SEMESTER -I

SEMESTER -I

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	GEO501	Remote Sensing, Photogrammetry and Satellite Image Processing	Core 1	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Introduction: History of Remote Sensing, Remote sensing components, Sources of Energy, EMS and Radiation Spectral reflectance curves, Radiation Calculation

Platforms and Sensors: Orbital movement and Earth coverage. Sun-synchronous and Geosynchronous satellites, Active and passive sensors, Sensors characteristics, Indian Remote Sensing Satellite Program, Other satellites

Aerial Photography and Photogrammetry: Introduction, Early history of aerial photography, Basic principles of photogrammetry, image parallax, ground control for aerial photography, production of maps and ortho-photos, flight planning

Visual Image Interpretation: Introduction, fundamentals of Visual image interpretation, basic equipment used, elements of visual image interpretation, methods of search, and applications of visual image interpretation.

Digital Image Processing. Introduction, image rectification and restoration, image enhancement, classification stage, training stage, hybrid classification, output stage, accuracy assessment

Remote sensing data collection: Analog image digitization, scanning mirrors, linear arrays, Indian remote sensing systems, ASTER imagery, Airborne digital cameras, digital image data formats

Digital image processing hardware and software: CPU, mode of operation and user interface, OS, compilers, Data storage, DIP Software

Image quality assessment and statistical evaluation: sampling theory, histogram, metadata, viewing pixel values, multivariate image statistics, feature space plots, geostatistical analysis, autocorrelation and interpolation

Display Alternatives and scientific visualization: black and white image display, temporary video display, fusing remotely sensed data, length measurement, perimeter, area and shape measurement, correcting slope and aspect effects

Geometric corrections: Internal and external geometric effects,types of geometric corrections, image to map rectification, mosaicking

Image Enhancement: Image reduction and magnification, spectral profiles, contrast enhancement, raster operations, spatial filtering, PCA, vegetation indices, texture transformations

List of Practicals:

1. Introduction to different types of remote sensing data products.
2. Use of spectroradiometer to collection signature of different earth objects.
3. Training of photo interpretation files.
4. Visual Analysis of a satellite data.
5. Demo on different types of remote sensing based software.
6. Initial Statistics Extraction.
7. Atmospheric Correction.
8. Geometric Correction
9. Image Enhancement
10. Image Transformation

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Chandra, A.M. and Ghosh, S.K., "Remote Sensing and Geographical Information System", Narosa.
2	Gibson, P.J., "Introductory Remote Sensing – Principles and Concepts", Routledge.
3	Gibson, P.J. and Power, C.H., "Introductory Remote Sensing – Digital Image Processing and applications", Routledge.
4	Jensen, J.R., Digital Image Processing A Remote Sensing Perspective, 4th ed., Pearson Education
5	Jensen, J.R., Remote sensing of environment: An Earth Resource Perspective, Pearson
6	Lillesand, T.M. and R.W. Kiefer, "Remote Sensing and Image Interpretation", 4th Ed., John Wiley.
7	Mather, P.M., "Computer Processing of Remotely Sensed Images", John Wiley.
8	Schowengerdt, R.A., "Remote Sensing – Models and Methods for Image Processing", Academic Press.
9	Garg P.K, "Principles and Theory of Geoinformatics", Khanna Book Publishing Co (P) Ltd
10	Tempfli et al., Principles of Remote Sensing An Introductory Text Book, ITC, the Netherlands

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	GEO503	Introduction to Geographic Information System and Web GIS	Core 2	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Introduction : Geographical concepts and Terminology, Utility of GIS.

GIS : Various GIS packages and their salient features, Essentials components of GIS, Data acquisition through scanners and digitizers.

Introduction and Descriptions : Raster and Vector data, Remote Sensing Data input in GIS, Data storage and editing, Topology and Spatial Relationships.

Data preprocessing : GPS Coordinates Georeferencing, Map Projections in GIS, Interpolation of data, Database Construction, GIS and the GPS, Data Output.

Database structure : Database management, Data manipulation and analysis.

Spatial and mathematical operations in GIS: Buffers, Overlay, Spatial analysis, statistical modeling, Statistical reporting and graphing.

Programming languages in GIS : Google Earth Engine/Python/R, Virtual GIS.

Applications : Applications of GIS to various natural resources mapping and monitoring and engineering problems.

Web GIS : Web Page Basics, Web Mapping, Geospatial Web Services, OGC-framework of open web mapping, importance of open web mapping, international open web standards as published by the Open Geospatial Consortium

Overview of Internet concepts & features: Internet protocol, Domain Name System, Internet services, www, Web servers, Web clients, Web GIS origin and Evolution

Fundamentals-principles-architecture-components-ThinVS thik Client architecture design development. Geospatial web services.

Evolution-Impact-web content-function and interfaces –Mashup design and implementation- challenges and prospects-uses and benefits-supporting technology solution and production.

Concept-uses -functions-architectures-geoportal applications-challenges and prospects. Web page design principles, HTML, XML, data formats, helper applications, Java, databases and the Web. Application of Internet services to GIS.

List of Practicals:

1. Demo on various GIS software and their salient features.
2. Scanning and digitization (on screen).
3. Registration of maps and satellite images, and digitization and editing of features.
4. Database creation and management.
5. Buffer and overlay analysis.
6. Map preparation and composition.
7. Spatial and Mathematical operations.
8. Area and query based analysis
9. Customized application in GIS.
10. Web publishing of GIS layers.
11. 3D GIS.
12. Demo on various GIS based application.

Suggested Books :

S.No.	Name of Books/Authors/Publisher
1	Burrough, P.A. and Mc Donnel, R.A., "Principles of Geographic Information System", Oxford University Press.
2	Chrisman, Nicholas R., "Exploring Geographic Information Systems", John Wiley.
3	Demers, Michael N., "Fundamentals of Geographic Information System", 2nd Ed. Wiley.
4	Ghosh, S.K. and Chandra, A.M., "Remote Sensing and GIS", Narosa Publishing House.
5	Lo, C.P. and Young, A.K.W., "Concepts and Techniques of Geographical Information System", Prentice Hall India.
6	Longley, Paul A, Goodchild, Michael F., Maguire, David J. and Rhind, David W., "Geographic Information Systems and Science", Wiley
7	Pinde Fu and Jiulin Sun,Web GIS: "Principles and Applications", ISBN:9781589482456,ESRI
8	Chang, K. –T., Introduction to Geographic Information Systems, 4th ed., Tata McGraw Hill
9	Huisman et al., Principles of GIS An Introduction, ITC, the Netherlands

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	GEO5401	Surveying, Satellite Geodesy, GPS/GNSS	Elective 1	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Principles of surveying: Various maps and their scales, Symbols and colours.
Surveying measuring equipments & techniques: Distance, Height, Angles and Directions. Compass Surveying: Bearings and Azimuths
Levelling: Balancing of sights, Differential leveling, profile and cross-section leveling, Fall method, Contouring
Trigonometrical Leveling and Tacheometric surveying
Methods of control establishment: Traversing, Traverse computations and adjustments.
Modern surveying equipments: Total Station, DGPS
Concept of observation and model: The mathematical model and errors, Purpose of adjustments
Least squares adjustment techniques: Adjustment by linear and non-linear functions in the model, condition equation methods.
Introduction to geodesy & its development
Earth and its size & shape: Earth and its motions
Earth and its gravity field: anomaly, gravity potential, geoid
Earth and its atmosphere: physical properties, wave propagation through atmosphere, temporal variations, gravitational field of the atmosphere.
Introduction to GPS/GNSS: Introduction to GPS/GNSS, Satellite Navigations constellations today, GPS Errors Future of GPS.
Reference Systems and Coordinate systems: Geodetic coordinate systems, Datum transformations, Height systems, Time systems.
Satellite Signal: Structure of GPS Signal, Frequency, P Code, C/A code and data format, Generation of C/A code, Navigation data bits.
GPS Observables: Pseudo range measurements, Phase measurements, system accuracy characteristics, DOP, Data formats.
Surveying with GPS: Planning a GPS Survey, Positioning methods, Static, Fast static, RTK, Differential.
Data Processing: Ambiguity resolution, Post processing, real-time processing, Accuracy measures, software modules, GIS and GPS data integration.
Surveying with GPS: Navigation with GPS, Future of GPS: Modernization plans of navigational satellites, Hardware and software improvements.
Recent trends in surveying and mapping: e.g. UAV/Drone based survey.

List of Practicals:

1. Introduction to surveying instruments
2. Traingulation survey using Theodolite/ Compass/ Chain & Tape
3. Levelling using different surveying methods
4. Demonstration, hands-on practice and collection of data using Total Station
5. Demonstration, hands-on practice and collection of data using navigational GPS receiver. Further, download and process the data using software.
6. To determine the relative as well as absolute gravity of some stations and along a profile of 100meter at an interval of 5 meter. Find the location of the stations as well as plot the profile using GPS receivers.
7. To determine the height of a tower using a Gravimeter and verify the result with that by using GPS receiver.
8. To determine the variations of gravity with elevation. Determine the elevation of the stations using GPS receiver.
9. To determine the gravity anomaly profile in the DTU campus having absolute locations of the stations using GPS receivers.

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Bomford, G., "Geodesy", Clarendon Press, Oxford.
2	Hoffmann-Wellenhoff, B., "GPS Theory & Practice", Springer.
3	Leick, A., "GPS Satellite Surveying", John Wiley.
4	Torge, W., "Geodesy : An Introduction", Walter de Gruyter, Berlin.
5	Vanicek, Peter and Krakiwsky, E.J., "Geodesy : The Concepts", Elsevier.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	GEO5301	Probability, Statistics and Information theory in Geoinformatics	Elective 2	3	3	0	0	Yes	No	20	30	50	-	00

Details of Course:

Basic Statistics: Sources of Data, The Histogram, Measures of central tendency, Mean Deviation, Standard Deviation, Correlation, Coefficient of correlation, Rank correlation.
Probability: Equally likely, mutually exclusive events, additions & multiplication theorems of probability and problems based on them. Bayesian approach
Geostatistics: Pattern Analysis, Measures of Arrangements & dispersion, Auto Correlation, Semiveriogram, Kriging.
One dimensional and Two dimensional random variables: Random variables, Probability function, Functions of a Random Variable, weighting of observations, multiple regression analysis
Distributions and Introduction to Estimation Theory: Different types of distributions, univariate, bivariate and multivariate distributions including density functions. Unbiased Estimators, Method of Moments, Maximum Likelihood Estimation, propagation of systematic and accidental errors, theory of least squares and its application to adjustment problems.
Multivariate analysis: Vector random variables, sample estimate of centroid, standard deviation, dispersion, correlation matrices and Gaussian mixture models. Statistics and sampling distributions, Type I and Type II errors, Tests based on Normal, T, Chi-square and F distributions for testing of mean, variance and proportions, Tests for Independence of attributes and Goodness of fit, Testing of hypotheses: Principal components, Sample variation by principal components, and Principal components by graphing.
Information Theory: Entropy, Relative Entropy, Mutual Information, Information Inequalities, Block to variable length coding, Kraft's inequality.

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Probability and statistics for Engineering and the Sciences-Jay L. Devore, Cengage Learning.
2	Applied multivariate methods for data analysis- Dallas E Johnson et al, S. Chand.
3	Probability and Statistics for Engineer Richard Johnson- Miller & Freund, Pearson.
4	Rice, J.A. "Mathematical Statistics and Data Analysis", 3rd Edition, Cengage Learning
5	Jay L. Devore, "Probability and statistics for Engineering and the Sciences", 8th Edition, Cengage Learning
6	Thomas M. Cover, Joy A. Thomas, ``Elements of Information Theory", 2nd Edition, John Wiley & Sons
7	Robert G. Gallager, ``Information Theory and Reliable Communications", John Wiley & Sons

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
I	GEO5201	Two week Survey and Mapping Camp (Local)	Elective 3	2	0	0	10	No	Yes	20	0	0	0	80* (40 each for Viva and Report)

Details of Course:

Reconnaissance and establishing the control stations, GNSS observation for control points, Control network densification and topographic mapping using Total Station, Road profiling, Hand-held GNSS survey for GIS data, collection, Second Week Course Content: Use of automatic and digital levels, Electronic theodolites, total stations, control surveys using GNSS, Total station and traversing methods (adjustment and computations of coordinates), Laser Scanning for mapping, Multi-sensor surveying, Cartography and report writing, UAV & Drone based survey, Identify the lake depth using Echo sounder, Task based projects (concurrent)

Instruments and Software Required:

1. Electronic theodolite, Total station
2. Handheld GPS, Differential Global Positioning System (DGPS) with two to three receivers
3. Laser Scanner, Echo sounder
4. Unmanned Aerial Vehicle (UAV)
5. GPS and LiDAR data processing software

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Bomford, G., “Geodesy”, Clarendon Press, Oxford.
2	Hoffmann-Wellenhoff, B., “GPS Theory & Practice”, Springer.
3	Leick, A., “GPS Satellite Surveying”, John Wiley.
4	Torge, W., “Geodesy : An Introduction”, Walter de Gruyter, Berlin.
5	Vanicek, Peter and Krakiwsky, E.J., “Geodesy : The Concepts”, Elsevier.

SEMESTER - II

SEMESTER - II

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
II	GEO502	Principles of Optical, Thermal and Hyperspectral Remote Sensing	Core 3	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Introduction to optical, thermal and hyperspectral remote sensing: Introduction to spectral characteristics of remote sensing data. Thermal sensors and their Characteristics.

History of thermal IR Sensing: Brief review of thermal remote sensing, Thermal IR properties, Thermal radiation laws, Interpretation of thermal images, Radiometric calibration of Thermal IR Scanner data, Thermal IR environmental considerations, Thermal IR Sensing Examples.

Thermal IR Sensor systems: Radiation terminology and Units, Introduction to IR target detection, IR signature characterization and signature measurement.

Thermal infrared region models: Emissivity consideration, Factors affecting analysis of thermal images, Estimation of land surface temperature from thermal images, Applications of thermal remote sensing.

Hyperspectral remote sensing: Hyperspectral sensors, data calibration, data exploitation algorithms, applications of imaging spectroscopy, history of spectral remote sensing.

Spectral properties of Materials: Geometrical description and directional emissivity, Elements of mineral spectroscopy, man made materials.

Statistical models of for spectral data: Univariate and bivariate distributions, statistical analysis of hyperspectral imaging data, Gaussian mixture models.

Linear spectral transformations: Implications of high dimensionality, Principal Component Analysis, MNF transforms, Canonical Correlation analysis (CCA), data compression.

Spectral Mixing: LMM model, Endmember determination techniques, least squares estimation, hypothesis tests for model parameters, model selection criteria, LSMA in practice.

Application of hyperspectral remote sensing: Target detection, hydrology, Lithology, mineral exploration, agricultural crop systems, environmental and resource management.

List of Practicals:

1. Familiarisation with various thermal remote sensing data products
2. Hands on experience on thermal data
3. data processing modules in an image processing software
4. Study and collection of emmissivity data pertaining to various earth surface features from different sources.
5. Visual image interpretation of thermal images.
6. Digital image interpretation of thermal images.
7. Land surface temperature estimation from thermal images
8. Collection of spectral signatures and study of hyperspectral image
9. Classification of hyperspectral data

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Richards and Jia, Remote Sensing Digital Image Analysis An Introduction, 4th ed., Springer
2	Manual of Remote Sensing, Vol. 1 to 5, American Society of Photogrammetry and Remote Sensing.
3	Schowengerdt, R.A., "Remote Sensing Models and Methods in Image Processing", Academic Press.
4	Matzler, C., "Thermal Microwave Radiation: Application for Remote Sensing", Institute of Electrical Engineers (IEE).
5	Chang, Chein, I., "Hyperspectral Data Processing", John Wiley and Sons.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
II	GEO504	Microwave and Lidar Remote Sensing	Core 4	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Introduction to Microwave Remote Sensing: Active and Passive Systems, Platforms and Sensors.
Passive Microwave Systems: Background, Mathematical formulation for microwave radiation and simulation, Measurement and analysis of Brightness Temperature, Applications in various fields— Oceanography and Meteorology.
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 – RAR and SAR. SAR Imagery—their characteristics and interpretation. Applications of microwave
remote sensing.
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.
Introduction to Lasers and Lidar: Difinitions - History of Lidar Development - Lidar System Components - lidar sensors single-return, multi-return, waveform, photon-counting, Characteristics of Lidar Data - interaction of laser energy with earth surface features - Lidar Systems.

List of Practicals:

1. Familiarisation with various microwave remote sensing data products
2. Hands on experience on microwave data processing modules in an image processing software
3. Study and collection of emmissivity data pertaining to various earth surface features from different sources.
4. Study implementation of brightness temperature estimation models for passive microwave remote sensing data
5. Study and implementation of backscatter estimation models for active microwave remote sensing data
6. Visual and Digital image interpretation of SAR images.
7. Use of Differential SAR Interferometry for surface displacement studies.

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Ulaby, F.T., Moore, R.K., and Fung, A.K. “Microwave Remote Sensing – Active and Passive “Wesley Publishing
2	Sabins F.F., Jr.”Remote Sensing Principles and Interpretation “W.H. Freeman and company
3	Iain H.woodhouse “Introduction to microwave remote sensing, 1st edition, CRC Press, ISBN-13: 978-0415271233
4	Alexay Bunkin & Konstantin Volia.K “ Laser Remote Sensing of the Ocean Methods & Publications” John & Wiley & Sons, New York
5	Robert M. Haralick and Simmonett “Image processing for remote sensing”.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
II	GEO5402	Advanced Image Processing in Geoinformatics	Elective 4	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Preprocessing of Remote sensing data: Atmospheric correction algorithms, resampling.
Dimensionality reduction of remote sensing imagery: PCA, MNF, Information and divergence based approaches.
Processing in Spatial Domain: linear transformation, non-linear transformation, logarithmic transformation, exponential transformation, histogram manipulations, histogram thresholding, histogram stretching, histogram equalization, Enhancement in Frequency Domain; ideal low pas filter, ideal high pass filters, band pass filter, Gaussian filters, Hough transform.
Processing in Spectral Domain: Introduction to spectral characteristics of remote sensing data, algorithms to extract spectral information.
DEM generation from stereo-satellite images: Correspondence problem, Harris corner detector, SIFT, SURF, image matching, disparity map generation, spatial interpolation, CARTOSAT DEM, SRTM DEM, ASTER DEM, Parameter extraction.
Thematic information Extraction: Pattern Recognition: Supervised classification, Unsupervised classification, fuzzy classification, Object based image analysis.
Information extraction using AI: Expert systems, decision tree classification, classification based on machine learning and regression, random forest classifier, support vector machines, neural networks.
Information extraction using image spectroscopy: Panchromatic, multispectral and hyperspectral data collection, initial image quality assessment, radiometric calibration, geometric correction, mapping and matching using hyperspectral data, selected indices useful for hyperspectral data analysis.
Change Detection: Steps required to perform change detection, thematic change detection algorithms, atmospheric correction for change detection.
Remotely Sensed derived thematic map accuracy assessment: Steps to perform accuracy assessment, error matrix, sample size, sampling design, evaluation of error matrix, change detection map accuracy assessment.

List of Practicals:

1. Study of different types of remote sensing data
2. Hands on experience on images processing modules
3. Data visualization tools – study of images
4. Feature and intensity based image registration of images
5. Spatial enhancement of remote sensing images
6. Data dimensionality reduction using feature selection and feature extraction methods
7. Advanced pattern recognition algorithms for extraction of information from images
8. Derivation of biophysical parameters from multi and hyperspectral remote sensing images

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Chen, C.H., "Information Processing for Remote Sensing", World Scientific.
2	Cheng, Chein I., "Hyperspectral Imaging : Techniques for Spectral Detection and Classification", Kluwer Academic.
3	Landgrebe, D., "Signal Theory Methods in Multi-spectral Remote Sensing", John Wiley.
4	Richards, John A. and Xiuping, Jia., "Remote Sensing Digital Image Analysis : An Introduction", Springer-Verlag.
5	Varshney, P.K. and Arora, Manoj K., "Advanced Image Processing Techniques for Hyperspectral Remote Sensing Data", Springer-Verlag.
6	Faugeras, O., Three dimensional computer vision, A geometric viewpoint, MIT Press.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
II	GEO5302	Modelling and Analysis of Geospatial Data	Elective 5	3	3	0	0	Yes	No	20	30	50	-	00

Details of Course:

Types of Geo-spatial Data: Ratio, Categorical and Ordinal Data, Spatial and Non-spatial data, Vector and Raster Data, Primary and Secondary Data.

Multi Criterion Decision Making: Standardisation of weights, Analytical, Hierarchical Process (AHP), Spatial Decision Support System.

Coordinate Transformations: Two-Dimensional, Conformal, Affine, Projective, Coordinate Transformation, Three-Dimensional, Conformal Coordinate Transformation, Map models and Map Projection Systems.

Geo-spatial Data Structures and Database Management Systems: Data Compression Models, DBMS and Relational DBMS, File Formats for various GIS Data Types, Digital Remote Sensing Data: File Formats.

Measurements and Analysis: Sample versus Population, Graphical Representation of Geo-spatial Data, Measures of Central Tendency – Mean, Median, Mode. Mean Vector, Measures of Variation in Data - Variance Covariance and Correlation Matrices.

Error in Geo-spatial Data and Error Modeling: Error Sources, Types of Errors – Gross, Systematic and Random Errors, Precision, Accuracy and Uncertainty, Errors in Geospatial data and measurements, Propagation of Random Errors.

Principles of Least Squares: Observation Equations, Least Squares Solution of Nonlinear Systems, Least Squares Fit of Points to a Line or Curve, Concept of Adjustment of Errors, Least Squares Adjustment Using Conditional Equations and Observation Equations.

Confidence Intervals and Statistical Testing: Sampling Distributions, Confidence Interval for the Mean: *t* Statistic, Confidence Interval for a Population Variance, Confidence Interval for the Ratio of Two Population Variances, Hypothesis Testing, Uses of Statistical Testing in Geo-spatial Data Processing.

Uncertainty Modeling of Geo-spatial Data: Uncertainties in various Geo-spatial Data, Fuzzy set, Monte Carlo Simulations, Error Ellipse for Uncertainty Quantification.

List of Practicals:

1. Familiarity with different types of Geodata: Ratio, Categorical and Nominal
2. Understanding raster and vector data
3. Familiarization with various 2D and 3D coordinate transformations and Map Projection Systems.
4. Working on a DBMS software
5. Introduction to a Statistical Software for various applications, namely,
   - i) Generation of random error data
   - ii) Error modeling
   - iii) Least Squares adjustment
   - iv) Statistical Testing
   - v) Uncertainty modeling

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Bossler, J. D., "Manual of Geospatial Science and Technology", Taylor and Francis.
2	Freund, J. E., "Mathematical Statistics", Prentice Hall of India.
3	Law, A. M. and Kelton, W. D., "Simulation, Modeling and Analysis", Tata McGraw Hill.
4	Mikhail, Edward M. and Gracie, Gordon, "Analysis & Adjustment of Survey Measurements", Van Nostrand Reinhold.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
II	GEO5202	Research Methods and Communication	Elective 6	2	2	0	0	Yes	No	20	30	50	-	-

Details of Course:

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory, Characteristics of scientific method, Understanding the language of research, Research Process
Problem Identification & Formulation: Research Question, Measurement Issues, Hypothesis, Hypothesis Testing
Research Design: Concept and Importance in Research, Features of a good research design, Descriptive Research Designs, Experimental Design, Concept of Independent & Dependent variables.
Qualitative and Quantitative Research: Qualitative research, Quantitative research, Concept of measurement, causality, generalization, replication. Merging the two approaches.
Measurement: Concept of measurement, Problems in measurement in research, Levels of measurement.
Sampling: Concepts of Statistical Population, Sample, Probability Sample, Determining size of the sample.
Data Analysis: Data Preparation, Bivariate analysis.

Interpretation of Data and Paper Writing: Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish? Intellectual property rights (IPR), Industrial design geographical indication, Ethical issues related to publishing, Plagiarism and Self-Plagiarism.
Use of Encyclopedias: Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.

Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Donald Cooper & Pamela Schindler, '' Business Research Methods'', TMGH, 9th edition
2	Alan Bryman & Emma Bell, '' Business Research Methods'', Oxford University Press.
3	C.R.Kothari, '' Research Methodology ''.

SEMESTER - III

SEMESTER – III

Track-I														
Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO651	Research Project	Core	12	0	0	12	No	Yes	0	0	100	-	0

Track-II														
Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO601	Major Project I	Core	3	3	0	0	Yes	No	20	30	50	-	-

Details of Course:

Seminar – Literature Review and Main project topic finalization

SEMESTER – III (Track-II)

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6401	Geoinformatics in Target Detection	Elective 7	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Introduction: Targets, target detection problem, types of resolutions and spatial resolutions necessary for analysis, target detection process, selection of suitable targets, properties of target, Applications of Geoinformatics in Target detection.

Datasets for target detection: Optical data, thermal data, LIDAR data, SAR data, Sources of data, Challenges in data acquisition, limitations and advantages of each dataset.

Target Detection: Target detection in Photos and Single Images/ PAN/ Multispectral Images / Optical Images, Target detection in IR images.

Target detection in Hyperspectral Images: Spectral properties of materials, statistical models for spectral data, Linear spectral transformations, Dimensionality reduction techniques, signal detection theory, hyperspectral data exploitation

Target detection algorithms: extraction targets and accuracy assessment, machine learning algorithms, unsupervised algorithms, Anomaly detection, Independent Component Analysis, Deep learning methods, thresholding, performance evaluation parameters.

Sub-pixel target detection and enhancement: Linear mixture model, end-member determination techniques, least square computation, Spectral mixture analysis. Super resolution techniques for target enhancement, Camouflaging and Camouflage breaking, Subsurface target detection using microwave data, Target detection using Lidar data, Lidar Target Detection Algorithms.

Alternative Strategies For Target detection: Assess and exploit impact of various parameters in target detection, identification of most suitable spectral wavelengths for target detection, exploitation of spectral indices, shadowed target detection and identification using decision level fusion of Hyperspectral data with LiDAR data, Camouflaged targets detection, Occluded targets using shape based contour methods on LiDAR data, Change detection strategies.

List of Practicals:

1. Image Enhancement
2. Perform Image Rectification
3. Perform Image registration
4. Perform Radiometric correction
5. Perform Geometric correction
6. Perform Histogram Stretching and Spatial Filters
7. Perform Contrast stretching, images of different spatial resolutions, and true and false color images (composites)
8. Perform Dimensionality reduction: Principal Components Analysis on satellite data
9. Perform **f**ormatting Imagery: Creating Image Mosaics
10. Explore Spectral Libraries and Hyperspectral Processing Tools (Envi/Erdas)
11. Perform Color Transforms and Data Fusion Techniques using different data sets
12. Perform Radar Image and Edge Enhancement**:** Texture analysis using synthetic aperture radar (SAR)
13. Perform Detection in multispectral images
14. Detection in IR images
15. Perform Detection in hyperspectral images (SAM, MF, ACE etc)
16. Detection in microwave data
17. Perform Detection in LIDAR data ((ENVI IDL or terra solid) (Lidar Point cloud classification and target's feature extraction)
18. Perform Object-Based Image Analysis
19. Perform Image Operations and Data Fusion
20. Perform Lidar and hyperspectral data fusion for detection of shadowed targets, camouflaged targets.
21. Accuracy Assessment

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	DimitrisManolakis, "Hyperspectral Imaging Remote Sensing: Physics, Sensors, and Algorithms", Cambridge University Press
2	Manolakis, D. and Shaw, G., "Detection algorithms for hyperspectral imaging applications". *IEEE signal processing magazine*, *19*(1), pp.29-43.
3.	Shaw, G. and Manolakis, D., "Signal processing for hyperspectral image exploitation". IEEE Signal processing magazine, 19(1), pp.12-16.
4	Tiwari, K.C., Arora, M.K., Singh, D.P. and Yadav, D.S., "Military target detection using spectrally modeled algorithms and independent component analysis". Optical Engineering, 52(2), p.026402.
5	Bioucas-Dias, J.M., Plaza, A., Camps-Valls, G., Scheunders, P., Nasrabadi, N. and Chanussot, J.,. "Hyperspectral remote sensing data analysis and future challenges". IEEE Geoscience and remote sensing magazine, 1(2), pp.6-36
6	Tiwari, K.C., Arora, M.K. and Singh, D., "An assessment of independent component analysis for detection of military targets from hyperspectral images". International Journal of Applied Earth Observation and Geoinformation, 13(5), pp.730-740.
7	Arora, M.K. and Tiwari, K.C., "Subpixel target enhancement in hyperspectral images". Defence science journal, 63(1), pp.63-68.
8	Weng, Q.,. "Remote sensing of impervious surfaces in the urban areas: Requirements, methods, and trends". Remote Sensing of Environment, 117, pp.34-49.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6403	Geoinformatics in Geotechnical Engineering and Geohazards	Elective 7	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Elements of image interpretation: photographic and applications in geotechnical engineering. Identification of bridges, dams, tunnels from digital maps, land form identification and land cover usage with reference to geotechnical engineering.

Possible disasters and mitigation approaches: Geoinformatics based site selection for river valley projects, surface water harvesting structures: check dam, Nala bunds, subsurface dykes etc.

Mapping of Geological Hazards: Landslide, Earthquake, Mining hazards (subsidence, flooding etc.), Volcanic hazards.

Geoinformatics applications in Hydro meteorological Hazards: Flash floods, River floods, Dam burst, Cloud burst, Cyclones, Coastal hazards and Drought. Case studies in India and neighboring countries

List of Practicals:

1. Downloading the microwave and optical data for the study
2. Geotechnical investigation of soil in disaster prone areas
3. Establishment of permananent control points in Landslide prone zones in India
4. Mapping of surface deformation in landslide prone areas
5. Mapping of earthquake prone zones in India
6. Mapping of Landslide prone areas in India
7. Mapping of flood prone areas in India
8. Mapping and monitoring of Glacial Lake Outburst Flood (GLOF) in Indian Himalaya
9. Mapping of cyclone prone zones in India
10. Mapping and monitoring of coastal zone areas

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Chu, J., Wardani, P.R., Iizuka, A., "Geotechnical Predictions and Practice in Dealing with Geohazards (Geotechnical, Geological and Earthquake Engineering)", Springer
2	Goudin, C, and White, D., "Physical Modelling in Geotechnics", CRC Press
3.	Issu, K., "Geoscience, GIS, GPS, and Remote Sensing", CRC Press

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6405	Geoinformatics in Transportation	Elective 7	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

GIS – 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 Analysis 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.

List of Practicals:

1.Network analysis for transportation

2.Shortest path analysis for transportation

3. Geotagging of various metro stations in Delhi/ NCR.

4.Routing vehicles within networks

5.Identifying jam related areas

6. Mapping of accident prone areas and safety anaylsis.

7.Land use transportation modelling

8.Mapping sensitive environmental features affected by transportation

9.Road condition analysis for transportation

10.Planning a Green corridor

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Miller HJ and Shaw SL, Geographic Information Systems for Transportation: Principles and Applications, Oxford University Press
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
5	Hill JC, GIS in Transportation, Transportation Research Part C

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6407	Geoinformatics in hydrology and Glaciology	Elective 7	4	3	0	2	Yes	Yes	15	20	40	25	-

Details of Course:

Fundamentals of Hydrology: Hydrological cycle – estimation of various components of hydrological cycle – clouds – rainfall – runoff – evaporation – transpiration – evapotranspiration – interception – depression storage – spectral properties of water – case studies.

Drainage Basin Assessment: Watershed divide – stream networks – Delineation and codification of watersheds – basin morphometric analysis – linear, aerial, relief aspects – Rainfall - runoff modeling – urban hydrology – flood forecasting, risk mapping, damage assessment - soil moisture area – drought forecasting and damage assessment – mitigation - Mapping of snow covered area – snow melt runoff - case studies.

Irrigation and Water Quality: Project investigation – implementation - maintenance stage - location of storage / diversion works – canal alignment – depth - area capacity curve generation - water quality parameters – physical, chemical, biological properties - water quality mapping and monitoring – correlation model for pollution detection and suspended sediment concentration– case studies.

Ground Water: Ground water prospects – surface water indicators – vegetation, geology, soil – aquifer parameters – well hydraulics – estimation of ground water potential – hydrologic budgeting – mathematical models – ground water modeling – sea water intrusion – modeling.

Watershed Management: Mapping and monitoring the catchment and command area – conjunctive use of surface and ground water – artificial recharge of groundwater – water harvesting structures – erosivity and erodability - Universal Soil Loss Equation – sediment yield – modeling of reservoir siltation – prioritization of watershed – modeling of sustainable development – information system for Natural resource management – case studies.

List of Practicals:

1. Basin/catchment/watershed delineation Statistical and spatial analysis of precipitation data using RS-GIS techniques
2. Rainfall retrieval using satellite data Estimation of interception using remote sensing Estimation of soil moisture using remote sensing
3. Estimation of evapotranspiration (ET) using remote sensing data
4. Surface water body mapping and water quality analysis
5. Snow cover area mapping and snow melt runoff modeling
6. Derivation of unit hydrograph, S-hydrograph and synthetic unit hydrograph Estimation of surface runoff using SCS method
7. Estimation of climatic water balance components
8. Soil erosion modeling using USLE & RUSLE Soil erosion modeling using revised MMF model
9. Watershed prioritization Geospatial data base creation for watershed conservation planning using RS & GIS
10. Database creation and identifying suitable sites for WHS Site suitability for hydro power projects using RS-GIS
11. Irrigation command area mapping using multi-temporal satellite data Crop water requirement calculation
12. Performance evaluation of irrigation command area using RS & GIS
13. Mapping and monitoring of waterlogged and saline areas using RS & GIS
14. Monitoring of reservoir sedimentation Area capacity curve updation using RS & GIS
15. Drought assessment using remote sensing approach
16. Trend analysis of hydro-meteorological parameters. Glacier retreat mapping and hydrological modeling for climate change scenarios
17. Planning for inter basin water transfer using geospatial technique

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Eric C. Barrett, Clare H.Power, Satellite Remote Sensing for Hydrology and Water Management, Gordon @ Breach Science publications - New York
2	Dr. David Maidment, Dr. Dean Djokic, Hydrologic and Hydraulic Modeling Support with Geographic Information Systems, Esri Press
3	Wilfried Brutsaert, Hydrology: An Introduction Cambridge University Press
4	Andy D. Ward and Stanley W. Trimble, Environmental Hydrology, 2 nd edition, Lewis Publishers
5	U.M. Shamsi, GIS Applications for Water, Wastewater, and Storm water Systems, CRC; I st edition
6	Hoalst-Pullen, Nancy; Patterson, Mark W; Geospatial Technologies in Environmental Management, Springer.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6301	Geoinformatics in Disaster Management	Elective 8	3	3	0	0	Yes	No	20	30	50	-	-

Details of Course:

Introduction: Definition, types of disasters, importance of RS and GIS for disaster management, forecast, forewarning system, disaster preparedness with respect to different disaster, SDI to facilitate Disaster Management, GIS based DSS for disaster management, satellite surveillance for disaster mitigation

Drought: Drought types, causes, mitigation measures, delineation of drought vulnerable areas, drought monitoring, GIS based drought analysis, desertification factors, monitoring vegetative biomass;

Forest Fire: Forest Fire – causes, management using GIS, risk zonation mapping, forecasting system.

Earthquake: Causes, types, effects and mitigation measures, RS and GIS in earthquake prediction and post-quake rehabilitation, GIS for earthquake disaster management, mapping tectonic lineament

Volcanoes: RS of geothermal field, mapping lava flows, volcano hazard management

Landslides: RS and GIS for zonation, monitoring and management

Soil erosion: RS and GIS for soil erosion and sediment estimation

Flood: Flood types- flash and riverine floods, snowmelt floods, ice jams and mud flows, causes and mitigation measures, flooding potential zonation mapping, flood hazard assessment, ice cover monitoring and its role in flooding

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Kates, B.I and G.F. White, ‘’The Environment as Hazards’’ Second Edition, THE Guilford Press New York/London
2	Singh, R.B , ‘’Disaster Management’’, Rawat Publications.
3	Gupta, H.K , ‘’Disaster Management ‘’.
4	Singh, R.B , ‘’Space Technology for Disaster Mitigation in India ‘’.
5	Savindra Singh, ‘’Disaster Management in Hills’’.
6	Sharma, V.K , ‘’Disaster Management ‘’.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6303	Geoinformatics in Health Care	Elective 8	3	3	0	0	Yes	No	20	30	50	-	-

Details of Course:

Health Infrastructure Mapping Studies: Disease Mapping: Spatio-temporal visualization of disease pattern and trends

Geostatistical Analysis for Health studies: Epidemiological Studies – Spatial analysis of Vector borne Diseases

Health GIS: Spatial epidemiology: RS and GIS in study of epidemics and their control- (malaria, leprosy, polio, TB, filariasis, dengue, chikengunya, cholera, AIDs, cancer),

Disease mapping: bioterrorism, infectious disease modeling, Health facility location mapping, health and disease atlas of India.

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Ellen K. Cromley and Sara McLafferty, "GIS and Public Health, Second Edition"

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6305	Geoinformatics in Geosciences	Elective 8	3	3	0	0	Yes	No	20	30	50	-	-

Details of Course:

Remote Sensing in geology: an overview, Basic concept of geomorphology, earth surface process and resultant landforms, Spectral characteristics of rocks and minerals, Drainage patterns – types and its significance in geologic interpretation

Interpretation of drainage patterns through aerial photographs and satellite images: Interpretation of landforms due to folding and faulting, geomorphic indices of active tectonics, Interpretation of fluvial landforms, Interpretation of glacial, coastal,eolian and volcanic landforms

Interpretation of Karst landforms: Interpretation of structural and denudational landforms – cuesta, hogback , butte, mesa etc., Interpretation of landforms related to igneous, sedimentary and metamorphic rocks, Geomorphological mapping and terrain evaluation

Lithological interpretation of igneous, sedimentary and metamorphic rocks, Structure – definition, types and structural mapping Interpretation of folds, faults, unconformities and lineaments, Tectonics- active and neotectonics in Northwest Himalaya, Tectonics landforms mapping and analysis using remote and digital terrain model

Remote Sensing in Mineral exploration: An Overview and application of Remote Sensing in Mineral Exploration – Indian Examples, Remote Sensing in Oil Exploration – Features helpful in detection of target areas for oil exploration, Engineering geological Investigation , Alignment studies – roads, tunnels, canals etc Site selection studies – Dams, bridges, highways, airstrips etc, Natural disaster mapping and management.

Cyclone: cyclone monitoring using INSAT, ERS-1, NOAA and DMSP satellites, RS and GIS in hurricane mapping and mitigation, damage assessment, warning

Tsunami: types, causes, RS and GIS for warning, damage assessment and rehabilitation

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Drury, S.A., "Image Interpretation in Geology. Allen and Unwin''
2	Gupta, R.P., "Remote Sensing Geology. Springer Verlag''
3	Jensen,J.R., ''Remote Sensing of the Environment: An Earth resource Perspective''. Prentice Hall
4	Ray, R.G., "Aerial Photographs in geologic Interpretations. USGS Prof, Paper 373"

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6201	Geoinformatics in Atmosphere and Oceanic Studies	Elective 9	2	2	0	0	Yes	No	20	30	50	-	-

Details of Course:

State of the atmosphere: Main constituents of dry air, Vertical thermal structure of the atmosphere; Standard atmosphere; Hydrostatic equilibrium; Weather and its phenomena – Winds, cyclones, precipitation, hydrologic cycle; Surface weather and vertical structure

Elements of radiative transfer in atmosphere: Basic quantities, Blackbody radiation – basic laws - Radiative transfer equation, Physics of Gaseous absorption, emission, Scattering, Solar radiation and surface reflection; Radiation balance

Satellite and radar meteorology: Meteorological satellite instrumentation - Operational polar orbiting and geostationary satellites, weather sensors – passive radiometry, spectroscopy and occultation; active - Radar basics, conventional, radar and satellite rainfall measurements

NEXRAD system, Image interpretation: Visible infrared and water vapor imagery, Spectral properties, inversion methods and Image processing techniques for atmosphere and ocean: calibration, validation and quality control for weather data products -

Applications of ground based and satellite remote sensing for studies of e.g. temperature, composition, aerosol and cloud properties, precipitation, as well as the properties of sea surface and sea ice: chlorophyll, sea surface temperature, carbon sequestration.

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	John M Wallace and Peter V Hobbs, ‘’ Atmospheric science – An introductory Survey’’ , 2nd edn,
2	Kidder, Stanley Q., Thomas H. VonderHaar. San Diego, CA, ‘‘Satellite meteorology: an introduction’’, Academic Press.
3	Satellite meteorology: online remote sensing guide. Prepared by WW2010, Urbana Champaign: University of Illinois. Online access: http://ww2010.atmos.uiuc.edu/(Gh)/guides/rs/sat/home.rxml
4	Burrows J.P., Borell P., and Platt U., The Remote Sensing of Tropospheric Composition from Space, Springer.
5	I. S. Robinson, ‘’Satellite Oceanography: An Introduction for Oceanographers and Remote Sensing Scientists’’, Chichester: Ellis Horwood Ltd

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6203	Geoinformatics in Agriculture	Elective 9	2	2	0	0	Yes	No	20	30	50	-	-

Details of Course:

Crops acreage and yield estimation: Spectral properties of crops in optical & TIR region, Microwave backscattering behavior of crop canopy – crops identification and crop inventory – crop acreage estimation – vegetation indices and biophysical model – Yield modeling – crop condition assessment – command area monitoring and management – Microwave RS for crop inventory – Case studies

Soil mapping: Soil classifications – Soil survey, Types and methods – Hydrological Soil grouping - Factors influencing soil reflectance properties – Characteristics of saline & alkaline Soils –principle component analysis and orthogonal rotation transformation - Soil mapping - watershed management - Problem soil identification – land evaluation – Case studies.

Damage assessment: Detection of pest & diseases – Flood mapping and Assessments of crop loss – drought assessment – Land degradation – Soil erosion & sedimentation – Soil loss assessment – Soil conservation – Agriculture damage prediction modeling.

Forestry: Forest taxonomy – inventory of forest land – forest types and density mapping – Forest stock mapping – factors influencing degradation of forest – Delineation of degraded forest - Forest change detection and monitoring – Forest fire mapping & damage assessment –– biomass estimation - carbon storage – ALTM for Forest studies – urban forestry issues.

Climatic impact of Agriculture and Forestry: Concepts of Integrated surveys– global effects and climatic changes: land degradation and desertification, extreme events, - effect on forest produces health, forest hazards, sustainable forest Management and practice - biodiversity issues – invasive biotics – mitigation and adaptation – RS & GIS for drawing out action plans – watershed approach – landuse planning for sustainable development – precision farming – Case studies.

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	John G. Lyon, Jack MCcarthy, "Wetland & Environmental application of GIS"
2	Margareb Kalacska, G. Arturosanchez, " Hyper spectral RS of tropical and sub tropical forest"
3	Shunlin liang, "Advances in land RS: System, modeling invention and applications"
4	James B, ''Introduction of Remote sensing, Third edition Campbell, 3rd edition Guilford Press''
5	David H. White, S. Mark Howden, ''Climate Change: Significance for Agriculture and Forestry'', Springer

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6205	Geoinformatics Urban Planning and Infrastructure	Elective 9	2	2	0	0	Yes	No	20	30	50	-	-

Details of Course:

Fundamentals: Concepts of Urbanization and Urban Areas - concept of regions - formal and functional regions - census classification of urban areas. Concepts of Urban Planning and Infrastructure, Spatial thinking, spatial tools and need of such tools for planning physical structures and functional domains - data and information, Urban land use classification. criteria and systems

Inventory and Mapping: Digital and image records, Segmentation of Built-up areas, Inventory of resources and measurements, Deduction of sprawl, renewal and morphological changes, resolution of RS data in feature extraction and object delineation, high resolution remote sensing data in urban analysis..

Assessment of Potentials: Urban morphology – Housing typology – Population estimation from remote sensing – Infrastructure demand analysis – Land suitability analysis for Urban renewal – Plan formulation for sectoral and regional, development –

Space use surveys - Urban Heat Islands- Urban Green Spaces.

Estimation and projections - Design of Urban and regional information systems – revenue and tax collection GIS - planning facilities and amenities.

Location: Allocation and Transportation Planning, Housing development, parks and social facilities planning , Classification of traffic – Optimum route and plans / shortest path – Alignment planning – Traffic and flow management – Accident analysis – case studies.

Modeling Techniques: Urban growth modeling, Expert systems in AM/FM planning, digital terrain of the urban areas and regions, DEM and socioeconomic , Land use Transportation interaction models, Intelligent transportation systems, Risk, vulnerability models in crime, accidents and disasters - case studies

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Juliana Maantay, John Ziegler, John Pickles, GIS for the Urban Environment, Esri Press
2	Allan Brimicombe, GIS Environmental Modeling and Engineering, CRC; 1 edition. CRC Press, 2nd Edition, ISBN: 978-1439808702
3	Paul Longley, Michael Batty, Spatial Analysis: Modeling in a GIS Environment Wiley
4	Michael F. Goodchild, Louis T. Steyaert, Bradley O. Parks, Carol Johnston, David Maidment, Michael Crane, Sandi Glendinning, GIS and Environmental Modeling: Progress and Research Issues (Hardcover) by,Publisher: Wiley; 1st edition
5	Roland Fletcher, The Limits of Settlement Growth: A Theoretical Outline (New Studies in Archaeology) (First edition), Cambridge University Press
6	Said Easa, Yupo Chan, "Urban Planning and Development Applications of GIS", Amer Society of Civil Engineers, ISBN: 978-0784404614
7	Harvey J. Miller, Shih-Lung Shaw, "Geographic Information Systems for Transportation: Principles and Applications (Spatial Information Systems)", Oxford University Press, USA, ISBN: 978-0195123944
8	David J Maguire, Michael F Goodchild, Michael Batty, "GIS, Spatial Analysis, and Modeling", ESRI Press
9	Urban Remote Sensing Books – CRC Press
10	Urban Remote Sensing Books – Wiley Online Books

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
III	GEO6207	Design and Development of Sensors for Remote Sensing	Elective 9	2	2	0	0	Yes	No	20	30	50	-	-

Details of Course:

EM Theory: Electromagnetic Spectrum, EM plane waves , Plane wave propagation in lossless media , Wave polarization in a lossless medium, Plane-wave propagation in lossy media , Electromagnetic power density , Wave reflection and transmission at normal incidence , Wave reflection and transmission at oblique incidence Reflectivity and transmissivity ,Oblique incidence onto a lossy medium , Oblique incidence onto a two-layer composite

Sensors and Transducers: Introduction, Classification of Transducers, Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Resistance Transducers, Variable Inductance Transducers, Capacitive Transducers, Piezoelectric Transducers, Hall Effect Transducers, Thermoelectric Transducers, Photoelectric Transducers, Light Sensors, Tactile Sensors, Fiber Optic Transducers, Digital Transducers, Recent Trends – Smart Pressure Transmitters, Selection of Sensors, Rotary – Variable Differential Transformer, Synchros and Resolvers, Induction Potentiometers, Micro Electromechanical Systems

Op-amp based Instrumentation: Op-Amp Fundamentals, Basic op-amp configurations, Ideal op-amp circuit analysis, Negative feedback, Feedback in op amp circuits, Loop gain, Op amp powering, I/V and V/I converters, Current amplifiers, Difference amplifiers, Triple and dual op-amp Instrumentation amplifiers, Instrumentation applications, Transducer bridge amplifiers.

Interfacing of Sensors and Signal Conditioning: Introduction, Functions of Signal Conditioning, Change of bios and level of signals, Loading effects on Sensor's output, Potential divider, Low-Pass RC filter, High-Pass RC filter, practical issues of designing passive filters, Transfer function, First order active filters, Standard second order responses, KRC filters, Multiple feedback filters, Sensitivity, Filter approximations, Cascade design, Direct design, Switched capacitor, Switched capacitor filter

Imaging sensors: Optical imaging sensors, Thermal imaging sensors, Microwave imaging sensors

Non Imaging Sensor: Spectroradiometer, Radiometer, Spectrometer, Laser range finder/altimeter

Suggested Book:

S.No.	Name of Books/Authors/Publisher
1	Electromagnetic waves and radiating systems / by Edward C. Jordan, Keith G. Balmain
2	Electronic Instrumentation by H S Kalsi, Tata McGraw-Hill Education
3	Sensors And Transducers by Patranabis D, Prentice Hall India Learning Private Limited

SEMESTER - IV

SEMESTER - IV

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
IV	GEO652	**Track 1*** Research Work	Core	12	0	0	12	No	Yes	0	0	100	-	0

Details of Course:

*Publication in category 1 or category 2 journal publication is mandatory outcome of the track1. In second year (i.e. III and IV semester) Track 1 option is by research work.; Candidate will be finally evaluated at the end of the semester IV out of 24 credits on the basis of his/her publication (Accepted or published in category 1 or 2 journals).
Minor project must be included as a part of electives.

Teaching and Evaluation Scheme				Credit	Hours/Week			Exam Duration (Hrs)		Relative Weightage (%)				
Sem	Subject Code (Proposed)	Course Title	Type		L	T	P	TH	PR	CWS	MTE	ETE	PRS	PRE
IV	GEO602	**Track 2** Project- 2	Core	12	0	0	12	No	Yes	0	0	100	-	0