1.	Interpretation and Measurement of 2D and 3D information about various features using Aerial photos, Satellite and UAV data.
2.	Utilisation of various analogue and digital photogrammetry based extraction techniques, both manuallay and using computers.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Use Pocket Stereoscope and make planimetric measurements from Aerial Photos.
CO2	Interpret Satellite Images and Aerial photos visually and with stereoscope for delineating various landforms and landcover features.
CO3	Use photogrammetric techniques and tools under Digital Environment so as to create digital surface models, and extract point, line and polygon features and their position, height, area and volume using Aerial, Satellite and UAV data.

LAB EXERCISES

Lab 1-2 Satellite Image Interpretation of various Terrestrial Features.

Lab 3 Use of Pocket & Mirror Stereoscope, parallax bar and measurement of distance and height

Lab 4-5 Stereoscopic vision and photo interpretation of B/W & Colour aerial photograph

Lab 6 Differential parallax measurement and contouring by parallax bar method

Lab 7 Digital Stereoscopic Model - Non-Oriented Approach

Lab 8 Digital Stereoscopic Model - Interior & Exterior Orientation

Lab 9 Digital Stereoscopic Model - 3D based Plannimetric Measurements

Lab 10 Digital Ortho-Rectification - Relief Displacement Correction

Lab 11 Point, Line & Polygon Feature Extraction using Stereopair from High Spatial Resolution Aerial & satellite images

Lab 12-13 UAV based Data acquisition and Modelling.

Course Evaluation:
Individual Experiment, Lab Quiz, Lab Record, End Sem Lab Examination and Viva

Course Delivery Methods

CD1	Laboratory experiments

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	1	-	2	2	1
CO2	1	1	3	2	1
CO3	3	3	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

Course code: RS 514
Course title: ADVANCED REMOTE SENSING AND GEOSPATIAL MODELLING LABORATORY
Pre-requisite(s): Basic physics
Co- requisite(s):

Credits: 2 L:0 T:0 P:4
Class schedule per week: 4
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to make the student with the ability to :

1.	Handle advanced sensor data and extract information using diverse software environment.
2.	Execute various spatial techniques and models to quantify and solve real-life spatial patterns and problems.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Dowload, Import, use and understand diverse spatial and satellite data.
CO2	Understand and use various remote sensing and GIS softwares, tools and models for information extraction in Stand-alone and Web environment.
CO3	Create a workflow and practically execute models for understanding spatial patterns, processes and solve real-life spatial problems.

LAB EXERCISES

Lab 1 Handling Thermal and Microwave Data

Lab 2 Modelling Urban Heat Island using Thermal data

Lab 3 SAR data processing and applications

Lab 4 Hyperspectral data processing

Lab 5 Spectral Mixture Analysis, Feature Extraction and Classification using Hyperspectral data

Lab 6 LIDAR data Processing

Lab 7 Surface Interpolation using Krigingtechnique

Lab 8 Spatial Pattern Analysis using GIS

Lab 9 Understanding Two-point and Multi-point Statistics

Lab 10 Modelling Resolution Uncertainty and Error in the Spatial Data

Lab 11 Spatial Regression and Geographically Weighted Regression

Lab 12 Smoothingand information extraction using Time Series Data

Lab 13 WebGIS relatedservices, programmingand Scripting

Course Evaluation:

Individual Experiment, Lab Quiz, Lab Record, End Sem Lab Examination and Viva

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Course Delivery Methods

CD1	Laboratory experiments

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	3	3	1
CO2	2	3	3	3	1
CO3	3	3	3	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

Course code: RS 515
Course title: PROGRAMMING AND CUSTOMISATION IN GEOSPATIAL DOMAIN LABORATORY
Pre-requisite(s): Basic physics
Co- requisite(s):

Credits: 2 L:0 T:0 P:4
Class schedule per week: 4
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to impart following practical knowledge to students:

1.	Practically carry out programming concepts learned in theory class.
2.	Write simple to advanced programming in different languages.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Understand and Use Compiler programming Environment
CO2	Understand and appropriately Utilise various libraries, Fuction and Syntaxes.
CO3	Write a simple to complicated Programming Codes in C, R and Python.

LAB EXERCISES

Lab 1. Introduction to computers & programming concept

Lab 2. Programming using concepts of Variables, Operators

Lab 3. Programming using Control Structures

Lab 4. Programming using Decision Making

Lab 5 Programming using Functions

Lab 6 Programming using Arrays& Strings

Lab 7, 8,9 &10 Basic and Advanced Geospatial Programming using R

Lab 11 Programming using concepts Python

Lab 12 Using Python to deal with Functions and Objects

Lab 13. Using Python to deal with Arrays and Satellite Images

Course Evaluation:

Individual Experiment, Lab Quiz, Lab Record, End Sem Lab Examination and Viva

Course Delivery Methods

CD1	Laboratory experiments

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	2	2	-
CO2	2	2	3	3	1
CO3	3	3	3	3	1

< 34% = 1, 34-66% = 2, > 66% = 3

Course code: RS 518
Course title: REMOTE SENSING IN SNOW AND GLACIER HYDROLOGY LABORATORY
Pre-requisite(s): Basic physics
Co- requisite(s):

Credits: 2 L:0 T:0 P:4
Class schedule per week: 4
Class: M. TECH
Semester / Level: 02 /05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to impart practical knowledge about:

1.	Mapping of Snow and associated parameters using satellite data
2.	Execution skills for various analogue and digital image processing techniques to map and model various processes associated with snow and glaciers.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Visually and Digitally differentiate various snow covered areas and Glacier landforms from satellite data.
CO2	Use optical remote sensing data and GIS tools to quantify glacial mass balance, snow water equivalent and snow indices.
CO3	Use Radar remote sensing data to quantify snow and glacier conditions.

LAB EXERCISES

Lab 1 Visual Interpretation of snow and glacier on optical satellite data.

Lab 2-3 On-Screen glacial landform mapping

Lab 4-5 Glacier area extraction and cumputation -Accumulation and Ablation using RS data

Lab 6-7 Computing glacier mass balance using Area Accumulation Ratio method.

Lab 8 Snow cover area and glacier mapping using SAR data.

Lab 9 Snow water equivalent estimation using delta - K technique.

Lab 10 Generation of Snow Indices for delineating snow cover.

Lab 11-12 SAR data processing and generation of snow backscater image

Lab 13 Wet SCA estimation using SAR data.

Course Evaluation:

Individual Experiment, Lab Quiz, Lab Record, End Sem Lab Examination and Viva

Course Delivery Methods

CD1	Laboratory experiments

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	2	2
CO2	2	2	3	3	2
CO3	2	3	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

Course code: RS 519
Course title: REMOTE SENSING IN CLIMATE CHANGE ANDENVIRONMENTAL IMPACT LABORATORY
Pre-requisite(s): Basic physics
Co- requisite(s):

Credits: 2 L:0 T:0 P:4
Class schedule per week: 4
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to make the student with following abilities:

1.	To create report and maps about various environmental features and parameters using satellite data and based on hard copy maps/reports provided by national/global mapping agencies.
2.	To carry out various digital image processing techniques and models to quantify continuously changing environmental features.

Course Outcomes (CO):

On completion of this course, students should be able to:

CO1	Visually and Digitally differentiate various environmental conditions including vegetated features and Glaciers from satellite data.
CO2	Use time-series remote sensing data and GIS tools to quantify drought condition/impact, vegetation growth rhythm, Glacier changes and environmental impact.
CO3	Gather and infer knowledge from various published reports and policies and link with local to regional problems and understand need for appropriate tools and models.

LAB EXERCISES

Lab 1 Visual Interpretation of different types of forests and crops.

Lab 2 On-Screen Mapping of Waterbodies, Wetlands and Glaciers.

Lab 3 Biomass and CarbonAccounting using RS & GIS.

Lab 4 Vegetation Phenology using Time-Series RS data.

Lab 5& 6 Drought Condition Assessment using RS & GIS.

Lab 7 & 8 Glacier Condition and Change Assessment using Temporal RS data.

Lab 9 Environmental Impact Assessment methods (example of Mining) using RS & GIS.

Lab 10& 11 TRMM based Rainfall Mapping and relating with Ground Meteorological Data.

Lab 12 Collect various Global Policies on UNFCCC, IPCC, REDD, CBD and relate with Indian Governmental Initiatives – Generate a Report.

Lab 13 Sustainability and Certification Methods.

Course Evaluation:

Individual Experiment, Lab Quiz, Lab Record, End Sem Lab Examination and Viva

Course Delivery Methods

CD1	Laboratory experiments

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	2	2	1
CO2	3	3	3	3	3
CO3	2	3	2	2	3

< 34% = 1, 34-66% = 2, > 66% = 3