ACADEMIC CURRICULA

POST GRADUATE DEGREE PROGRAMMES

Master of Technology

(NEP based Flexible Credit System)

Syllabi for M Tech in Remote Sensing and GIS Programme

Professional Core and Elective Courses

BIRLA INSTITUTE OF TECHNOLOGY, MESRA

(Deemed to be university)

Mesra, Ranchi, Jharkhand, 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 Geospatial Technology education and research in the areas of Earth Resources, Environment & Climate 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)	Programme Outcomes (POs)
1. To prepare the students in identifying, analysing and solving geospatial problems.	1. An ability to independently carry out research/ investigation and development work to solve real life geospatial problems.
2. To train the students in developing practical and executable solutions to the challenges of growing field of Remote Sensing and GIS.	2. An ability to write and present a substantial technical report/document and publish international level research articles.
3. To impart the students with strong base of knowledge that makes them suitable both for industries as well as for teaching and research.	3. 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.
4. To inculcate the students with the sensitivity towards ethics, public policies and their responsibilities towards the society.	4. An ability to share theoretical and practical knowledge in both teaching and research as well as in industries.
	5. An ability to apply professional ethics, accountability and equity.

M. Tech (Remote Sensing and GIS)

PROGRAMME SCHEME - SEMESTER WISE DISTRIBUTION

S. No	Semester	Course Category	Credits	Total
1	FIRST	4 Programme Core (PC)	12	20
		1 Programme Elective (PE)	3	
		2 LABS (PC)	3 (1.5+1.5)	
		Skill development I	2	
		Field study	0	
2	SECOND	4 Programme Core (PC)	12	20
		1 Programme Elective (PE)	3	
		2 LABS (PC)	3 (1.5+1.5)	
		Skill development II	2	
3	THIRD	Research Project - Thesis (Part – I)	14	20
		1 Open Elective (OE-I)/ MOOC	3	
		1 Open Elective (OE-II)/ MOOC	3	
4	FOURTH	Research Project - Thesis (Part – II)	20	20
TOTAL				**80**

COURSE STRUCTURE

SEMESTER – I (FOR BOTH I. EARTH RESOURCES & II. ENVIRONMENT & CLIMATE)

	Course Category	Course Code	Subjects	L	T	P	Credit
SEMESTER-I	PC	RG26501	Principles of Remote Sensing	3	0	0	3
		RG26503	Satellite Image Processing	3	0	0	3
		RG26505	Geographic Information System	3	0	0	3
		RG26507	Global Navigation Satellite Systems and Surveying	3	0	0	3
		RG26502	Remote Sensing and Satellite Image Processing Laboratory	0	0	3	1.5
		RG26504	GIS, GNSS and Surveying Laboratory	0	0	3	1.5
		RG26506	Skill Development- I	3	0	0	2
		RG26540	Field Study (Non-Credit)	0	0	2	0
	PE	RG *	ELECTIVE – I	3	0	0	3
	Total Credits (1st Semester)						**20.0**

SEMESTER – II (EARTH RESOURCES)

	Course Category	Course Code	Subjects	L	T	P	Credit
SEMESTER-II	PC	RG26511	Advanced Geospatial Modelling	3	0	0	3
		RG26513	Aerial, Satellite Photogrammetry and Image Interpretation	3	0	0	3
		RG26515	Data Sources, Statistics and Research Methods in Geospatial Domain	3	0	0	3
		RG26517	Programming concepts for spatial data handling	2	1	0	3
		RG26512	Advanced Remote Sensing and Geospatial Modelling Laboratory	0	0	3	1.5
		RG26514	Aerial, Satellite Photogrammetry and Image Interpretation Laboratory	0	0	3	1.5
		RG26516	Skill Development- II	3	0	0	2
	PE	RG *	ELECTIVE – II	3	0	0	3
	Total Credits (2nd Semester)						**20**

SEMESTER – II (ENVIRONMENT AND CLIMATE)

	Course Category	Course Code	Subjects	L	T	P	Credit
SEMESTER-II	**PC**	RG26513	Aerial, Satellite Photogrammetry and Image Interpretation	3	0	0	3
		RG26515	Data Sources, Statistics and Research Methods in Geospatial Domain	3	0	0	3
		RG26517	Programming concepts for spatial data handling	2	1	0	3
		RG26519	Physical Meteorology	3	0	0	3
		RG26514	Aerial, Satellite Photogrammetry and Image Interpretation Laboratory	0	0	3	1.5
		RG26518	Meteorological Laboratory	0	0	3	1.5
		RG26516	Skill Development- II	3	0	0	2
	PE	RG *	ELECTIVE – II	3	0	0	3
	Total Credits (2nd Semester)						**20**

SEMESTER – III

	Course Category	Course Code	Subjects	L	T	P	Credit
SEMESTER-III	**PC**	RG 26601	Thesis (Part – I)				14
	OE+	**OPEN ELECTIVE I / MOOC**		3	0	0	3
	OE+	**OPEN ELECTIVE II / MOOC**		3	0	0	3
	Total Credits (3rd Semester)						**20**

SEMESTER – IV

	Course Category	Course Code	Subjects	L	T	P	Credit
SEMESTER-IV	**PC**	RG 26603	Thesis (Part – II)				20
	Total Credits (4th Semester)						**20**

TOTAL (40+40) = 80 credits

***PROGRAM ELECTIVES:**
'GROUP - A' MO SESSION

Semester-I

EARTH RESOURCE

Course No.	**Course Title**
RG26521	Remote Sensing in Agriculture & Forestry
RG26523	Remote Sensing in Hydrology & Water Resources

ENVIRONMENT & CLIMATE

RG26525	Remote Sensing in Climate Change and Environmental Impact Assessment

'GROUP - B' SP SESSION

Semester- II

EARTH RESOURCES

RG26527	Remote Sensing in Disaster Management
RG26529	Remote Sensing in Snow and Glacier Hydrology

ENVIRONMENT & CLIMATE

RG26531	Dynamic Meteorology
RG26533	Remote Sensing of Environment

RG26601 Thesis (Part – I) Semester III – Focus on Problem definition, Literature Review, Data Collection, Objectives and Research Questions Formulation and Detailed Work Plan, and partial fulfilment of initial objectives.
RG26603 Thesis (Part – II) Semester IV – Focus on systematic execution of work plan, data processing, analysis, interpretation, inferences and fulfilment of objectives and research questions, report preparation, and finally leading to a research publication in peer reviewed journals.

OE^{+} OPEN ELECTIVE / RGMC 26611 and 26613 MOOC – To be opted as offered by other Departments/ SWAYAM or NPTEL

TOTAL (40+40) = 80 credits

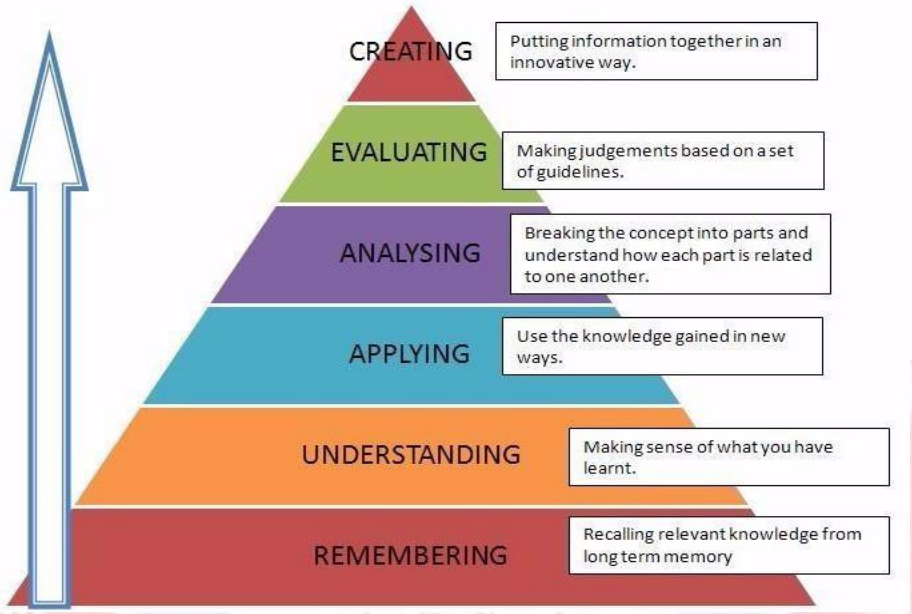
OE OPEN ELECTIVE / RG26541 - To be offered for other Departments for PG Courses.

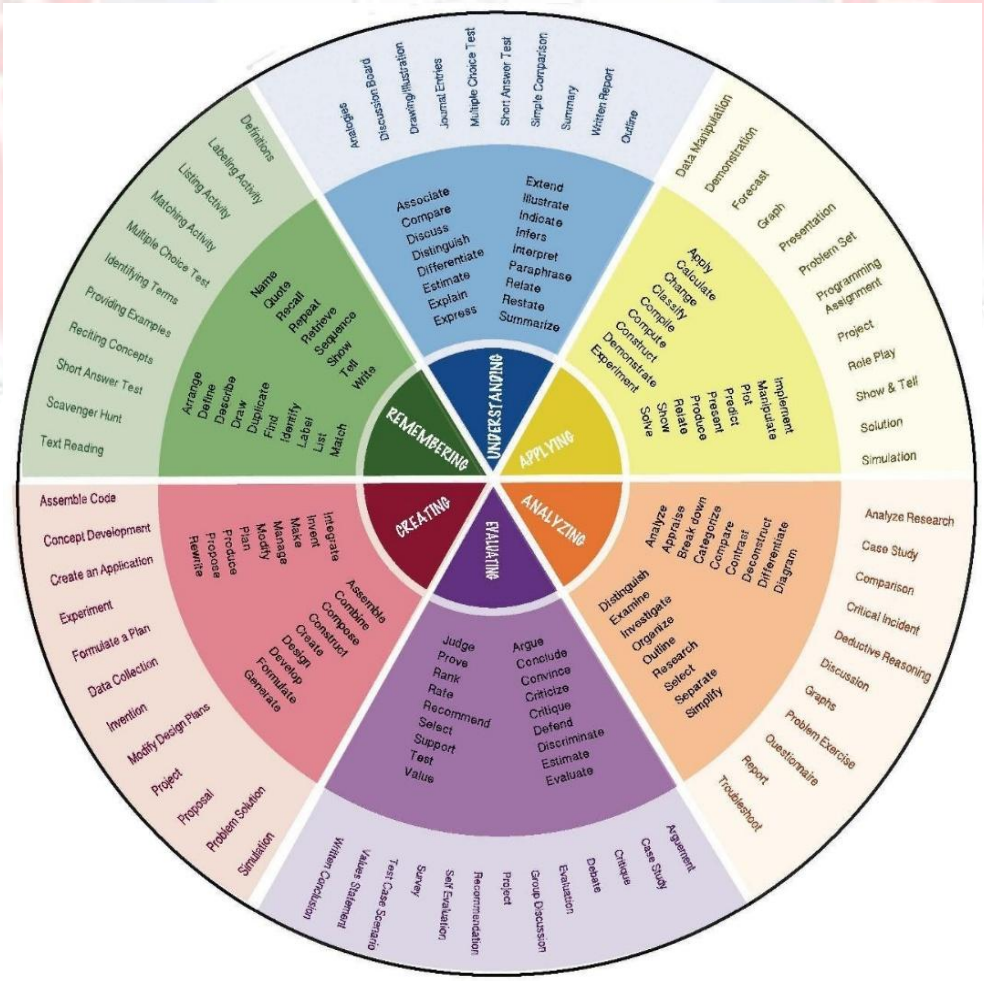
OE OPEN ELECTIVE / RG26301 - To be offered for other Departments for UG Courses.

BLOOM'S TAXONOMY FOR CURRICULUM DESIGN AND ASSESSMENT:

Preamble

The design of curriculum and assessment is based on Bloom's Taxonomy. A comprehensive guideline for using Bloom's Taxonomy is given below for reference.





SEMESTER – I

COURSE INFORMATION

(FOR BOTH I. EARTH RESOURCES & II. ENVIRONMENT & CLIMATE)

Course code	RG26501 in 1st year
Course title	PRINCIPLES OF REMOTE SENSING
Pre-requisite(s)	Basic Physics/Science/Allied subject
Co-requisite	Computer Knowledge
Credits	L: 3; T:0; P:0; SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	01/05 (Monsoon)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	Concepts of remote sensing imaging, energy balance, data acquisition platforms, sensors and their characteristics
2	Fundamental knowledge of Optical, Thermal, Hyperspectral and Microwave-based Remote Sensing and their major applications

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Understand electromagnetic radiation, principles of satellite imaging and sensing processes.
CO2	Describe different types of sensors, their characteristics and principles of various imaging and non-imaging scanners, spectroscopy.
CO3	Understand image characteristics and image correction techniques.
CO4	Explain thermal imaging mechanism and hyperspectral imaging and potential applications
CO5	Explain principles of microwave remote sensing, associated concepts and major applications

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1	CONCEPTS	Definition, Concept and Principles of Remote Sensing, Electromagnetic Radiation (EMR) and its Characteristics, Wavelength Regions and their Significance, Energy Balance Equation, Interaction of EMR with Atmosphere and Earth's Surface: Absorption, Reflectance and Scattering, Atmospheric Windows, Spectral Response and Spectral Signature, Spectral, Spatial, Radiometric and Temporal resolution. Image Interpretation keys	7
2	DATA ACQUISITION & OPTICAL REMOTE SENSING SYSTEM	Various Imaging Platforms: Aircraft and Spacecraft, UAV, Satellites for Earth and Planetary observations, Weather and Communication Satellites, Different Sensors and their Specifications. Electro-Optical Systems, Opto-Mechanical Scanners, Infrared Scanners, Scatterometer. Fundamentals of spectroscopy	5
3	IMAGE CHARACTERISTICS AND CORRECTION TECHNIQUES	Digital image and its characteristics, Image data storage and retrieval. Radiometric correction techniques, Geometrical errors and its rectification. Sources of image degradation - Image restoration and Noise Abatement, linear and nonlinear transformation for geometric corrections, Look-up Tables (LUT) and Types of image displays and FCC,	7
4	THERMAL AND HYPERSPECTRAL REMOTE SENSING	Thermal Imaging System: Basic principles and laws; Space-based thermal imaging systems; Thermal properties and Diurnal temperature of common materials; Emissivity, Characteristics and interpretation of thermal images; Land surface temperature estimation; Major applications of thermal remote sensing. Hyperspectral Sensors, data characteristics and Applications	8
5	MICROWAVE REMOTE SENSING	Microwave Remote sensing concepts: Backscattering, Range Direction, Azimuth Direction, Incident Angle, Depression Angle, Polarization, Dielectric Properties, Surface Roughness and Interpretation, Resolutions.	8

Learning Resources

Textbooks	*Reference Books*
1. Joseph,George and Jeganathan, C. (2017). "Fundamentals of Remote Sensing", 3rd Edition, Universities press (India) Pvt. Ltd., Hyderabad. 2. Jensen, J.R. (2015). "Remote Sensing of the Environment – An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pvt. Ltd., 3rd edition. 3. Jensen, J.R. (1996). Introductory Digital Image Processing A remote sensing perspective. Prentice Hall Series in GIS, USA 4. Lillesand, Thomas M. and Kiefer, Ralph, W. (2015). "Remote Sensing and Image Interpretation", 7th Edition, John Wiley and Sons, New York.	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 3. Dimitris G. Manolakis, Ronald B. Lockwood, Thomas W. Cooley(2016). Hyperspectral Imaging Remote Sensing. Cambridge Press. ISBN: 9781316017876. 4. Iain H. Woodhouse (2005). Introduction to Microwave Remote Sensing. CRC Pr I Llc .ISBN- 0415271231. 5. Ruiliang Pu, Qiuyan Yu (2026). Thermal Infrared Remote Sensing-Principles and Applications. CRC Press. ISBN 9781032231808

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Terrestrial sensors and their calibration***
Pos met through Gaps in the Syllabus	***PO4***
Topics beyond syllabus/Advanced topics/Design	***Integration of AI in Geospatial data sources***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO3, PO5***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***%Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	Best 2 Quiz marks out of 3Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+A ssig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	0	3	2	0
CO2	1	0	3	2	0
CO3	2	0	3	2	0
CO4	2	0	3	2	0
CO5	2	0	3	2	1

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	Field/Institutions visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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 Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26503 in 1st year
Course title	SATELLITE IMAGE PROCESSING
Pre-requisite(s)	Basic Science/Allied subjects
Co-requisite	Computer Knowledge
Credits	L:3; T:0; P:0; SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	01/05 (Monsoon)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	Understanding of digital image processing tools and techniques.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Describe different image enhancements techniques.
CO2	Characterize spectral pattern in image and explain different image classification approaches with respect to diverse applications
CO3	Explain various AI based image classification techniques
CO4	Explain preprocessing of hyperspectral images and link these data to real life applications
CO5	Explain preprocessing of microwave images and understand deriving of backscattering.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	IMAGE ENHANCEMENT TECHNIQUES	Radiometric enhancement techniques, Spatial enhancement techniques, Contrast stretching: Linear and non-linear methods. Band ratio, Types of Vegetation indices, Principal Component Analysis, Multi dated data analysis and Change detection, Image fusion techniques. Low Pass Filtering: Image smoothing, High Pass Filtering: Edge enhancement and Edge detection, Gradient filters, Directional and non-directional filtering	7
2	PATTERN RECOGNITION	Concept of Pattern Recognition, Multi-spectral pattern recognition, Spectral discrimination, Signature bank, Parametric and Non-Parametric classifiers, Unsupervised classification methods. Supervised classification techniques, Limitations of standard classifiers.	7
3	AI/ML AND IMAGE CLASSIFICATION	Concepts of AI, Techniques and Algorithms; Advanced Classification Techniques, Random Forest, Support Vector Machine, XGBoost.	7
4	HYPERSPECTRAL IMAGE PROCESSING	Hyperspectral Data pre-processing: Atmospheric correction, Noise reduction; data reduction - MNF transformation, spectral library, End member extraction, Classification methods, Spectral Angle mapper.	7
5	MICROWAVE IMAGE PROCESSING	Different SAR Image Processing techniques, Measurement and discrimination of Backscattering, Noise and speckle filtering.	7

Learning Resources

Textbooks	*Reference 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	Sabins, F.F. Jr. (2007). 'Remote Sensing – Principles and Interpretation", W.H. Freeman & Co. Reeves, Robert G. (1991), "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA. Dimitris G. Manolakis, Ronald B. Lockwood, Thomas W. Cooley(2016).

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.	Hyperspectral Imaging Remote Sensing. Cambridge Press. ISBN: 9781316017876. Iain H. Woodhouse (2005). Introduction to Microwave Remote Sensing. CRC Pr I Llc . ISBN-0415271231. Ruiliang Pu, Qiuyan Yu (2026). Thermal Infrared Remote Sensing-Principles and Applications. CRC Press. ISBN 9781032231808 .

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Deep learning classifiers and pre-trained models***
Pos met through Gaps in the Syllabus	***PO3***
Topics beyond syllabus/Advanced topics/Design	***Case Studies on AI based Image Processing***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO4***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***%Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	Best 2 Quiz marks out of 3Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+ Assig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	0	3	2	0
CO2	1	0	3	2	0
CO3	2	0	3	2	0
CO4	3	1	3	2	0
CO5	3	1	3	2	1

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/in-plant training
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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 Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26505 in 1st year
Course title	GEOGRAPHIC INFORMATION SYSTEM
Pre-requisite(s)	Basic Sciences
Co-requisite	Basic Computing
Credits	L:3; T:0; P:0; SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	01/05 (Monsoon)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	The basic concepts of GIS, GIS data models - spatial and non-spatial data structures and handling.
2	Tools and techniques of GIS for various spatial applications.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Understand various GIS data models, Geodatabase and data structures.
CO2	Describe data sources, data acquisition, coordinate systems and data quality.
CO3	Elucidate integrated geospatial techniques and apply them in solving real world problems.
CO4	Explain different interpolation and network analysis techniques for applying in solving real-world applications
CO5	Explain various data visualization models and decision support system for real-world applications

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	BASIC CONCEPTS OF GIS	Definition, Historical evolution of GIS, Spatial vs. Non-spatial data, Components of GIS, Spatial data models – Raster and Vector; advantages & disadvantages, Raster Data: Data Structure& File format, Data Compression (block code, chain code, run length code, quadtree, MrSID), Vector: Data Structure& File format, Topology, DBMS: Relational and Object Oriented. Basics of Geodatabase Model.	7
2	DATA INPUT AND GEO-CORRECTION	Sources of Spatial Data (Raster and Vector), Data Acquisition, Types of Co-ordinate Systems and Projections, Geometric Transformations of Raster and Vector Data (Affine Transformation and Transformation Coefficients), RMS Error, Sources of Errors, Spatial Data Quality: Accuracy, Precision, Error and uncertainty.	6
3	SPATIAL ANALYSIS AND VISUALIZATION	Spatial Analysis: Definition, Steps and classification, Raster Data Analysis Tools – Local, Focal, Zonal and Global, Vector Data Analysis – Buffering, Overlay Analysis, Distance Measurements, Spatial Auto Correlation, Introduction to Geo-AI and its application.	8
4	GEOSTATISTICAL TECHNIQUES AND NETWORK ANALYSIS	Spatial Interpolation: Introduction, Different Interpolation Techniques. Network Analysis: Structure (Alpha and Gamma Index) and Applications (Location- allocation, Linear Referencing), DEM Generation Surface Representation & Analysis, Difference between DTM, DSM and TIN.	8
5	GEOSPATIAL MODELS AND DECISION SUPPORT SYSTEM	Difference between 2D,2.5D, 3D and 4D GIS, Current issues and trends in GIS. Introduction to decision making process and decision support systems, Introduction of a framework for planning and decision making, Different types of DSS, Components of DSS, GIS and Spatial Decision Making, Difference between DSS & SDSS.	6

Learning Resources	
Textbooks	***Reference 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.	1. Kemp, Karen K. (Karen Kathleen),(2008). Encyclopedia of geographic information science. Los Angeles: SAGE Publications, c2008.

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Spatial data infrastructure (SDI) and metadata standards (ISO 19115); digital twin concepts applied to urban and environmental systems***
Pos met through Gaps in the Syllabus	***PO3, PO4***
Topics beyond syllabus/Advanced topics/Design	***Assignment Build a spatial decision support dashboard using open-source tools (Leaflet.js + Post GIS)***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO2***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***%Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	Best 2 Quiz marks out of 3Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+ Assig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

Course Delivery Methods	
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Institutions visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	0	3	2	0
CO2	2	0	3	2	1
CO3	3	0	3	2	1
CO4	2	0	3	2	0
CO5	2	0	3	2	1

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
CO5	CD1, CD2, CD3, CD4, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26507 in 1st year
Course title	GLOBAL NAVIGATION SATELLITE SYSTEM AND SURVEYING
Pre-requisite(s)	Basic Sciences
Co-requisite	Basic Computing
Credits	L:3; T:0; P:0; SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	01/05 (Monsoon)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	The concepts of satellite-based positioning, various positioning satellite systems, signal transmissions and associated errors.
2	Knowledge of coordinate systems, datum, augmentation systems and surveying concepts

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Understand satellite-based positioning system, various global satellite systems and errors
CO2	Explain various datums, coordinate systems and coordinate transformation
CO3	Understand site characteristics of a reference station, associated equipment and augmentation systems
CO4	Explain DGPS concept and different DGPS survey methods
CO5	Explain various surveying concepts and techniques.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	CHARACTERISTICS AND PRINCIPLES OF GNSS	Introduction to Global Navigation Positioning System: NAVSTAR GPS, GLONASS, IRNSS, BeiDou, Geo-positioning - Basic Concepts, Pseudo Range Measurement, Phase Difference Measurement, Sources of GNSS errors, DOP.	7
2	GEODESY	Geoid, Datum/Ellipsoid - definition and basic concepts, Global Datum vs. Indian Geodetic Datum, Coordinate Systems, Transformation of coordinates, GNSS Remote Sensing.	7
3	REFERENCE STATION AND AUGMENTATION SYSTEMS	Site characteristics of Reference Station, Reference Station Equipment. Basic concepts, Augmentation Systems (GAGAN, WAAS, LAAS, etc.).	7
4	CONVENTIONAL SURVEYING TECHNIQUES	Various levels, Levelling methods, Compass, Theodolite and Total Station and their uses, Tachometer, Trigonometric levelling, Traversing, Triangulation and Trilateration	7
5	DGPS AND AI USAGE IN NAVIGATION	Differential Global Positioning System: Concept, Various Surveying Methods, Data Processing, Smart Station and Applications. AI based tracking systems and Navigation	7

Learning Resources

Textbooks

1. Satheesh Gopi (2005). Global Positioning System: Principles and Applications. McGraw Hill Publishers.
2. N. Madhu, R. Sathikumar, Satheesh Gopi (2006). Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson India Publisher.

Reference Books

1. N. K. Agrawal (2004). Essentials of GPS, Spatial Network Pvt. Ltd
2. Leica. A. (2003). GPS Satellite Surveying, John Wiley & Sons. New York
3. Terry-Karen Steede (2002). Integrating GIS and the Global Positioning System, ESRI Press
4. Hofmann W.B &Lichtenegger, H. Collins (2001). Global Positioning System – Theory and Practice, Springer-Verlag Wein, New York.
5. Gunter Seeber (2003). Satellite Geodesy Foundations-Methods and Applications, Gruyter, Walter de GmbH.

Gaps in the Syllabus (to meet Industry/Profession requirements)	***GNSS-Reflectometry (GNSS-R) for soil moisture and sea surface monitoring***
Pos met through Gaps in the Syllabus	***PO1***
Topics beyond syllabus/Advanced topics/Design	***Case studies on GNSS-R data from CYGNSS mission for flood inundation mapping***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO3***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***%Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	Best 2 Quiz marks out of 3Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+ Assig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	0	3	2	0
CO2	1	0	3	2	0
CO3	2	0	3	2	1
CO4	2	0	3	2	1
CO5	2	0	3	2	1

Course Delivery Methods	
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Field/Institutions visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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
CO5	CD1, CD2, CD3, CD4, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26506 in 1st year
Course title	Skill Development- I
Pre-requisite(s)	Basic Sciences
Co-requisite	Basic Computing
Credits	L:0; T:0; P:2; SL: 0
Class schedule per week	3
Class	M. TECH
Semester / Level	01/05 (Monsoon)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	Knowledge and Concepts of C programming
2	Concepts of Technical Writing and Structing

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Understand the Basic Concept of C programming
CO2	Understand the concepts of functions and recursion in C programming
CO3	Conceptualize structure of scientific documents and develop writing skill with ethical use of AI
CO4	Demonstrate skills in technical writing and documentation following international standard
CO5	Use software for technical writing

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	BASICS OF C PROGRAMMING	Syntax, and constructs of C; variables, assignment, declarations, expressions, statements, input/output, conditionals, branching, iteration. Arrays, pointers, static and dynamic structures, dynamic allocation, file structures.	8
2	BASICS OF C PROGRAMMING	Functions and recursion: Parameter passing in a function, procedure call, call by value and reference, function prototypes; recursion; library functions, static functions.	7
3	FUNDAMENTALS OF TECHNICAL WRITING	Structure of reports, papers, thesis and documentation, Clarity and formatting; avoiding plagiarism and using AI writing assistants ethically. Paragraph writing, one idea per sentence, avoiding repetition. Using simple plain language, reducing adjectives and adverbs, avoiding unnecessary words	7
4	STRUCTURED DOCUMENTATION	Rewriting in smaller number of words/sentences. Precise writing through meticulous editing, proofreading. Writing abstracts and conclusions. Drafting reports, research papers, thesis, Referencing styles (APA/IEEE basics) and tools	7
5	INTRODUCTION TO LATEX	Setting up environments (Overleaf/MiKTeX); document classes, Formatting text, equations, tables, figures, Bibliography and citations	6

Learning Resources

Textbooks	*Reference Books*
1. Reema Thareja (2015). Introduction to C Programming. 2nd Ed. ISBN-10 : 9780199452057. Oxford University Press 2. Suzan Last (2019). Technical Writing Essentials. Creative Commons Attribution 4.0 International License,	1. Darrel L. Graham (2016) C Programming: Language: A Step-by-Step Beginner's Guide to Learn. ISBN- 978-1534679702.

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Structured abstract writing for conference submissions (beyond thesis/report documentation)***
Pos met through Gaps in the Syllabus	***PO2, PO4***
Topics beyond syllabus/Advanced topics/Design	***Sample Writing Exercises***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO3***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***%Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***%Distribution***				
	2 Quizzes	30 % (2 × 15%)				
	Group Assignment I(writing review article)	20%				
	Presentation Design and Poster Making (Clarity, Visual appeal, tool usage)	10%				
	Semester End Examination					
	Presentation (fluency, confidence, voice modulation, body language), Handling Q & A	20%				
	Mock interview cum Viva	20%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Group Assig	Q2+ Group Assig	Q2+ Poster making	Q1+ Poster making	Q1+Q2 +Poster making
	Semester End Examination	Presen tation+ viva	Presenta tion+ viva	Present ation+ viva	Present ation+ viva	Present ation+ viva

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	1	-
CO2	2	1	2	1	-
CO3	1	3	1	2	3
CO4	1	3	0	0	2
CO5	0	3	0	0	1

Course Delivery Methods	
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Self-learning (SL) such as use of NPTEL materials and internets

Mapping Between Course Outcomes and Course Delivery Method

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

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26502 in 1st year
Course title	REMOTE SENSING & SATELLITE IMAGE PROCESSING LAB
Pre-requisite(s)	Basic science/ Allied subjects
Co-requisite	Basic computing knowledge
Credits	L:0; T:0; P:1.5; SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	01/05 (Monsoon)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	Usage of diverse remote sensing data for extracting needed geo-spatial information.
2	Execution of various analogue and digital information extraction techniques, both manually and using computers.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Interpret Hard copy Satellite FCC images and survey of India Toposheets.
CO2	Collect and analyse Field Spectra for various land cover features.
CO3	Execute various radiometric and spatial enhancement techniques
CO4	Create land cover maps using different clustering techniques and AI.

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
	Lab 1	Understanding Satellite Remote Sensing Data and Visual Interpretation of earth surface features	
	Lab 2	Import / Export of Satellite data and image correction - Radiometric and atmospheric corrections	
	Lab 3	Geo-referencing and Geocoding	
	Lab 4	Field Spectra Collection: vegetation, bare soil, and concrete using Spectro Radiometer	
	Lab 5	Analysis of satellite derived spectral response and field spectra	
	Lab 6	Contrast enhancement techniques	
	Lab 7	Spectral Enhancement (Ratio images, Vegetation Indices) techniques	
	Lab 8	Spectral Enhancement techniques -PCA	
	Lab 9	Spatial Enhancement: Low Pass Filtering & High Pass Filtering Techniques	
	Lab 10	Multi-Resolution Analysis – Fusion	
	Lab 11	Unsupervised Classification	
	Lab 12	Supervised Classification & Accuracy Evaluation	
	Lab 13	AI based Advanced Classifications	

Learning Resources	
Textbooks	***Reference Books***
1.	1. *ESRI (2021).* Getting to Know ArcGIS Image Analyst

Gaps in the Syllabus (to meet Industry/Profession requirements)	***No lab exercise using open-source tools (SNAP, QGIS)***
Pos met through Gaps in the Syllabus	***PO3, PO4***
Topics beyond syllabus/Advanced topics/Design	***Assignments***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO1, PO3***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***%Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***%Distribution***				
	2 Quizzes	20 % (2 × 10%)				
	Day to Day Performance & Lab File	30%				
	Viva	20%				
	Final Exam	30%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Day to Day Perf	Q2+ Day to Day Perf	Q2+ Day to Day Perf		
	Semester End Examination	Viva + FE	Viva + FE	Viva + FE	Viva + FE	

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	0	3	3	1
CO2	3	0	3	3	2
CO3	3	1	3	3	1
CO4					
CO5					

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	Field visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD3, CD4, CD5
CO2	CD3, CD4, CD5
CO3	CD3, CD4, CD5
CO4	CD3, CD4, CD5
CO5	

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26504 in 1st year
Course title	GEOGRAPHIC INFORMATION SYSTEMS & NAVIGATION SYSTEMS LABORATORIES
Pre-requisite(s)	Basic physics
Co-requisite	
Credits	L:0 T:0 P:1.5 SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	01/05 (Monsoon)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
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 (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
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.

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
	Lab 1	Basics of Geodatabase, Vector, Raster, Catalogue and Georeferencing	
	Lab 2	Spatial data base creation	
	Lab 3	Topology creation and correcting topological errors & non-topological editing	
	Lab 4	Linking spatial with non-spatial data and 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 (Arithmetic, Logical and Global functions)	
	Lab 7	Raster Analysis II (Local, Focal and Zonal functions)	
	Lab 8	Different projection, coordinate system, Datums and Standardisation	
	Lab 9	Introduction to GNSS receivers, initial settings, creating codes and attribute table in GNSS receiver	
	Lab 10	Point, Line and Polygon Data collection using GNSS for Planimetric Measurements	
	Lab 11	GNSS Data collection in differential positioning mode	
	Lab 12	Post processing of the GNSS data and exporting	
	Lab 13	GNSS and GIS integrations output preparation	

Learning Resources	
Textbooks	***Reference Books***
	1. *ESRI (2021).* Getting to Know ArcGIS Image Analyst

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Network analysis using real-world data (OpenStreetMap)***
Pos met through Gaps in the Syllabus	***PO3***
Topics beyond syllabus/Advanced topics/Design	***Assignments on Real world data***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO4***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***%Distribution***				
	2 Quizzes	20 % (2 × 10%)				
	Day to Day Performance & Lab File	30%				
	Viva	20%				
	Final Exam	30%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Day to Day Perf	Q2+ Day to Day Perf	Q2+ Day to Day Perf		
	Semester End Examination	Viva + FE	Viva + FE	Viva + FE	Viva + FE	

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	0	3	3	1
CO2	3	1	3	3	2
CO3	3	0	3	3	2
CO4	3	1	3	3	2

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	Field/Institution visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD3, CD4, CD5, CD6
CO2	CD1, CD3, CD4, CD5, CD6
CO3	CD1, CD3, CD4, CD5, CD6
CO4	CD1, CD3, CD4, CD5, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

SEMESTER- II

COURSE INFORMATION

Specialization: EARTH RESOURCES

Course code	RG26511 in 1st year
Course title	ADVANCED GEOSPATIAL MODELLING
Pre-requisite(s)	(i) Basic knowledge of Remote Sensing, GIS, and GNSS (ii) Student must have undergone RG26501 and RG26502
Co-requisite	
Credits	L:3 T:0 P:0 SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
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)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Describe various advanced GIS tools and techniques within spatial analytical framework to solve natural, environmental and societal problems and challenges.
CO2	Explain point pattern analysis, time-series analysis for various real-life problems and associated uncertainty and errors.
CO3	Understand concepts of GeoAI and utilize it in Geospatial technology
CO4	Integrate AI in raster and vector data modeling
CO5	Explain WebGIS concepts and use it in various scripting languages, web tools in implementing GIS functions on web.

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1	SPATIAL PATTERNS, PROCESSES AND UNCERTAINTY MODELLING	Geostatistics & Interpolation: Kriging (Ordinary/Universal), Thiessen Polygons, IDW, Regression, 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.	7
2	GEO-SPATIAL MODELLING, TIMESERIES ANALYSIS	DSS and SDSS, Multicriteria Analysis: AHP, 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.	7
3	FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE (AI)	Introduction to AI, History and evolution of AI in Geoinformatics, Key concepts and terminology, AI Techniques and Algorithms: Random Forest, Support Vector Machines (SVM), and K-Means clustering.	7
4	INTEGRATING AI IN GEOSPATIAL MODELLING	Data Structures: Handling Raster (imagery, grids) and Vector (points, lines, polygons) data in an AI pipeline, Geospatial Data Preparation for AI: Tiling/chipping large satellite imagery into ML-ready formats (e.g., 256 X 256pixels); Handling Coordinate Reference Systems (CRS) and map projections in data arrays; Data augmentation techniques (e.g., rotation, flipping, spectral bands normalization); Feature Engineering for Space: Creating spatial predictors, such as distance-based features, terrain attributes (slope, aspect), and spectral indices (NDVI, NDWI).	9
5	WEB GIS	Roles of Clients & Servers, basics of Web GIS, architecture, data warehouse 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, APIs, GeoServer, NSDI, Census GIS, BHUVAN, Crowd Sourcing	5

Learning Resources

Textbooks	*Reference Books*
1. Mitchell, Andy (2012). The Esri Guide to GIS Analysis, Volume 3: Modeling Suitability, Movement, and Interaction. Redlands, CA, Esri Press. 2. Yue-hong Chou (1997). Exploring Spatial Analysis in Geographical Information System. Onword Press. Thomson Learning. 3. Devillers, R. and Jeansoulin, R. (2006). Fundamentals of Spatial Data Quality. ISTE Ltd., USA. 4. Handbook of Geospatial Artificial Intelligence * Editors: Song Gao, Yingjie Hu, and Wenwen Li, CRC Press (Published late December 2023) 5. GeoAI for Earth Observation Imagery: Fundamentals and Practical Applications; Dalton Lunga and Ronny Hänsch (Elsevier)	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/

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Geospatial foundation models and their integration with time-series analysis***
Pos met through Gaps in the Syllabus	***PO1, PO3***
Topics beyond syllabus/Advanced topics/Design	***Applications of GeoAI***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO4***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***%Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+ Assig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

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

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	Field/Institutional visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26513 in 1st year
Course title	AERIAL AND SATELLITE PHOTOGRAMMETRY & IMAGE INTERPRETATION
Pre-requisite(s)	Knowledge of fundamentals of Remote Sensing, GIS & GNSS
Co-requisite	Basic understanding of various satellite data
Credits	L:3 T:0 P:0 SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
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)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Explain the historic developments in the field of Photogrammetry and image interpretation concepts.
CO2	Carry out planimetric measurements and principles with reference to Aerial and Satellite High Resolution Images.
CO3	Explain the Analytical aspects of Photogrammetric technique.
CO4	Justify the need for orthophotos and satellite-based photogrammetry and explain the modern digital photogrammetric approaches using satellite, GPS.
CO5	Explain the role of UAV in terrain mapping and apply photogrammetric principles.

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1	ENVIRONMENTAL MAPPING & INTERPRETATION	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	6
2	GEOMETRY OF AERIAL PHOTOGRAPHS	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	7
3	ANALYTICAL PHOTOGRAMMETRY	Co-ordinate system, air base components, degree of freedom, Elements of interior and exterior orientation of aerial photographs, Numerical Derivations for Height based on relief displacement, coordinates, parallax, Orientation Procedures, Coordinate Transformation concepts, Epi-polar Geometry, Photo-triangulation: Pass-points for Aero triangulation, semi-analytical aero-triangulation, analytical aero-triangulation, bundle adjustment with GNSS, Aero-triangulation with Satellite images, strategies for aero-triangulation	8

4	DIGITAL PHOTOGRAMMETRY	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 derivation from Satellite images, Limitations, quality checks and interactive control	7
5	UAV FUNDAMENTALS AND APPLICATIONS	Types of drones, Drone components and terminology, Regulations and Guidelines for drone usage, Flight Mechanics and Dynamics: Structural elements of drones, calibration techniques, basic principles of flight mechanics, flight controller board, flight planning, Factors affecting drone flight performance and efficiency, coverage types, and processing methods, Applications and future trends of UAVs in Geospatial studies	7

Learning Resources

Textbooks	*Reference 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. ***4.*** Garvith Pandya (2021). Basics of Unmanned Aerial Vehicles: Time to start working on Drone Technology. Notion Press.	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/

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Deep learning for automated feature extraction from aerial/satellite imagery (roads, buildings)***
Pos met through Gaps in the Syllabus	***PO1, PO4***
Topics beyond syllabus/Advanced topics/Design	***Integration of LiDAR point clouds with photogrammetric DSMs (fusion workflows)***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO2, PO3***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	Best 2 Quiz marks out of 3Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+ Assig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	0	1	2	3	0
CO2	3	1	3	3	1
CO3	2	1	3	3	0

CO4	3	2	3	3	1
CO5	3	1	3	3	2

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	Field/Institutions visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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 Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26515 in 1st year
Course title	DATA SOURCES, STATISTICS AND RESEARCH METHODS IN GEOSPATIAL DOMAIN
Pre-requisite(s)	Knowledge of statistics
Co-requisite	Knowledge of RS & GIS
Credits	L: 3 T: P: SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1.	International, national spatial research problems and projects, various geo-spatial data platforms at global and national level.
2.	Various important components involved in project management, field report/thesis preparation, and statistics.
3.	Knowledge about importance of quality, ethics, and different research methods being used in the geo-spatial domain.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Understand international and national research issues, projects, and data platforms
CO2	Write Project reports, thesis and project proposals
CO3	Apply various sampling techniques and statistics to spatial research
CO4	Apply research methods quantitatively and qualitatively
CO5	Use the National/Global standards of research

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	GEO-SPATIAL RESEARCH & DATA SOURCES	Geo-spatial Research Problems, National and International Projects: Past and Recent, Different types of Geo-spatial data requirement, Bhuvan, Bhoonidhi, Bhusampda, MOSDAC, India-WRIS USGS Global Visualization Viewer (GloVis), NASA Earth Observation (NEO), GEE, USGS Earth Explorer, ESA's Sentinel data, NOAA, Copernicus, IPMUS Terra	8
2	FIELD AND PROJECT REQUIREMENTS	Need for Field Visit and Preparation of field reports, Research proposal, Literature review, Components of Research Thesis/Project Report, Project Administrator and project management, Classification of Projects/thesis, Problems and opportunities in Projects	8
3	SAMPLING AND STATISTICS	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	8
4	RESEARCH METHODS	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	6
5	TOOLS, QUALITY AND ETHICS	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, AI ethics	5

Learning Resources	
Textbooks	***Reference 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 4. Kothari, C. R and Garg, G. (2019). Research Methodology, Methods and Techniques, New Age International Publishers, New Delhi	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)

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Bayesian inference and spatial Bayesian models for geospatial uncertainty quantification***
Pos met through Gaps in the Syllabus	***PO2, PO5***
Topics beyond syllabus/Advanced topics/Design	***FAIR data principles and data management plans***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO3, PO5***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	Best 2 Quiz marks out of 3Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+ Assig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

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

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	Field/ Institutional visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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 Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26517 in 1st year
Course title	PROGRAMMING CONCEPTS FOR SPATIAL DATA HANDLING
Pre-requisite(s)	(i) Knowledge of Basic Sciences (ii) (ii) Student must have undergone RG26501, RG26502
Co-requisite	
Credits	L:3 T: P: SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1.	Enhance the student's understanding of logic development and its transformation into programs
2.	Make the student learn to solving simple problems through Python
3.	Utilize programming to solve problems of various application areas of Earth Science.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	To Develop algorithms for arithmetic and logical problems in Python
CO2	Handle Spatial data in Python
CO3	Make use of Python for deployment of programs to process spatial data
CO4	Utilise Python tools for digital image processing
CO5	Make computations using Images & Image Collections in Google Earth Engine

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	BASICS OF PYTHON	Introduction to Python, Basics of Python Syntax, Data Types of Pythons, Basic Operations of Python, Functions: Recursion, Scope of Variable, Standard Library Functions; Modules, and Packages of Python, Extension: Building a Python Environment, conditions, range, Loops, break, continue, and else in Loops	9
2	PREPARING DATA FOR SPATIAL MODELING	Understanding Classes and Objects (essential for working with APIs like ArcPy or PyQGIS, NumPy: Multi-dimensional arrays (the basis for Raster data); Pandas: Handling attribute tables, Data Frames, cleaning CSVs, and time-series analysis; Matplotlib & Seaborn: Scientific plotting and statistical visualization	7
3	VECTOR DATA PROCESSING USING PYTHON	GeoPandas: The industry standard for vector data manipulation; Shapely: Geometric operations (Point in Polygon, Buffering, Union, Intersection); Fiona & Pyproj: Reading/writing spatial formats and handling Coordinate Reference Systems (CRS) transformations	7
4	PYTHON LIBRARIES FOR RASTER DATA HANDLING	Rasterio: Reading and writing GeoTIFFs, band math (NDVI, NDWI calculation); Xarray: Working with multi-dimensional "Data Cubes" (NetCDF files); Whitebox Tools: Advanced terrain analysis and hydrological modelling via Python; OpenCV: Basic image processing for feature extraction.	7
5	GOOGLE EARTH ENGINE WITH PYTHON	Introduction to Cloud Computing, Google Earth Engine, Earth Engine Objects and Methods, Functional Programming Concepts, Introduction to the Earth Engine API Authentication: Setting up Google Cloud Projects, installing libraries; Jupyter & Google Colab: Setting up notebooks for interactive geospatial development, Understanding the "Server-side" vs. "Client-side" distinction, Exploring raster data, bands, and metadata; Handling vector data	7

Learning Resources	
Textbooks	***Reference Books***
1. B. W. Kernighan and D. M. Ritchie: The 'C' Programming Language. 2. Mark Lutz: Learning Python 3. Hadley Wickham, Garrett Grolemund: R for Data Science 4. Mikhailov, Eugeniy E: Programming with MATLAB for Scientists: A Beginner's Introduction 5. Lalit Kumar, Onisimo Mutanga: Google Earth Engine Applications	1. B. Gottfried: Programming in C. 2. Wes McKinney: Python for Data Analysis 3. Colin Gillespie, Robin Lovelace: Efficient R Programming 4. Stormy Attaway: Matlab A Practical Introduction to Programming and Problem Solving

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Machine Learning Algorithms in GEE***
Pos met through Gaps in the Syllabus	***PO3***
Topics beyond syllabus/Advanced topics/Design	***Geospatial REST API development (FastAPI + GeoJSON) for serving spatial data as web services***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO3***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***%Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	Best 2 Quiz marks out of 3Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+ Assig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	0	2	2	0
CO2	3	0	3	2	1
CO3	3	1	3	2	1
CO4	3	1	3	2	0
CO5	3	1	3	2	1

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	Field/Institutional visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26512 in 1st year
Course title	ADVANCED REMOTE SENSING AND GEOSPATIAL MODELLING LABORATORY
Pre-requisite(s)	Basic physics
Co-requisite	
Credits	L: T: P:1.5 SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
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 (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Download, 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.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
	Lab 1	Handling Thermal data and Modelling Urban Heat Island	
	Lab 2	Microwave Data processing and interpretation	
	Lab 3	SAR data classification 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 techniques – Krigging and IDW	
	Lab 8	Spatial Pattern Analysis in GIS	
	Lab 9	Understanding Two-point and Multi-point Statistics	
	Lab 10	Modelling Resolution Uncertainty and Error in the Spatial Data	
	Lab 11	AI based Spatial Weighted Regression	
	Lab 12	Time Series data Smoothing and information extraction	
	Lab 13	WebGIS services related programming and Scripting	

Learning Resources	
Textbooks	***Reference Books***
	1. Image Processing Lab Manual for ArcGIS Pro and Desktop Supplemental Material for: Floyd F. Sabins and James M. Ellis, April 2020, Remote Sensing Principles, Interpretation, and Applications, 4th Edition, Waveland Press

Gaps in the Syllabus (to meet Industry/Profession requirements)	***InSAR coherence and displacement map generation using SNAP (Sentinel-1 SLC data — freely available)***
Pos met through Gaps in the Syllabus	***PO4***
Topics beyond syllabus/Advanced topics/Design	***PolSAR decomposition***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO2***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	2 Quizzes	20 % (2×10%)				
	Day to Day Performance & Lab File	30%				
	Viva	20%				
	Final Exam	30%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Day to Day Perf	Q2+ Day to Day Perf	Q2+ Day to Day Perf		
	Semester End Examination	Viva + FE	Viva + FE	Viva + FE		

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	0	3	2	1
CO2	3	1	3	3	1
CO3	3	2	3	3	1
CO4					
CO5					

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	Field/Institutional visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26514 in 1st year
Course title	AERIAL AND SATELLITE PHOTOGRAMMETRY & IMAGE INTERPRETATION LABORATORIES
Pre-requisite(s)	Fundaments of Remote Sensing
Co-requisite	
Credits	L: T: P: 1.5 SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
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 manually and using computers.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
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.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
	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	

Learning Resources	
Textbooks	***Reference Books***
Gezahegn Weldu W/Mariam (2015). ArcGIS 10x PRACTICAL MANUAL. Haramaya University.	

Gaps in the Syllabus (to meet Industry/Profession requirements)	***No deep learning-based feature extraction lab (building/road detection from aerial imagery)***
Pos met through Gaps in the Syllabus	***PO3***
Topics beyond syllabus/Advanced topics/Design	***Point cloud processing to visualise, classify, and compute volume from a LiDAR tile***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO1***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***%Distribution***				
	2 Quizzes	20 % (2 × 10%)				
	Day to Day Performance & Lab File	30%				
	Viva	20%				
	Final Exam	30%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Day to Day Perf	Q2+ Day to Day Perf	Q2+ Day to Day Perf		
	Semester End Examination	Viva + FE	Viva + FE	Viva + FE		

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	0	3	3	1
CO2	3	1	3	3	1
CO3	3	2	3	3	2
CO4					
CO5					

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	Field/ Institutional visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26520 in 1st year
Course title	Skill Development-II
Pre-requisite(s)	Computer skills
Co-requisite	
Credits	L:2 T: P: SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	To demonstrate the contents of various interview rounds and understand the importance of company profile while applying for a job.
2	To develop background knowledge and prerequisites for efficient operations of software.
3	Participate effectively in groups emphasizing listening, critical and reflective thinking, and responding and develop the ability to technical research and presentations.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Acquire knowledge about various interview sessions and readiness.
CO2	Develop know-hows about domain specific industries and companies.
CO3	Understand the basics of hardware requirement and lab development.
CO4	Well-groomed candidates able to address the real-world.
CO5	Develop Contents and ability to present ideas.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	PERSONALITY DEVELOPMENT AND SOCIAL BEHAVIOURS	Speaking, Reading, Writing and Presenting. Innovative Thinking in Hobbies. Linking technical subjects with innovative thinking. Developing Managerial skills- Team and Single workforce, social perception, attitudes, and stereotypes, Leadership styles and influence, Conformity, persuasion, and social norm. Professional grooming and etiquette, Workplace ethics and values, Time management and productivity, Conflict resolution and negotiation	7
2	WORKPLACE KNOWLEDGE AND CAREER ALIGNMENT	Learn about RS and GIS companies, their HR, contact Id, Scope of work. Aligning CV and Interview. CV writing. Technical skills and Knowledge. Production managers: Listening to staff complaints and demands; Listening to a talk on risk in business.	7
3	TECHNICAL WRITING	Technical knowledge about Software-hardware and software, development of laboratories, new course contents. Exposure to emerging trends in geospatial domain, GEO AI etc.	7
4	LISTENING AND SPEAKING SESSIONS	Ideas sharing, content development in power point, Oral display. Technical Presentations. Advanced Interview Rounds.	8
5	INTERVIEW READINESS	Conducting Mock Interview with experts of various domains: HR, Technical, Finance, challenges, weaknesses. Domain specific interactions.	6

Learning Resources	
Textbooks	***Reference Books***
1. Dr. Anubhuti Dubey, Prof. Aradhna Shukla (2023). Personality Development and Communication Skills. Laxmi Pub.	

Gaps in the Syllabus (to meet Industry/Profession requirements)	*Build a professional portfolio*

Pos met through Gaps in the Syllabus	***PO4***
Topics beyond syllabus/Advanced topics/Design	***Intellectual Property Rights (IPR) module for geospatial software/data products***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO2, PO4***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***%Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***%Distribution***				
	2 Quizzes	20 % (2 × 10%)				
	Group Assignment I(writing review article)	20%				
	Presentation Design and Poster Making (Clarity, Visual appeal, tool usage)	10%				
	Semester End Examination					
	Presentation (fluency, confidence, voice modulation, body language), Handling Q & A	20%				
	Mock interview cum Viva	20%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+Group Assig	Q2+Group Assig	Q2+Poster making	Q1+Poster making	Q1+Q2+Poster making
	Semester End Examination	Presentation+viva	Presentation+viva	Presentation+ viva	Presentation+ viva	Presentation+viva

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	0	1	1	2	2
CO2	1	2	2	3	2
CO3	1	1	2	2	1
CO4	0	1	0	2	3
CO5	1	3	1	3	2

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	Field/Institutional visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Specialization: Environment and Climate

Course code	RG26513 in 1st year
Course title	AERIAL AND SATELLITE PHOTOGRAMMETRY & IMAGE INTERPRETATION
Pre-requisite(s)	knowledge of fundamental of Remote Sensing, GIS & GNSS
Co-requisite	Basic understanding of various satellite data
Credits	L:3 T:0 P:0 SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1.	Fundamentals of 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)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Explain the historic developments in the field of Photogrammetry and image interpretation concepts.
CO2	Carry out planimetric measurements and principles with reference to Aerial and Satellite High Resolution Images.
CO3	Explain the Analytical aspects of Photogrammetric technique.
CO4	Justify the need for orthophotos and satellite-based photogrammetry and explain the modern digital photogrammetric approaches using satellite, GPS.
CO5	Understand components of UAV, flight planning and policies, role of UAV in terrain mapping and linking it to various real-life applications.

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1	ENVIRONMENTAL MAPPING & INTERPRETATION	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	7
2	GEOMETRY OF AERIAL PHOTOGRAPHS	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	8
3	ANALYTICAL PHOTOGRAMMETRY	Co-ordinate system, air base components, degree of freedom, Elements of interior and exterior orientation of aerial photographs, Numerical Derivations for Height based on relief displacement, coordinates, parallax, Orientation Procedures, Coordinate Transformation concepts, Epi-polar Geometry, Photo-triangulation: Pass-points for Aero triangulation, semi-analytical aero-triangulation, analytical aero-triangulation, bundle adjustment with	7

		GNSS, Aero-triangulation with Satellite images, strategies for aero-triangulation	
4	DIGITAL PHOTOGRAMMETRY	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 derivation from Satellite images, Limitations, quality checks and interactive control	6
5	UAV FUNDAMENTALS AND APPLICATIONS	Types of drones, Drone components and terminology, Regulations and Guidelines for drone usage, Flight Mechanics and Dynamics: Structural elements of drones, calibration techniques, basic principles of flight mechanics, flight controller board, flight planning, Factors affecting drone flight performance and efficiency, coverage types, and processing methods, Applications and future trends of UAVs in Geospatial studies	7

Learning Resources

Textbooks	*Reference 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. ***1.*** Moffit, F.M. (1980). Photogrammetry, International Text Book Co.	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/

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Deep learning for automated feature extraction from aerial/satellite imagery (roads, buildings)***
Pos met through Gaps in the Syllabus	***PO1, PO4***

Topics beyond syllabus/Advanced topics/Design	***Integration of LiDAR point clouds with photogrammetric DSMs (fusion workflows)***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO2, PO3***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***%Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	Best 2 Quiz marks out of 3Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+Assig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	0	1	2	3	0
CO2	3	1	3	3	1
CO3	2	1	3	3	0
CO4	3	2	3	3	1
CO5	3	1	3	3	2

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	Field /Institutional visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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 Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26515 in 1st year
Course title	DATA SOURCES, STATISTICS AND RESEARCH METHODS IN GEOSPATIAL DOMAIN
Pre-requisite(s)	Knowledge of statistics
Co-requisite	Knowledge of RS & GIS
Credits	L:3 T: P: SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
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 (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
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
CO5	Learn tools and methods for research and along with AI ethics.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	GEO-SPATIAL RESEARCH & DATA SOURCES	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), GEE, USGS Earth Explorer, ESA's Sentinel data, NOAA, Copernicus, IPMUS Terra, Bhuvan, Bhoonidhi, Bhusampda, MOSDAC, India-WRIS	7
2	FIELD AND PROJECT REQUIREMENTS	Need for Field Visit and Preparation of field reports, Research proposal, Literature review, Components of Research Thesis/Project Report, Project Administrator and project management, Classification of Projects/thesis, Problems and opportunities in Projects	6
3	SAMPLING AND STATISTICS	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	8
4	RESEARCH METHODS	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	6
5	TOOLS, QUALITY AND ETHICS	Tools & Methods: Project Communications and Presentation, Intellectual Property Right, Plagiarism and associated software, Evaluating Quality of Research paper/journal: Citation Index, Impact Factor, National/Global standards, SCI, SCOPUS, etc., Referencing/Citation methods, Reference management software, AI ethics	8

Learning Resources	
Textbooks	***Reference 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	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)

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Bayesian inference and spatial Bayesian models for geospatial uncertainty quantification***	
Pos met through Gaps in the Syllabus	***PO2, PO5***	
Topics beyond syllabus/Advanced topics/Design	***FAIR data principles and data management plans***	
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO3, PO5***	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	Best 2 Quiz marks out of 3Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	SeminarbeforeaCommittee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+A ssig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

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

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	Field/Institutional visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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 Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26517 in 1st year
Course title	PROGRAMMING CONCEPTS FOR SPATIAL DATA HANDLING
Pre-requisite(s)	(iii) Knowledge of Basic Sciences (iv) (ii) Student must have undergone RG26501, RG26502
Co-requisite	
Credits	L: 3 T: P: SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1.	Enhance the student's understanding of logic development and its transformation into programs
2.	Make the student learn to solving simple problems through Python
3.	Utilize programming to solve problems of various application areas of Earth Science.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	To Develop algorithms for arithmetic and logical problems in Python
CO2	Handle Spatial data in Python
CO3	Make use of Python for deployment of programs to process spatial data
CO4	Utilise Python tools for digital image processing
CO5	Make computations using Images & Image Collections in Google Earth Engine

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	BASICS OF PYTHON	Introduction to Python, Basics of Python Syntax, Data Types of Pythons, Basic Operations of Python, Functions: Recursion, Scope of Variable, Standard Library Functions; Modules, and Packages of Python, Extension: Building a Python Environment, conditions, range, Loops, break, continue, and else in Loops	9
2	PREPARING DATA FOR SPATIAL MODELING	Understanding Classes and Objects (essential for working with APIs like ArcPy or PyQGIS, NumPy: Multi-dimensional arrays (the basis for Raster data); Pandas: Handling attribute tables, Data Frames, cleaning CSVs, and time-series analysis; Matplotlib & Seaborn: Scientific plotting and statistical visualization	7
3	VECTOR DATA PROCESSING USING PYTHON	GeoPandas: The industry standard for vector data manipulation; Shapely: Geometric operations (Point in Polygon, Buffering, Union, Intersection); Fiona & Pyproj: Reading/writing spatial formats and handling Coordinate Reference Systems (CRS) transformations	7
4	PYTHON LIBRARIES FOR RASTER DATA HANDLING	Rasterio: Reading and writing GeoTIFFs, band math (NDVI, NDWI calculation); Xarray: Working with multi-dimensional "Data Cubes" (NetCDF files); Whitebox Tools: Advanced terrain analysis and hydrological modelling via Python; OpenCV: Basic image processing for feature extraction.	7
5	GOOGLE EARTH ENGINE WITH PYTHON	Introduction to Cloud Computing ,Google Earth Engine, Earth Engine Objects and Methods, Functional Programming Concepts, Introduction to the Earth Engine API Authentication: Setting up Google Cloud Projects, installing libraries; Jupyter & Google Colab: Setting up notebooks for interactive geospatial development, Understanding the "Server-side" vs. "Client-side" distinction, Exploring raster data, bands, and metadata; Handling vector data	7

Learning Resources	
Textbooks	***Reference Books***
1. B. W. Kernighan and D. M. Ritchie: The 'C' Programming Language. 2. Mark Lutz: Learning Python 3. Hadley Wickham, Garrett Grolemund: R for Data Science 4. Mikhailov, Eugeniy E: Programming with MATLAB for Scientists: A Beginner's Introduction 5. Lalit Kumar, Onisimo Mutanga: Google Earth Engine Applications	1. B. Gottfried: Programming in C. 2. Wes McKinney: Python for Data Analysis 3. Colin Gillespie, Robin Lovelace: Efficient R Programming 4. Stormy Attaway: Matlab A Practical Introduction to Programming and Problem Solving

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Machine Learning Algorithms in GEE***	
Pos met through Gaps in the Syllabus	***PO3***	
Topics beyond syllabus/Advanced topics/Design	***Geospatial REST API development (FastAPI + GeoJSON) for serving spatial data as web services***	
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO3***	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***%Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	Best 2 Quiz marks out of 3Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+A ssig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	0	2	2	0
CO2	3	0	3	2	1
CO3	3	1	3	2	1
CO4	3	1	3	2	0
CO5	3	1	3	2	1

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	Field/Institutional visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26519 in 1st year
Course title	PHYSICAL METEOROLOGY
Pre-requisite(s)	i) Knowledge of Basic Sciences ii) RG26501 and RG26502
Co-requisite	
Credits	L:3 T: P: SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1.	Learn basic concepts of Atmospheric Phenomenon
2.	Understand Thermodynamic energy and its role in weather
3.	Learn the radiative balance and its importance
4.	Acquire the knowledge of clouds and importance of Indian Monsoon

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Explain atmospheric processes in depth
CO2	Demonstrate the understanding of the importance of vertical thermal structure and related weather phenomenon
CO3	Explain the cloud formation
CO4	Demonstrate the understanding of the unequal heating and the relation with Indian monsoon
CO5	Explain understanding of Global perspective of Indian monsoon

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1	ELEMENTARY CONCEPTS OF ATMOSPHERIC SCIENCES	Structure of the atmosphere and its composition, pressure and its variation with height, variation of temperature with height, Equation of state for dry and moist air, Adiabatic and Isothermal Processes, Humidity Parameters, Virtual Temperature, Standard Atmosphere, Atmospheric Boundary Layer Structure and evolution, turbulence etc.	6
2	ATMOSPHERIC THERMODYNAMICS	Laws of thermodynamics, Entropy, Potential Temperature, Pseudo-adiabatic Process, Equivalent Temperature, Equivalent Potential Temperature, Claussius–Clapeyron Equation, Stability and Instability, Thermodynamic Diagram: T-gram, Uses of thermodynamic diagrams, Precipitable Water Vapor, Rate of Precipitation, Role of Convective Available Potential Energy (CAPE) and Convective Inhibition Energy (CINE) in thunderstorm development, Dew, Frost, Fog, Clouds, Precipitation, Airmass, Fronts, Tornado, Cyclones, Dust Storm	8
3	RADIATIVE TRANSFER IN THE ATMOSPHERE	The fundamental physics of radiation: solar and terrestrial radiation, radiation laws; absorption, emission and scattering in the atmosphere, Schwarzchild's equation; Radiation in the earth-atmosphere system: Geographical and seasonal distribution, Radiative heating and cooling of the atmosphere, Surface energy budget, The mean annual heat balance	7
4	WEATHER AND CLIMATE	Definition of weather and climate, physical factors of climate, earth-sun relationship, ecliptic and equatorial plane, rotation of the earth, seasons, climatic controls, Climatic classification: methods of Koppen and Thornthwaite, Microclimate-basic concepts, Indian climatology: Climate zones of India; pressure, wind, temperature and rainfall distribution during the four seasons, Cloud types; cloud formation; cloud dynamics, homogeneous and heterogeneous	8

		nucleation; CCN, fundamental equations governing cloud processes	
5	INDIAN MONSOONS	Land and sea breezes, Definition of monsoon, Synoptic features of southwest monsoon and northeast monsoon, Global perspective of monsoons, ITCZ over Indian Ocean - Structure and movement, Intraseasonal oscillation, Interannual and decadal time scales, Atmospheric-Ocean surface patterns of Southern Oscillation, El-Nino, La Nina, ENSO, Indian Ocean Dipole mode, Walker circulation, Hadley circulation, Tropical Biennial Oscillation, Tropical cyclones: Formation, movement, life cycle	6

Learning Resources

Textbooks	***Reference Books***
1. Atmospheric Science: An Introductory Survey: J.M Wallace and P.V. Hobbs, 2nd edition, Academic Press, 2006 2. Introduction to Theoretical Meteorology by S.L. Hess.	1. An Introduction to Atmospheric radiation: K.N. Liou 2dn edition Academic Press, 2002 2. Dynamic and Physical Meteorology by G.L. Haltiner and F.L. Martin, Mc Graw Hill. 3. The Physics of the Atmosphere by Houghton 4. The Physics of Monsoons R.N. Keshava Murthy and M.Shankar Rao, Allied Publishers, 1992.

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Reanalysis products (ERA5, NCEP/NCAR, MERRA-2) and their use in satellite data validation***
Pos met through Gaps in the Syllabus	***PO3***
Topics beyond syllabus/Advanced topics/Design	***Machine learning for weather prediction and statistical downscaling of climate model outputs***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO1, PO2***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	Best 2 Quiz marks out of 3Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+A ssig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	1	2	3	0
CO2	2	1	2	3	0
CO3	1	1	2	3	0
CO4	2	1	3	3	0
CO5	2	2	3	3	1

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	Field/Institutional visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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 Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26514 in 1st year
Course title	AERIAL AND SATELLITE PHOTOGRAMMETRY & IMAGE INTERPRETATION LABORATORIES
Pre-requisite(s)	
Co-requisite	
Credits	L: T: P:1.5 SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
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 manually and using computers.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
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.

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
	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	

Learning Resources	
Textbooks	***Reference Books***

Gaps in the Syllabus (to meet Industry/Profession requirements)	***No deep learning-based feature extraction lab (building/road detection from aerial imagery)***	
Pos met through Gaps in the Syllabus	***PO3***	
Topics beyond syllabus/Advanced topics/Design	***Point cloud processing to visualise, classify, and compute volume from a LiDAR tile***	

Pos met through Topics beyond syllabus/Advanced topics/Design	***PO1***	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	2 Quizzes	20 % (2 × 10%)				
	Day to Day Performance & Lab File	30%				
	Viva	20%				
	Final Exam	30%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Day to Day Perf	Q2+ Day to Day Perf	Q2+ Day to Day Perf		
	Semester End Examination	Viva + FE	Viva + FE	Viva + FE		

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	0	3	3	1
CO2	3	1	3	3	1
CO3	3	2	3	3	2
CO4					
CO5					

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	Field/Institutional visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD3, CD4, CD5, CD6
CO2	CD1, CD3, CD4, CD5, CD6
CO3	CD1, CD3, CD4, CD5, CD6
CO4	
CO5	

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26518 in 1st year
Course title	METEOROLOGICAL LABORATORY
Pre-requisite(s)	Basic Science
Co-requisite	
Credits	L: T: P: 1.5 SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	01/05 (Monsoon)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	Familiarize with atmospheric data variables and their variability
2	Enriching knowledge in atmospheric data and its relationships
3	Knowledge on the analytical methods of atmospheric/climate data

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Understand the atmospheric data methods
CO2	Basic analytical techniques for atmospheric data
CO3	Knowledge of necessary atmospheric background
CO4	Derive meteorological information from satellite data
CO5	Elucidate the skills on statistical data analysis

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
	Lab 1 and 2	Clouds classification and Observations: Students would be shown slides of all 10 major types of clouds and by end of the Lab training it is expected from students to be able to identify real weather clouds.	
	Lab 3	Plot and analysis of the variation of vertical temperature by Radiosonde data from https://weather.uwyo.edu/upperair/sounding.html or any other data source.	
	Lab 4	To determine the vertical lapse rate of the standard atmosphere	
	Lab 5	Principle and working of the sun photometer	
	Lab 6	Estimation and analysis of Sea surface temperature with satellite data in different latitudes.	
	Lab 7 and 8	Statistical analysis for one month data of atmospheric parameters (Temperature, Relative humidity)	
	Lab 9 and 10	Plot the back trajectory and forward trajectory for different height/pressure level from https://www.ready.noaa.gov/HYSPLIT.php or any other online sources	
	Lab 11	Estimation and analysis of Outgoing longwave radiation with satellite data for different atmospheric condition	
	Lab 12 and 13	Climatic classification of Koppen and the difference with Thornthwaite	

Learning Resources	
Textbooks	***Reference Books***

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Climate indices computation (SPI, PDO, AMO, IOD) using observational data***
Pos met through Gaps in the Syllabus	***PO1***
Topics beyond syllabus/Advanced topics/Design	***Python-based atmospheric data visualisation (sounding plots, thermodynamic diagrams using MetPy)***

Pos met through Topics beyond syllabus/Advanced topics/Design	***PO1, PO3***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	2 Quizzes	20 % (2 × 10%)				
	Day to Day Performance & Lab File	30%				
	Viva	20%				
	Final Exam	30%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Day to Day Perf	Q2+ Day to Day Perf	Q2+ Day to Day Perf		
	Semester End Examination	Viva + FE	Viva + FE	Viva + FE	Viva + FE	Viva + FE

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	0	2	2	0
CO2	2	0	2	2	0
CO3	2	0	2	3	0
CO4	2	0	3	3	0
CO5	3	1	2	2	1

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	Institutional visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD1, CD3, CD4, CD6
CO2	CD1, CD3, CD4, CD6
CO3	CD1, CD3, CD4, CD6
CO4	CD1, CD3, CD4, CD6
CO5	CD1, CD3, CD4, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26516 in 1st year
Course title	Skill Development-II
Pre-requisite(s)	Computer skills
Co-requisite	
Credits	L:2 T: P: SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	To demonstrate the contents of various interview rounds and understand the importance of company profile while applying for a job.
2	To develop background knowledge and prerequisites for efficient operations of software.
3	Participate effectively in groups emphasizing listening, critical and reflective thinking, and responding and develop the ability to technical research and presentations.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Acquire knowledge about various interview sessions and readiness.
CO2	Develop know-hows about domain specific industries and companies.
CO3	Understand the basics of hardware requirement and lab development.
CO4	Well-groomed candidates able to address the real-world.
CO5	Develop Contents and ability to present ideas.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	INTERVIEW READINESS	Conducting Mock Interview with experts of various domain: HR, Technical, Finance, challenges, weaknesses. Domain specific interactions.	7
2	WORKPLACE KNOWLEDGE AND CAREER ALIGNMENT	Learn about RS and GIS companies, their HR, contact Id, Scope of work. Aligning CV and Interview. CV writing. Technical skills and Knowledge. Production managers: Listening to staff complaints and demands; Listening to a talk on risk in business.	7
3	KNOWLEDGE DEVELOPS CONFIDENCE	Technical knowledge about Software-hardware and software, development of laboratories, new course contents. Exposure to emerging trends in geospatial domain, GEO AI etc.	7
4	PERSONALITY DEVELOPMENT AND SOCIAL BEHAVIOURS	Speaking, Reading, Writing and Presenting. Innovative Thinking in Hobbies. Linking technical subjects with innovative thinking. Developing Managerial skills- Team and Single workforce, social perception, attitudes, and stereotypes, Leadership styles and influence, Conformity, persuasion, and social norm. Professional grooming and etiquette, Workplace ethics and values, Time management and productivity, Conflict resolution and negotiation	8
5	LISTENING AND SPEAKING SESSIONS	Ideas sharing, content development in power point, Oral display. Technical Presentations. Advanced Interview Rounds.	6

Learning Resources	
Textbooks	***Reference Books***

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Build a professional portfolio***	
Pos met through Gaps in the Syllabus	***PO4***	
Topics beyond syllabus/Advanced topics/Design	***Intellectual Property Rights (IPR) module for geospatial software/data products***	
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO2, PO4***	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	60%				
	Semester End Examination	40%				
	Continuous Internal Assessment	***%Distribution***				
	2 Quizzes	20 % (2 × 10%)				
	Day to Day Performance & Lab File	30%				
	Viva	20%				
	Final Exam	30%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Day to Day Perf	Q2+ Day to Day Perf	Q2+ Day to Day Perf		
	Semester End Examination	Viva + FE	Viva + FE	Viva + FE	Viva + FE	Viva + FE

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	0	1	1	2	2
CO2	1	2	2	3	2
CO3	1	1	2	2	1
CO4	0	1	0	2	3
CO5	1	3	1	3	2

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	Fiel/Institutional visits
CD6	Self-learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

SEMESTER I: PROGRAMME ELECTIVES

EARTH RESOURCES

Course code	RG26521 in 1st year
Course title	REMOTE SENSING IN AGRICULTURE AND FORESTRY
Pre-requisite(s)	(i) Knowledge of Basic Sciences (ii) Computer Knowledge
Co-requisite	
Credits	L: 3 T: 0 P:0 SL:
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 provide students with:

Sl No.	Objectives
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 (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Map and quantify various agricultural features, yield, and sensor requirements.
CO2	Identify the difference between healthy crop and affected crop using remote sensing data 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 model land capabilities and classifications using RS&GIS.
CO4	Able to identify different types of forests features and landscape metrics
CO5	Able to identify risk associated with forests (such as forest fire, degradation, deforestation etc) with the help of satellite data.

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1	INTRODUCTION	Spectral Properties of Vegetation: Natural and Man-made, Crop Yield and Acreage Estimation, Discriminate Analysis, Agricultural Applications: Sensor Requirements.	7
2	DAMAGE ASSESSMENT	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. Agricultural drought and indices.	7
3	LAND USE/LAND COVER	Basic Concept and Criteria of Land Use / Land Cover Classification, Methodology, Classification System, Level of Classification, Land Capability Assessment.	7
4	FORESTRY CONCEPTS	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.	7
5	VISUAL AND DIGITAL ANALYSIS	Forest Cover, Canopy Density, Biomass Assessment, Forest Fire and Burnt Area Identification, Indian Forest Fire Alarm, Soil-Moisture concepts, 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.	7

Learning Resources

Textbooks

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 Books

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 Society 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

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Carbon credit estimation***	
Pos met through Gaps in the Syllabus	***PO1, PO3, PO5***	
Topics beyond syllabus/Advanced topics/Design	***Above Ground Biomass using SAR data***	
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO4, PO5***	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+A ssig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty	
	Student Feedback on Course Outcome	

CO	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
CO5	3	1	2	3	2

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/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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
CO5	

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26523 in 1st year
Course title	REMOTE SENSING IN HYDROLOGY & WATER RESOURCES
Pre-requisite(s)	(i) Knowledge of Basic Sciences (ii) Student must have computer knowledge
Co-requisite	
Credits	L: 3 T:0 P:0 SL:
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 provide students with:

Sl No.	Objectives
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 (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
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 No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	**BASIC CONCEPTS**	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.	
2	**GROUND-WATER EXPLORATION AND EVALUATION**	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.	
3	**RIVER BASINS**	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.	
4	**WATERSHED MANAGEMENT**	Watershed characterization using remote sensing, Morphometric parameters and analysis, Watershed problems and management strategy. Ground water recharge structures and their site suitability analysis. Wetlands concepts and dynamics.	
5	**OPERATIONAL APPLICATIONS IN WATER RESOURCES**	Satellite image-based surface runoff modelling, Flood and drought- mapping and modelling, Reservoir sediment estimation, Snow and Glacier Hydrology, Snowmelt runoff modelling, Soil erosion modelling.	

Learning Resources	
Textbooks	***Reference 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.*	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.

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".*	

Gaps in the Syllabus (to meet Industry/Profession requirements)	***GRACE/GRACE-FO satellite data for groundwater storage anomaly monitoring***
Pos met through Gaps in the Syllabus	***PO5***
Topics beyond syllabus/Advanced topics/Design	***Integrated water resource management (IWRM) frameworks and geospatial tools***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO3***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+A ssig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	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

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/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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 Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

SEMESTER I: PROGRAMME ELECTIVES

ENVIRONMENT & CLIMATE

Course code	RG26525 in 1st year
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	
Credits	L: 3 T: P: SL:
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 provide students with:

Sl No.	Objectives
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)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Understand and explain the differences between weather and climate, local to global climatic variations, and El Nino vs La Nina.
CO2	Quantify relationship between ecosystems (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	Understand concepts of EIA, Environmental Clerance and Environmental Reporting
CO5	Describe global policies and link them with local, regional and national developmental initiatives and generate report.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	**INTRODUCTION TO WEATHER AND CLIMATE**	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 – El Nino, La Nina, Southern Oscillation, Drought and Flood Scenario; Mapping weather parameters with a focus on rainfall, temperature and wind. Remote Sensing missions for weather monitoring.	7
2	**AGRICULTURE, FOREST AND CLIMATE**	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.	7
3	**SNOW, GLACIER WATER AND CLIMATE**	Surface water mapping and monitoring; snow cover mapping; snowmelt runoff forecasting; Glaciers Inventory; Glacial Mass Balance and Glacial retreat with changing climate.	7
4	**ENVIRONMENTAL IMPACT ASSESSMENT**	Scope of EIA; EIA Methods and Mitigation; Criteria and Indicators; Certification; Ecological, Economic and Demographic impact assessment. Environmental Clerance and Report Preparation as per EIA notification 2006.	7
5	**GLOBAL POLICIES**	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.	7

Learning Resources

Textbooks

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 Books

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.

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Remote sensing of greenhouse gases: OCO-2/GOSAT for CO_2 and CH_4 monitoring***
Pos met through Gaps in the Syllabus	***PO3, PO5***
Topics beyond syllabus/Advanced topics/Design	***Blue carbon ecosystems: mangrove and seagrass carbon stock mapping using remote sensing***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO1, PO3***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+A ssig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	

CO	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
CO5	2	3	2	3	3

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/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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
CO5	

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

SEMESTER II: PROGRAMME ELECTIVES

EARTH RESOURCES

Course code	RG26527 in 1st year
Course title	**REMOTE SENSING IN DISASTER MANAGEMENT**
Pre-requisite(s)	**(i) Knowledge of Basic Sciences** **(ii) Computer Knowledge**
Co-requisite	
Credits	L: 3 T: P: SL:
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 provide students with:

Sl No.	Objectives
1.	Impart basic concepts of disaster, its causes and its historical 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 (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
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 No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	**INTRODUCTION**	Natural and human induced disasters, Fundamental concept of Disaster Management, Various natural disasters and their characterization: Cyclones, Floods, Earthquakes, 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.	7
2	**RS & GIS FOR HAZARD, RISK AND DAMAGE ASSESSMENT**	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.	7
3	**LONG TERM MITIGATION MEASURES**	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. Study Science Policy gaps.	7
4	**DISASTER MANAGEMENT PLANNING**	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.	7
5	**DISASTER MODELING AND CASE STUDIES**	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. Application of Machine Learning tools.	7

Learning Resources

Textbooks

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. A. 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

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Community-based disaster risk reduction (CBDRR)***
Pos met through Gaps in the Syllabus	***PO1***
Topics beyond syllabus/Advanced topics/Design	***AI & Disaster Risk Reduction***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO2***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+A ssig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

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

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/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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 Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26529 in 1st year
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	
Credits	L: 3 T: P: SL:
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 provide students with:

Sl No.	Objectives
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)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
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	Acquire knowledge on thermal and optical properties of snow and its retreat
CO4	Able to measure depth of snow cover, snow water equivalent and snow response to microwave.
CO5	Describe implications of snowmelt models including inferences on their efficacy to describe global climate change phenomena and able to generate report.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	**GLACIAL GEOMORPHOLOGY**	Ice and related phenomena, 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.	7
2	**HYDROLOGICAL ASPECTS OF GLACIERS**	Classification of glaciers and 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.	7
3	**SPATIAL SNOW, ICE AND GLACIERS**	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, records of glacier retreat and advancement in centuries with spatial distribution.	7
4	**MEASUREMENT OF DEPTH, WATER EQUIVALENT AND AREA OF SNOW COVER**	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.	7
5	**REMOTE SENSING BASED SNOWMELT ESTIMATION, RUNOFF MODELLING AND FORECASTING**	Remote Sensing in estimating Snowmelt indices, Comparison of energy balance and index approach, observed maximum snowmelt rates, Modelling of snowmelt runoff, Storage potential, Time delay in runoff generation, Forecasting of snowmelt runoff, Simulation accuracy. Snowmelt Runoff Model (SRM), Precipitation Runoff Modelling System (PRMS), HBV Model, University of British Columbia Watershed Model (UBC).	7

Learning Resources	
Textbooks	***Reference 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.	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.

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Permafrost mapping using thermal RS data and linkages with climate change***
Pos met through Gaps in the Syllabus	***PO1, PO5***
Topics beyond syllabus/Advanced topics/Design	***Glacier dynamics modelling using machine learning (glacier retreat prediction, mass balance modelling)***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO2, PO3***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+A ssig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	

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

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/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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
CO5	CD1, CD2, CD3, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

SEMESTER II – PROGRAMME ELECTIVE (ENVIRONMENT & CLIMATE)

Course code	RG26531 in 1st year
Course title	DYNAMIC METEOROLOGY
Pre-requisite(s)	(i) Elementary knowledge of differential equations; (ii) RS 501 and RS 502
Co-requisite	
Credits	L: 3; T: 0; P: 0; C:
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	Basic concepts of different frames of reference and evolution of apparent forces.
2	Basic conservation laws of momentum, thermodynamic energy and continuity equations.
3	Diagnostic and prognostic equations in different coordinate systems.
4	Atmospheric circulation, vorticity and different types of flow.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Deep learning of basic dynamical processes.
CO2	Understanding of the use of potential vorticity; ability to diagnose and interpret atmospheric flow and instabilities.
CO3	Ability to develop ideas for analytical and numerical solutions to a problem.
CO4	Ability to formulate problems in a physical and mathematical framework.
CO5	Basic knowledge enhancement on turbulent systems.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	**BASIC CONCEPT OF DIFFERENT FORCES AND FRAMES OF REFERENCE**	Natural coordinate system, Lagrangian and Eulerian frames of reference, Inertial and non-inertial frames of reference. Pressure Gradient Force, Viscous Force, Gravitational Force, Frictional Force, Coriolis force, Centripetal and centrifugal force, Stream function, velocity potential.	7
2	**BASIC CONSERVATION LAW – I**	Conservation of momentum, Vectorial form of the momentum equation, Scale analysis of equation of motion, Introduction to Diagnostic and prognostic equation, Hydrostatic Approximation, Geostrophic Approximation, Geostrophic wind, Rossby number.	7
3	**BASIC CONSERVATION LAW – II**	Continuity equation in Eulerian and Lagrangian coordinate systems. Scale analysis of continuity equation, Thermodynamic energy equation, Scale analysis of thermodynamic energy equation, Thermodynamics of dry and moist air, Adiabatic and Pseudo-adiabatic lapse rate, Potential and equivalent potential temperature, different types of stability.	7
4	**APPLICATION TO UNDERSTAND WEATHER SYSTEMS**	Momentum, Continuity, Thermodynamic energy equations in isobaric coordinates; Geostrophic Flow, Inertial Flow, Cyclostrophic flow; Gradient wind; Thermal wind; Kinematic Method; Adiabatic Method, Surface pressure and its influence.	7
5	**CIRCULATION AND VORTICITY**	Trajectory and Streamlines, Differential equation for streamlines, Circulation, vorticity, divergence, Stokes Theorem, Divergence Theorem, Circulation theorems – Kelvin's Theorem and Bjerknes Theorem and their applications (Sea Breeze and Land Breeze); Solenoidal Vector, split of vorticity and divergence equations into rotational and irrotational terms.	7

Learning Resources

Textbooks	*Reference Books*
1. An Introduction to Dynamic Meteorology, J.R. Holton, Academic Press. 2. Dynamic Meteorology, Askel Wiin Nelson, WMO Publication.	1. Weather Forecasting Vol I and II by S. Pettersen 2. Dynamic Meteorology, A Basic Course By Adrian Gordon, Warwick Grace, Roland Byron-Scott, Peter Schwerdtfeger 3. Dynamic Meteorology by S. Panchev

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+A ssig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	

CO	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

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/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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 Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26533 in 1st year
Course title	REMOTE SENSING OF ENVIRONMENT
Pre-requisite(s)	(i) Elementary knowledge of geography and environment; (ii) RS 501 and RS 502
Co-requisite	
Credits	L: 3; T: 0; P: 0; C: 3
Class schedule per week	3
Class	M. TECH
Semester / Level	02/05 (Spring)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	Basic understanding of sustainable development and its need in the current scenario.
2	Concepts of ecosystem functions and environmental pollution monitoring.
3	Insights of EIA and EMP.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Explain the need of sustainable development in the current scenario.
CO2	Quantify energy flow in different ecosystems (forest, wetland, etc.).
CO3	Monitor environmental pollution impacts from satellite imageries.
CO4	Implement EIA methods and Environmental Management Plan.
CO5	Describe global policies on climate change and their implications.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	**RS & SUSTAINABLE DEVELOPMENT**	Sustainability and Sustainable Development. Ecological and Biological Aspects of Environment: Hydrosphere, Lithosphere, Cryosphere, Biosphere. Spectral Properties of Air, Land (Soil), Vegetation and Water. Remote Sensing for Assessment of Air, Land (Soil) and Water Quality Parameters, Sustainable Forest Management, Forest Change Detection, Forest Modelling and GIS.	7
2	**ECOSYSTEM STRUCTURE AND FUNCTION**	Kinds of Ecosystem, Structure of Ecosystem, Function of Ecosystem, Energy Flow in Ecosystem, Cycles in Ecosystems, Major Ecosystems, Productivity of Different Ecosystems, Ecosystem Modelling. Introduction to Landscape Ecology, Theories and Models in Landscape Ecology, Scaling Patterns and Processes across Landscapes, Emerging Processes in the Landscape.	7
3	**POLLUTION MONITORING**	Types of Pollution, Chemistry of Pollutants: Air, Land (Soil) and Water. Acid Rain, Smog, Green House Effect and Global Warming. Eutrophication, Water logging and Salinization.	7
4	**ENVIRONMENTAL ASSESSMENT**	Selection of Disposal Sites for Industrial and Municipal Wastes; Air, Land, and Water Quality Management; Solid Waste Management; EIA Methods and Mitigation; Criteria and Indicators; Certification; Remote Sensing and GIS in EIA and EMP. EIA reports.	7
5	**CLIMATE CHANGE AND POLICIES**	Climate Change, Energy Balance and Climate, Green House Gases and Green House Effect, Carbon Cycle, Past Climate, Climate Models, Future Climate Change. UNFCCC, Kyoto Protocol, IPCC. Review of Policies.	7

Learning Resources

Textbooks	*Reference Books*
1.Lillesand, T. M. and Kiefer, R.W., 2007, Remote Sensing and Image Interpretation, Wiley and Sons	1. Sabins, F.F. Jr., 2007, (2nd) Edition, '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, USA. 3. Jensen, J.R., 2004, Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+A ssig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	

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

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/in-plant training
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

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 Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

SEMESTER III – IV: EARTH RESOURCES / ENVIRONMENT & CLIMATE

Course code	RG26601 & RG26603 in 2nd year
Course title	**RESEARCH PROJECT (Thesis Part I and II)**
Pre-requisite(s)	**All the courses of semester I and semester II**
Co-requisite	
Credits	L: T: P: SL:
Class schedule per week	
Class	
Semester / Level	
Branch	Remote Sensing
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1	Carry out Independent Research Project addressing real life geospatial problems with sound scientific framework.
2	Prepare thematic and topographic maps from satellite data and other sources and utilise various Geospatial processing and modelling techniques.
3.	Prepare research report with acceptable quality and ethics and communicate results to stakeholders.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Identify, Collect, Compare, evaluate and summarise relevant existing literatures related to the problem in hand.
CO2	Identify Research Gaps, Develop appropriate research questions and Objectives in relation to their domain of research.
CO3	Design Research Strategy and Methodology and Create coherent geospatial database and other relevant data for each objective.
CO4	Apply Geospatial, Geostatistical, Statistical tools and techniques, and evaluate the appropriateness of results in relation to objectives and research questions.
CO5	Integrate, interpret and synthesis all results and write a scientifically sound academic report with appropriate referencing, and communicate research findings to stakeholders and in peer reviewed journal/conferences.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*

Learning Resources	
Textbooks	*Reference Books*

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Mid Evalu	Mid Evalu	Mid Evalu		
	Semester End Examination	End Evalu	End Evalu	End Evalu	End Evalu	End Evalu

Indirect Assessment	

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

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	Field/Institutional visits
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes and Course Delivery Method	
Course Outcomes	**Course Delivery Method**
CO1	CD2, CD3, CD4, CD5, CD6
CO2	CD2, CD3, CD4, CD5, CD6
CO3	CD2, CD3, CD4, CD5, CD6
CO4	CD2, CD3, CD4, CD5, CD6
CO5	CD2, CD3, CD4, CD5, CD6

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

COURSE INFORMATION

Course code	RG26541
Course title	**Real-World Operationalisation of GIS & GNSS**
Pre-requisite(s)	**Basic Computer Skills**
Co-requisite	
Credits	L:3 T:0 P:0 SL:
Class schedule per week	3
Class	All UG and PG Programs
Semester / Level	01/05 (Spring) and 02/06 (Monsoon)
Branch	Remote Sensing
Name of Teacher	

Course Objectives

This course aims to provide students with:

Sl No.	Objectives
1.	Understand basic concepts about GIS & GNSS, and able to Create 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 (COs)

Upon successful completion of the course, students will be able to

CO	Course Outcomes
CO1	Describe various GIS techniques within spatial analytical framework and handle huge spatial and non-spatial database.
CO2	Apply spatial analysis techniques of GIS software to solve environmental and societal problems and challenges.
CO3	Handle integrated geospatial techniques and apply them in solving real world problems.
CO4	Understand Satellite based positioning concepts and spatial data frames
CO5	Collect GNSS data in different survey modes and post process them to generate output to be integrated in GIS environment.

Syllabus

Module No.	*Module name*	*Detailed Contents*	*No. of Lecture*
1	BASICS OF GIS & SPATIAL DATABASE CREATION	Definition of GIS, components of GIS, Functions of GIS software, Spatial Vs Non-spatial data, Vector, Raster, Catalogue and Georeferencing Hands on GIS software: Georeferencing of raster, Geodatabase, creation of Geodatabase, types of Geodatabases Hands on GIS software: creation of Vector layer (point, line and polygon), Importing raster, vector and non-spatial data in Geodatabase	
2	TOPOLOGY & RDBMS CONCEPTS	Basics of topology and its importance, Role of RDBMS in GIS Hands on GIS software: Topology creation, correcting topological errors, non-topological editing, Linking spatial with non-spatial data.	
3	SPATIAL ANALYSIS & LAYOUT GENERATION	Vector analysis tools (Query, Overlay, Clip, Dissolve and Merge Functions), Raster analysis tools (Local, Focal, Global functions and Zonal functions) Hands on GIS software: Performing Query, Overlay, Clip, Dissolve and Merge, Layout generation (designing a map, cartographic elements, thematic mapping), Performing Raster Analysis II (DEM generation, slope generation, filtering)	
4	GLOBAL POSITIONING SYSTEM CONCEPTS	GPS positioning concept, sources of errors Hands on GNSS receivers: initial settings and creating codes and attribute table in GNSS receiver	
5	DGPS AND FIELD DATA CAPTURING	Understanding coordinate system and Datums Hands on GNSS receivers: Point, Line and Polygon Data collection using GNSS for Planimetric Measurements, Data collection with Differential Positioning, GNSS and GIS integrations output preparation	

Learning Resources	
Textbooks	***Reference 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.	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. ArcGIS 10.1 Manuals, 2016. 4. N.K.Agrawal (2004). Essentials of GPS, Spatial Network Pvt. Ltd 5. Leica. A. (2003). GPS Satellite Surveying, John Wiley & Sons. New York 6. Terry-Karen Steede (2002). Integrating GIS and the Global Positioning System, ESRI Press 7. Hofmann W.B &Lichtenegger, H. Collins (2001). Global Positioning System – Theoryand Practice, Springer-Verlag Wein, New York,. 8. Gunter Seeber (2003). Satellite Geodesy Foundations-Methods and Applications,Gruyter, Walter de GmbH.

Gaps in the Syllabus (to meet Industry/Profession requirements)	
Pos met through Gaps in the Syllabus	
Topics beyond syllabus/Advanced topics/Design	
Pos met through Topics beyond syllabus/Advanced topics/Design	

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***% Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***% Distribution***				
	Best 2 Quiz marks out of 3 Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1+ Assig	Q1+Q2 +Assig	Q2+ Assig	Q2+Q3 +Assig	Q3+ Assig
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

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

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
CO5	

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	Field/Institutional visits
CD6	Self- learning (SL) such as use of NPTEL materials and internets
CD7	Simulation

Course Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***

Course code	RG26301
Course title	PRINCIPLES OF REMOTE SENSING
Pre-requisite(s)	Basic Physics/Science/Allied subject
Co-requisite	Computer Knowledge
Credits	L: 3; T:0; P:0; SL:
Class schedule per week	3
Class	M. TECH
Semester / Level	01/05 (Monsoon)
Branch	REMOTE SENSING AND GIS
Name of Teacher	

Course Objectives *This course aims to provide students with:*	
Sl No.	Objectives
1	Concepts of remote sensing imaging, energy balance, data acquisition platforms, sensors and their characteristics
2	Fundamental knowledge of Optical, Thermal, Hyperspectral and Microwave-based Remote Sensing and their major applications

Course Outcomes (COs) *Upon successful completion of the course, students will be able to*	
CO	Course Outcomes
CO1	Understand electromagnetic radiation, principles of satellite imaging and sensing processes.
CO2	Describe different types of sensors, their characteristics and principles of various imaging and non-imaging scanners, spectroscopy.
CO3	Understand image characteristics and image correction techniques.
CO4	Explain thermal imaging mechanism and hyperspectral imaging and potential applications
CO5	Explain principles of microwave remote sensing, associated concepts and major applications

Syllabus

Module No.	***Module name***	***Detailed Contents***	***No. of Lecture***
1	CONCEPTS	Definition, Concept and Principles of Remote Sensing, Electromagnetic Radiation (EMR) and its Characteristics, Wavelength Regions and their Significance, Energy Balance Equation, Interaction of EMR with Atmosphere and Earth's Surface: Absorption, Reflectance and Scattering, Atmospheric Windows, Spectral Response and Spectral Signature, Spectral, Spatial, Radiometric and Temporal resolution. Image Interpretation keys	7
2	DATA ACQUISITION & OPTICAL REMOTE SENSING SYSTEM	Various Imaging Platforms: Aircraft and Spacecraft, UAV, Satellites for Earth and Planetary observations, Weather and Communication Satellites, Different Sensors and their Specifications. Electro-Optical Systems, Opto-Mechanical Scanners, Infrared Scanners, Scatterometer. Fundamentals of spectroscopy	5
3	IMAGE CHARACTERISTICS AND CORRECTION TECHNIQUES	Digital image and its characteristics, Image data storage and retrieval. Radiometric correction techniques, Geometrical errors and its rectification. Sources of image degradation - Image restoration and Noise Abatement, linear and nonlinear transformation for geometric corrections, Look-up Tables (LUT) and Types of image displays and FCC,	7
4	THERMAL AND HYPERSPECTRAL REMOTE SENSING	Thermal Imaging System: Basic principles and laws; Space-based thermal imaging systems; Thermal properties and Diurnal temperature of common materials; Emissivity, Characteristics and interpretation of thermal images; Land surface temperature estimation; Major applications of thermal remote sensing. Hyperspectral Sensors, data characteristics and Applications	8
5	MICROWAVE REMOTE SENSING	Microwave Remote sensing concepts: Backscattering, Range Direction, Azimuth Direction, Incident Angle, Depression Angle, Polarization, Dielectric Properties, Surface Roughness and Interpretation, Resolutions.	8

Learning Resources	
Textbooks	***Reference Books***
5. Joseph,George and Jeganathan, C. (2017). "Fundamentals of Remote Sensing", 3rd Edition, Universities press (India) Pvt. Ltd., Hyderabad. 6. Jensen, J.R. (2015). "Remote Sensing of the Environment – An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pvt. Ltd., 3rd edition. 7. Jensen, J.R. (1996). Introductory Digital Image Processing A remote sensing perspective. Prentice Hall Series in GIS, USA 8. Lillesand, Thomas M. and Kiefer, Ralph, W. (2015). "Remote Sensing and Image Interpretation", 7th Edition, John Wiley and Sons, New York.	6. Sabins, F.F. Jr. (2007). 'Remote Sensing – Principles and Interpretation", W.H. Freeman & Co. 7. Reeves, Robert G. (1991), "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA 8. Dimitris G. Manolakis, Ronald B. Lockwood, Thomas W. Cooley(2016). Hyperspectral Imaging Remote Sensing. Cambridge Press. ISBN: 9781316017876. 9. Iain H. Woodhouse (2005). Introduction to Microwave Remote Sensing. CRC Pr I Llc .ISBN- 0415271231. 10. Ruiliang Pu, Qiuyan Yu (2026). Thermal Infrared Remote Sensing-Principles and Applications. CRC Press. ISBN 9781032231808

Gaps in the Syllabus (to meet Industry/Profession requirements)	***Terrestrial sensors and their calibration***
Pos met through Gaps in the Syllabus	***PO4***
Topics beyond syllabus/Advanced topics/Design	***Integration of AI in Geospatial data sources***
Pos met through Topics beyond syllabus/Advanced topics/Design	***PO3, PO5***

Course Outcome (Co) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment	***Assessment Tool***	***%Contribution during CO Assessment***				
	Continuous Internal Assessment	50%				
	Semester End Examination	50%				
	Continuous Internal Assessment	***%Distribution***				
	Best 2 Quiz marks out of 3Quizzes of 15 marks each.	30%				
	Assignment(s)	10%				
	Seminar before a Committee	10%				
	Assessment Components	***CO1***	***CO2***	***CO3***	***CO4***	***CO5***
	Continuous Internal Assessment	Q1 + Mid term	Q2 + Mid Term	Q2 + Mid term	Mid Term	Mid Term
	Semester End Examination	End Sem	End Sem	End Sem	End Sem	End Sem

Indirect Assessment	Student Feedback on Faculty
	Student Feedback on Course Outcome

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	0	3	2	0
CO2	1	0	3	2	0
CO3	2	0	3	2	0
CO4	2	0	3	2	0
CO5	2	0	3	2	1

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
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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 Designers		
Experts from Industry	***Experts from Higher Technical Institutions***	***Internal Experts***