Course Structure
&
Syllabus

M.Tech. Remote Sensing

Department of Remote Sensing

Birla Institute of Technology

Mesra, Ranchi- 835215

Jharkhand, INDIA

Restructured and applicable from
Session 2021-22 onwards

Institute Vision

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

Institute Mission

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

Department Vision

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

Department Mission

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

Programme Educational Objectives (PEOs)	**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

PROGRAMME SCHEME - SEMESTER WISE DISTRIBUTION

S. No	Semester	Course Category	Credits	Total
1	FIRST	2 Programme Core (PC)	8	19
		1 Progammet Elective (PE)	3	
		4 LABS (2 PC + 2 PE)	8	
2	SECOND	3 Programme Core (PC)	10	19
		1 Progamme Elective (PE)	3	
		3 LABS (2 PC + 1 PE)	6	
3	THIRD	Research Project	8	14
		Open Elective (OE-I)/MOOC	3	
		Open Elective (OE-II)/MOOC	3	
4	FOURTH	Research Project	16	16
TOTAL				**68**

MASTER OF TECHNOLOGY (*Remote Sensing*)

PROGRAMME CORE (PC) (*offered in MO session only)*

S. No	Course Code	Course Title	Pre requisites / Co requisites	Credits
1	RS 501R1	Principles of Remote Sensing and Digital Satellite Image Processing	Basic Physics/Science Computer Knowledge	4
2	RS 502R1	Geographic Information System and Satellite Navigation System	Basic Sciences/ Basic Computing	4
3	RS 503	Remote Sensing and Digital Satellite Image Processing Laboratory	RS 501	2
4	RS 504	GIS &Satellite Navigation System Laboratory	RS 502	2
5	RS 515	Programming and Customisation in geospatial domain Laboratory	RS 501, RS 502	2

PROGRAMME CORE (PC) (*offered in SP session only)*

S. No	Course Code	Course Title	Pre requisites / Co requisites	Credits
1	RS 511	Aerial and Satellite Photogrammetry & Image Interpretation	RS 501	3
2	RS 512	Advanced Remote Sensing and Geospatial Modelling	RS 501, RS 502	4
3	RS 513	Aerial and Satellite Photogrammetry & Image Interpretation Laboratory	RS 511	2
4	RS 514	Advance Remote Sensing and Geospatial Modelling Laboratory	RS 512	2
5	RS 521	Data Sources, Statistics and Research Methods in Geospatial Domain	RS 501, RS502	3

ELECTIVES

Students pursuing M. Tech in Remote Sensing Technology should complete at least three (*09 credits*) courses each from the Programme Electives and atleast 2 Open electives (*06 credits*) listed below.

PROGRAMME ELECTIVE (PE) (Theory & Laboratory)

S. No	Course Code	Course Title	Pre requisites / Co requisites	Credits
GROUP-A (MO session only)				
1	RS 505	Remote Sensing in Agriculture & Forestry	RS 501 & RS 502.	3
2	RS 506	Remote Sensing in Disaster Management		3
3	RS 507	Remote Sensing in Hydrology & Water Resources		3

4	RS 508	Remote Sensing in Agriculture & Forestry Laboratory	RS 503, RS 504 & RS 505	2
5	RS 509	Remote Sensing in Disaster Management Laboratory	RS 503, RS 504 & RS 506	2
6	RS 510	Remote Sensing in Hydrology & Water Resources Laboratory	RS 503, RS 504 & RS 507	2
GROUP-B (SP session only)				
7	RS 516	Remote Sensing in Snow and Glacier Hydrology	RS 501, RS 502	3
8	RS 517	Remote Sensing in Climate Change and Environmental Impact Assessment	RS 501 & RS 502	3
9	RS 518	Remote Sensing in Snow and Glacier Hydrology Laboratory	RS 503, RS 504 & RS 516	2
10	RS 519	Remote Sensing in Climate Change and Environmental Impact Assessment Laboratory	RS 503, RS 504 & RS 517	2

OPEN ELECTIVE (OE)

These open elective courses are available only to candidates from other departments. However, all the courses (listed below) may not be announced in a semester. Students are requested to contact the department Head or Coordinator to know the availability on semester basis.

Choice A: Open Electives (beginner level)

GI 501 Principles of Remote Sensing (Theory = 3 Credits) – Monsoon Semester
GI 505 Principles of Remote Sensing (Laboratory = 2 Credits) – Monsoon Semester
RS 502 Geographic Information System and Satellite Navigation System (Theory = 3 Credits) – Monsoon Semester
RS 504 Geographic Information System and Satellite Navigation System Lab (Laboratory = 2 Credits) – Monsoon Semester
GI 509 Digital Satellite Image Processing (Theory = 4 Credits) – Spring Semester
GI 511 Digital Satellite Image Processing (Laboratory = 2 Credits) – Spring Semester
RS 520 Real World Operationalisation of GIS and GNSS (3 Credits) – Spring Semester

Choice B: Open Electives (Advanced level)

RS 511 Aerial and Satellite Photogrammetry & Image interpretation (Theory = 3 Credits) – Spring Semester
RS 513 Aerial and Satellite Photogrammetry & Image interpretation (Laboratory = 2 Credits) – Spring Semester
GI 602 Advanced Geo-Spatial Modelling and Decision Support System (Theory = 4 Credits) – Spring Semester
GI 604 Advanced Geo-Spatial Modelling and Decision Support System (Laboratory = 2 Credits) – Spring Semester
RS 507 Remote Sensing in Hydrology & Water Resources (Theory = 3 Credits) – Monsoon Semester
RS 510 Remote Sensing in Hydrology & Water Resources (Laboratory = 2 Credits) – Monsoon Semester

MINOR PRGRAMME

Minor in Remote Sensing: (minimum required credits = 12) (Only for Students from OTHER DEPARTMENTS). Subjects can be chosen from the list of Open Electives.

Beginner Level Credit Requirement = 6 Credits
Advanced Level Credit Requirement = 6 Credits

COURSE STRUCTURE

SEMESTER - I

	Course Category	Course Code	Subjects	L	T	P	Credit
SEMESTER-I	PC	RS 501R1	Principles of Remote Sensing and Digital Satellite Image Processing	3	1	0	4
		RS 502R1	Geographic Information System and Satellite Navigation System	3	1	0	4
		RS 503	Remote Sensing and Digital Satellite Image Processing Laboratory	0	0	4	2
		RS 504	Geographic Information System&Satellite Navigation SystemLaboratory	0	0	4	2
		RS 515	Programming and Customisation in geospatial domain Laboratory	0	0	4	2
	PE	RS *	ELECTIVE – I	3	0	0	3
		RS *	ELECTIVE – I Laboratory	0	0	4	2
	Total Credits (1st Semester)						**19**

SEMESTER – II

	Course Category	Course Code	Subjects	L	T	P	Credit
SEMESTER-II	PC	RS 511	Aerial and Satellite Photogrammetry & Image Interpretation	3	0	0	3
		RS 512	Advanced Remote Sensing and Geospatial Modelling	3	1	0	4
		RS 513	Aerial and Satellite Photogrammetry & Image Interpretation Laboratory	0	0	4	2
		RS 514	Advanced Remote Sensing and Geospatial Modelling Laboratory	0	0	4	2
		RS 521	Data Sources, Statistics and Research Methods in Geospatial Domain	3	0	0	3
	PE	RS *	ELECTIVE – II	3	0	0	3
		RS *	ELECTIVE – II Laboratory	0	0	4	2
	Total Credits (2ndSemester)						**19**

SEMESTER – III

	Course Category	Course Code	Subjects	L	T	P	Credit
SEMESTER-III	PC	RS 601	Thesis (Part – I)				8
	OE I	**OPEN ELECTIVE / MOOC**		3	0	0	3
	OE II	**OPEN ELECTIVE / MOOC**		3	0	0	3
	Total Credits (3rdSemester)						**14**

SEMESTER – IV

	Course Category	Course Code	Subjects	L	T	P	Credit
SEMESTER-IV	PC	RS 604	Thesis (Part – II)				16
	Total Credits (4thSemester)						**16**

TOTAL = 68 credits

PROGRAMME ELECTIVES

Course No.	Course Title

PE-I (Semester-I)

RS 505	Remote Sensing in Agriculture & Forestry
RS 506	Remote Sensing in Disaster Management
RS 507	Remote Sensing in Hydrology & Water Resources
RS 508	Remote Sensing in Agriculture & Forestry Laboratory
RS 509	Remote Sensing in Disaster Management Laboratory
RS 510	Remote Sensing in Hydrology & Water Resources Laboratory

PE-II (Semester- II)

RS 516	Remote Sensing in Snow and Glacier Hydrology
RS 517	Remote Sensing in Climate Change and Environmental Impact Assessment
RS 518	Remote Sensing in Snow and Glacier Hydrology Laboratory
RS 519	Remote Sensing in Climate Change and Environmental Impact Assessment Laboratory

THESIS (Programme Core)

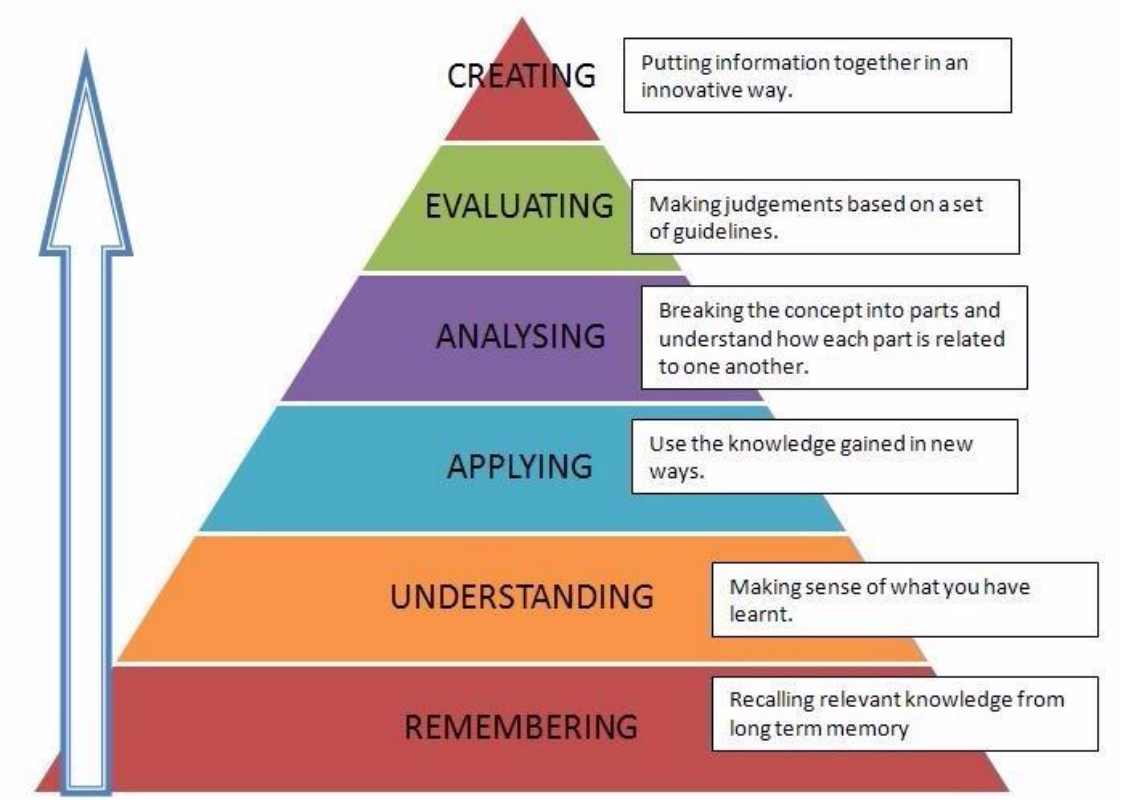
RS 601 - Thesis (Part – I) – Focus on Problem definition, Literature Review, Data Collection, Objectives and Research Qeustions Formulation and Detailed Work Plan, and partial fulfillment of initial objectives.

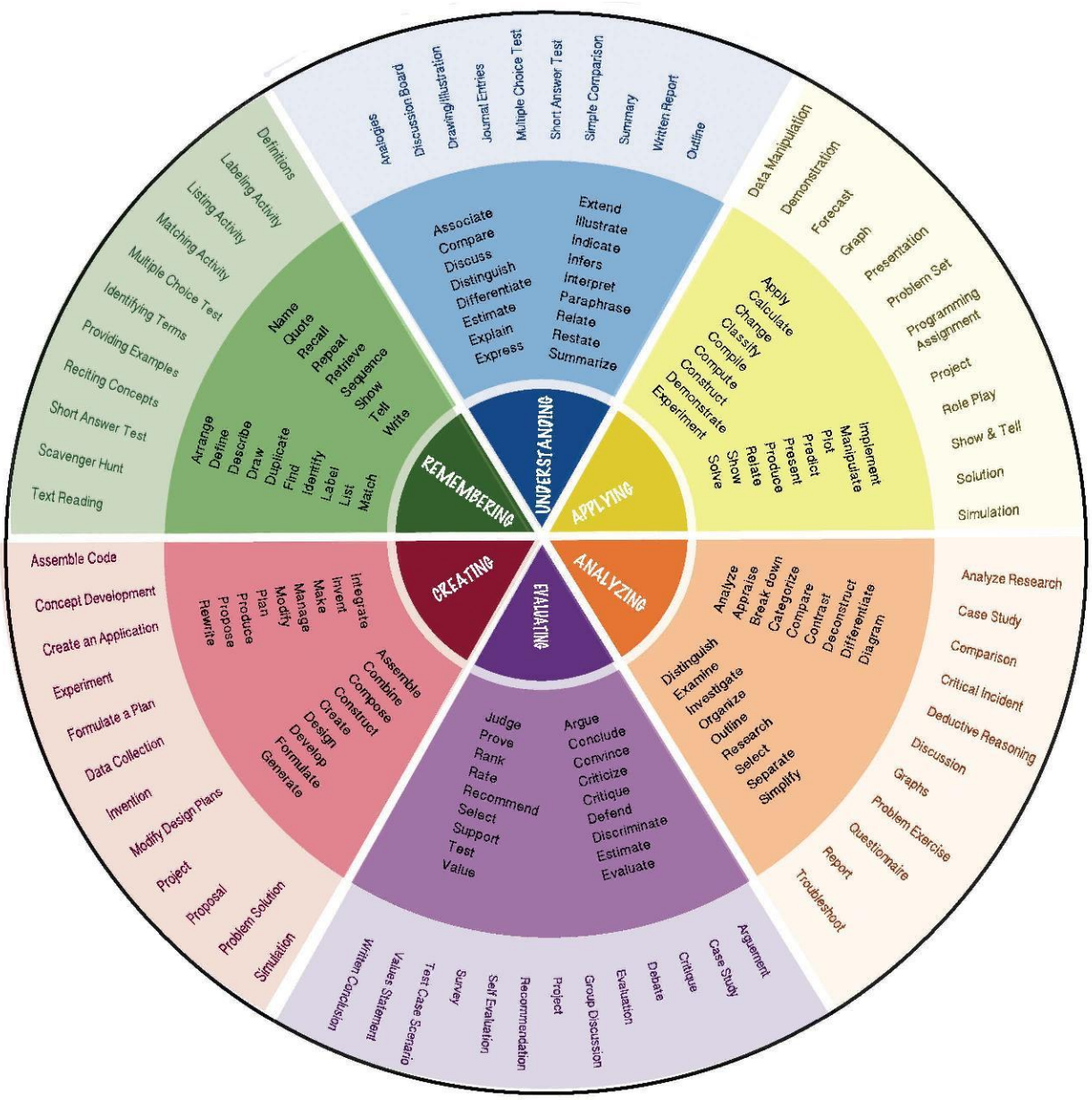
RS 604 - Thesis (Part – II) – Focus on systematic execution of work plan, data processing, analysis, interpretation, inferences and fulfillment of objectives and research questions, and report preparation, and finally leading to a research publication in peer reviewed journals.

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.




REMEMBERING
UNDERSTANDING
APPLYING
ANALYZING
EVALUATING
CREATING
Definitions
Labeling Activity
Listing Activity
Matching Activity
Multiple Choice Test
Identifying Terms
Providing Examples
Reciting Concepts
Short Answer Test
Scavenger Hunt
Text Reading
Name
Quote
Recall
Repeat
Retrieve
Sequence
Show
Tell
Write
Arrange
Define
Describe
Draw
Duplicate
Find
Identify
Label
List
Match
Analogies
Discussion Board
Drawing/Illustration
Journal Entries
Multiple Choice Test
Short Answer Test
Simple Comparison
Summary
Written Report
Outline
Associate
Compare
Discuss
Distinguish
Differentiate
Estimate
Explain
Express
Extend
Illustrate
Indicate
Infers
Interpret
Paraphrase
Relate
Restate
Summarize
Data Manipulation
Demonstration
Forecast
Graph
Presentation
Problem Set
Programming Assignment
Project
Role Play
Show & Tell
Solution
Simulation
Apply
Calculate
Change
Classify
Compile
Compute
Construct
Demonstrate
Experiment
Implement
Manipulate
Plot
Predict
Present
Produce
Relate
Show
Solve
Analyze
Appraise
Break down
Categorize
Compare
Contrast
Deconstruct
Differentiate
Diagram
Distinguish
Examine
Investigate
Organize
Outline
Research
Select
Separate
Simplify
Analyze Research
Case Study
Comparison
Critical Incident
Deductive Reasoning
Discussion
Graphs
Problem Exercise
Questionnaire
Report
Troubleshoot
Argue
Conclude
Convince
Criticize
Critique
Defend
Discriminate
Estimate
Evaluate
Judge
Prove
Rank
Rate
Recommend
Select
Support
Test
Value
Argument
Case Study
Critique
Debate
Evaluation
Group Discussion
Project
Recommendation
Self Evaluation
Survey
Test Case Scenario
Values Statement
Written Conclusion
Assemble
Combine
Compose
Construct
Create
Design
Develop
Formulate
Generate
Integrate
Invent
Make
Manage
Modify
Plan
Produce
Propose
Rewrite
Assemble Code
Concept Development
Create an Application
Experiment
Formulate a Plan
Data Collection
Invention
Modify Design Plans
Project
Proposal
Problem Solution
Simulation

M. Tech. (REMOTE SENSING)

SEMESTER II

Course code: RS 511
Course title: AERIAL AND SATELLITE PHOTOGRAMMETRY & IMAGE INTERPRETATION
Pre-requisite(s): Student must have the knowledge of Remote Sensing, GIS & GNSS
Co- requisite(s): Basic understanding of various satellite data

Credits:	**L:**	**T:**	**P:**	**C:**
	3	**0**	**0**	**3**

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 make the students:

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

Course Outcomes (COs):

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

CO1	Explain the historic developments in the field of Photogrammetry, and image interpretation concepts.
CO2	Carry out plannimetric measurements and principles with reference to Aerial and Satellite High Resolution Images.
CO3	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.

MODULE 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.

MODULE 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.

MODULE 3: ANALYTICALPHOTOGRAMMETRY

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

MODULE 4: DIGITAL PHOTOGRAMMETRY

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

MODULE 5: TERRAIN MODELING WITH UAV

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

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

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

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

Low = 1, Medium = 2, High= 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

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

CO4	CD1, CD2, CD3, CD6
CO5	CD1, CD2, CD3, CD4, CD6

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

Credits:	**L:**	**T:**	**P:**	**C:**
	3	**1**	**0**	**4**

Class schedule per week: 4
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to make the students:

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

Course Outcomes (COs):

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

CO1	Describe various advanced RS & GIS tools and techniques within spatial analytical framework to solve natural, environmental and societal problems and challenges.
CO2	Relate backscattering signals from different surfaces to physical processes, and understand SAR processing techniques.
CO3	Make use of thermal and hyperspectral data for real world applications (analysing Urban Heat Island problem, estimation of surface composition, forest species identification etc.).
CO4	Utilise sampling concepts, point pattern analysis, time-series analysis for various real life problems and associated uncertainty and errors.
CO5	Explain WebGIS concepts and able to use various scripting languages, web tools in implementing GIS functions on web.

MODULE 1: Advances in Thermal and Microwave Remote sensing

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

MODULE 2: Hyperspectral and LASER Remote sensing

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

MODULE 3: Spatial Patterns, Processes and Uncertainty Modelling

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

MODULE 4: Geo-spatial Modelling and TimeSeries Analysis

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

MODULE 5: Web GIS

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

TEXT BOOKS:

1. Floyd M. Henderson et.al.(1998). Imaging Radar (Manual of Remote Sensing, Volume 2) 3rd Edition , Wiley.
2. Dale A. Quattrochi et.al. (2004). Thermal Remote Sensing in Land Surface Processing.CRC Press.
3. Marcus Borengasser et.al. (2007). Hyperspectral Remote Sensing: Principles and Applications ,*CRC Press.*
4. Mitchell, Andy (2012). The Esri Guide to GIS Analysis, Volume 3: Modeling Suitability, Movement, and Interaction. Redlands, CA, Esri Press.
5. Yue-hong Chou (1997). Exploring Spatial Analysis in Geographical Information System. Onword Press. Thomson Learning.
6. Devillers, R. and Jeansoulin, R. (2006). Fundamentals of Spatial Data Quality. ISTE Ltd., USA.

REFERENCE MATERIALS:

1. ArcGIS Resource Center Web APIs, http://resources.arcgis.com/content/web/web-apis
2. ArcGIS JavaScript APIs, http://help.arcgis.com/en/webapi/javascript/arcgis/
3. ArcGIS JavaScript API Samples, https://developers.arcgis.com/en/javascript/jssamples/
4. Parker, D.C., Manson, S.M., Janssen, A., Hoffmann, M. and Deadman, P. (2003). Multi-agent systems for the simulation of land use and land cover change. A Review. Annals of the Association of American Geographer, 93(2).

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

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

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

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5
CO1	3	1	2	3	3

CO2	2	2	3	3	2
CO3	3		2	3	3
CO4	3	1	2	3	3
CO5	2	2	3	3	1

Low = 1, Medium = 2, High= 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

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

Course code: RS 521
Course title: DATA SOURCES, STATISTICS AND RESEARCH METHODS IN GEOSPATIAL DOMAIN
Pre-requisite(s): Knowledge of statistics
Co- requisite(s): (ii) Student must have undergone RS 501R1, RS 502R1

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

Class schedule per week: 3
Class: M.Sc.
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to make the students:

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

Course Outcomes (CO):

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

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

SYLLABUS

MODULE 1: GEO-SPATIAL RESEARCH & DATA SOURCES

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

MODULE 2: FIELD AND PROJECT REQUIREMENTS

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

MODULE 3: SAMPLING AND STATISTICS

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

MODULE 4: METHODS IN GEOINFORMATICS

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

MODULE 5: TOOLS, QUALITY AND ETHICS

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

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

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

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

Low = 1, Medium = 2, High= 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

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

ELECTIVES

Course code: RS 516
Course title: REMOTE SENSING IN SNOW AND GLACIER HYDROLOGY
Pre-requisite(s): (i) Knowledge of Basic Sciences
(ii) Student must have undergone RS 501, RS 502

Co- requisite(s):

Credits:	**L:**	**T:**	**P:**	**C:**
	3	**0**	**0**	**3**

Class schedule per week: 3
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to:

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

Course Outcomes (Cos)

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

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

MODULE 1: GLACIAL GEOMORPHOLOGY

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

MODULE 2: HYDROLOGICAL ASPECTS OF GLACIERS

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

MODULE 3: SPATIAL SNOW, ICE AND GLACIERS

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

MODULE 4: MEASUREMENT OF DEPTH, WATER EQUIVALENT AND AREA OF SNOW COVER

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

MODULE 5: REMOTE SENSING BASED SNOWMELT ESTIMATION, SNOWMELT RUNOFF MODELING AND FORCASTING

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

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

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

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

Low = 1, Medium = 2, High= 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

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

Course code: RS 517
Course title: REMOTE SENSING IN CLIMATE CHANGE AND ENVIRONMENTAL IMPACT ASSESSMENT
Pre-requisite(s): (i) Knowledge of Basic Sciences
(ii) Student must have undergone RS 501, RS 502

Co- requisite(s):

Credits:	**L:**	**T:**	**P:**	**C:**
	3	**0**	**0**	**3**

Class schedule per week: 3
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to:

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

Course Outcomes (Cos):

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

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

MODULE 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 - Elnino, LaNino, Southern Oscillation, Drought and Flood Scenario; Mapping weather parameters with a focus on rainfall, temperature and wind. Remote Sensing missions for weather monitoring.

MODULE 2: AGRICULTURE, FOREST AND CLIMATE

Vegetation growth rhythm and climatic interaction; Food security, Drought monitoring and forecast; Weather dependence of Agriculture; Climate change impact on agriculture economy.

Carbon accounting with climate change scenario; Time-Series Satellite data; space-time dynamics; Phenology of Vegetation; Global changes in phenology; Droughts in Amazon and monitoring mechanism; Forest Fire and climate change.

MODULE 3: SNOW, GLACIER WATER AND CLIMATE

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

MODULE 4: ENVIRONMENTAL IMPACT ASSESSMENT

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

MODULE 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.

TEXT BOOKS:

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

REFERENCE MATERIALS:

1. ECA (Economics of Climate Adaptation) (2009). Shaping climate resilient development: a framework for decision making. ClimateWorks Foundation, Global Environment Facility, European Commission, McKinsey & Company, The Rockefeller Foundation, Standard Chartered Bank and Swiss Re. 164pp.
2. FAO (2015). Booklet on FAO's work on Climate Change. Job Number 15165.
3. FAO (2016). Planning, implementing and evaluating Climate-Smart Agriculture in Smallholder Farming Systems. Job Number 15805. Report under Mitigation of Climate Change in Agriculture (MICCA) Programme of FAO. ISBN: 978925109305.
4. IPCC (2014). IPCC Assessment Report. UNFCCC.
5. Kulkarni, A., I.M. Bahuguna, B.P. Rathore, S.K. Singh, S.S. Randhawa, R.K. Sood and S. Dhar (2007). Glacial retreat in Himalaya using Indian Remote Sensing satellite data. Current Science, Vol. 92, No. 1.
6. Lal, M., T. Nozawa, S. Emori, H. Harasawa, K. Taka, A. Abe-Ouchi, T. Nakajima, T. Takemura and A. Numaguti (2001). Future climate change: Implications for Indian summer monsoon and its variability. Current Science, Vol. 81, No. 9, 10.
7. Milly, P.C.D., R.T. Wetherald, K.A. Dunne and T.L. Delworth (2002). Increasing risk of great floods in a changing climate. Nature Vol 415: 514–517.

8. Rees, H.G. and D.N. Collins (2006). Regional differences in response of flow in glacier-fed Himalayan rivers to climatic warming. Hydrological Processes, 20 (10). 2157–2169. 10.5002/hyp.6209.
9. Schmidhuber, J. and F. Tubiello (2007). Global food security under climate change. PNAS 104 (50) 19703–19708.
10. Tubiello, F. and G. Fischer (2007). Reducing climate change impacts on agriculture: Global and regional effects of mitigation, 2000–2080 Technological Forecasting & Social Change 74 1030–1056.
11. USDA (ed Walsh, M) (2008). The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States. U.S. Climate Change Science Program Synthesis and Assessment Product 4.3.
12. WWF (2005). An Overview of Glaciers, Glacier Retreat, and Subsequent Impacts in Nepal, India and China. Kathmandu. Nepal.
13. World Bank (2010). Economics of Adaptation to Climate Change: Synthesis Report. Washington DC. 100pp.
14. World Bank (2009b). Water and Climate Change: Impacts on groundwater resources and adaptation options. Water Unit Energy, Transport, and Water Department. Washington DC. 98pp.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

Course Delivery Methods

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

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAMME OUTCOMES

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

Low = 1, Medium = 2, High= 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

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

LABORATORIES

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

Credits:	**L:**	**T:**	**P:**	**C:**
	0	**0**	**4**	**2**

Class schedule per week: 4
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

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

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

Course Outcomes (CO):
On completion of this course, students should be able to:

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

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

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

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

Lab 6 Differential parallax measurement and contouring by parallax bar method

Lab 7 Digital Stereoscopic Model - Non-Oriented Approach

Lab 8 Digital Stereoscopic Model - Interior & Exterior Orientation

Lab 9 Digital Stereoscopic Model - 3D based Plannimetric Measurements

Lab 10 Digital Ortho-Rectification - Relief Displacement Correction

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

Lab 12-13 UAV based Data acquisition and Modelling.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & 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%

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping Course Outcome with Programme Outcome

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

Low = 1, Medium = 2, High= 3

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

Credits:	**L:**	**T:**	**P:**	**C:**
	0	**0**	**4**	**2**

Class schedule per week: 4
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

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

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

Course Outcomes (CO):
On completion of this course, students should be able to:

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

Lab 1 Handling Thermal and Microwave Data

Lab 2 Modelling Urban Heat Island using Thermal data

Lab 3 SAR data processing and applications

Lab 4 Hyperspectral data processing

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

Lab 6 LIDAR data Processing

Lab 7 Surface Interpolation using Krigingtechnique

Lab 8 Spatial Pattern Analysis using GIS

Lab 9 Understanding Two-point and Multi-point Statistics

Lab 10 Modelling Resolution Uncertainty and Error in the Spatial Data

Lab 11 Spatial Regression and Geographically Weighted Regression

Lab 12 Smoothingand information extraction using Time Series Data

Lab 13 WebGIS relatedservices, programmingand Scripting

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & 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%

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping Course Outcome with Programme Outcome

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

Low = 1, Medium = 2, High= 3

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

Credits:	**L:**	**T:**	**P:**	**C:**
	0	**0**	**4**	**2**

Class schedule per week: 4
Class: M. TECH
Semester / Level: 02 /05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to impart practical knowledge about:

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

Course Outcomes (CO):
On completion of this course, students should be able to:

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

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

Lab 2-3 On-Screen glacial landform mapping

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

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

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

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

Lab 10 Generation of Snow Indices for delineating snow cover.

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

Lab 13 Wet SCA estimation using SAR data.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & 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%

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping Course Outcome with Programme Outcome

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

Low = 1, Medium = 2, High= 3

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

Credits:	**L:**	**T:**	**P:**	**C:**
	0	**0**	**4**	**2**

Class schedule per week: 4
Class: M. TECH
Semester / Level: 02/05 (Spring)
Branch: REMOTE SENSING
Name of Teacher:

Course Objectives

This course aims to make the student with following abilities:

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

Course Outcomes (CO):
On completion of this course, students should be able to:

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

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

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

Lab 3 Biomass and CarbonAccounting using RS & GIS.

Lab 4 Vegetation Phenology using Time-Series RS data.

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

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

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

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

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

Lab 13 Sustainability and Certification Methods.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & 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%

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping Course Outcome with Programme Outcome

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

Low = 1, Medium = 2, High= 3