# BIRLA INSTITUTE OF TECHNOLOGY

## CHOICE BASED CREDIT SYSTEM (CBCS) CURRICULUM

***(Effective from Academic Session: Monsoon 2018)***

## M. TECH REMOTE SENSING

## DEPARTMENT OF REMOTE SENSING

## Institute Vision

To become a Globally Recognised 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 Under Graduate, 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 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)**

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

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

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

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

**Programme Outcomes (POs)**

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

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

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

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

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

## PROGRAMME COURSE STRUCTURE

### SEMESTER - I

| | Course Category | Course Code | Subjects | L | T | P | Credit |
|---|---|---|---|---|---|---|---|
| SEMESTER-I | PC | RS 501 | Principles of Remote Sensing and Digital Satellite Image Processing | 3 | 0 | 0 | 3 |
| | | RS 502 | Geographic Information System and Satellite Navigation System | 3 | 0 | 0 | 3 |
| | | 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 |
| | PE | RS * | ELECTIVE – I | 3 | 0 | 0 | 3 |
| | | RS * | ELECTIVE – I Laboratory | 0 | 0 | 4 | 2 |
| | OE | OPEN ELECTIVE | | 3 | 0 | 0 | 3 |
| | Total Credits (1st Semester) | | | | | | **18** |

### 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 515 | Programming and Customisation in geospatial domain Laboratory | 0 | 0 | 4 | 2 |
| | PE | RS * | ELECTIVE – II | 3 | 0 | 0 | 3 |
| | | RS * | ELECTIVE – II Laboratory | 0 | 0 | 4 | 2 |
| | OE | OPEN ELECTIVE | | 3 | 0 | 0 | 3 |
| | Total Credits (2ndSemester) | | | | | | **21** |

## SEMESTER – III

| | Course Category | Course Code | Subjects | L | T | P | Credit |
|---|---|---|---|---|---|---|---|
| SEMESTER-III | PC | RS 601 | Thesis (Part – I) | | | | 8 |
| | | RS 602 | Data Sources, Statistics and Research Methods in Geospatial Domain | 3 | 1 | 0 | 4 |
| | OE | OPEN ELECTIVE / MOOC (excluding already taken courses) | | 3 | 0 | 0 | 3 |
| | Total Credits (3rd Semester) | | | | | | **15** |

## SEMESTER – IV

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

**TOTAL = 70 credits**

***ELECTIVE SUBJECTS**

**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

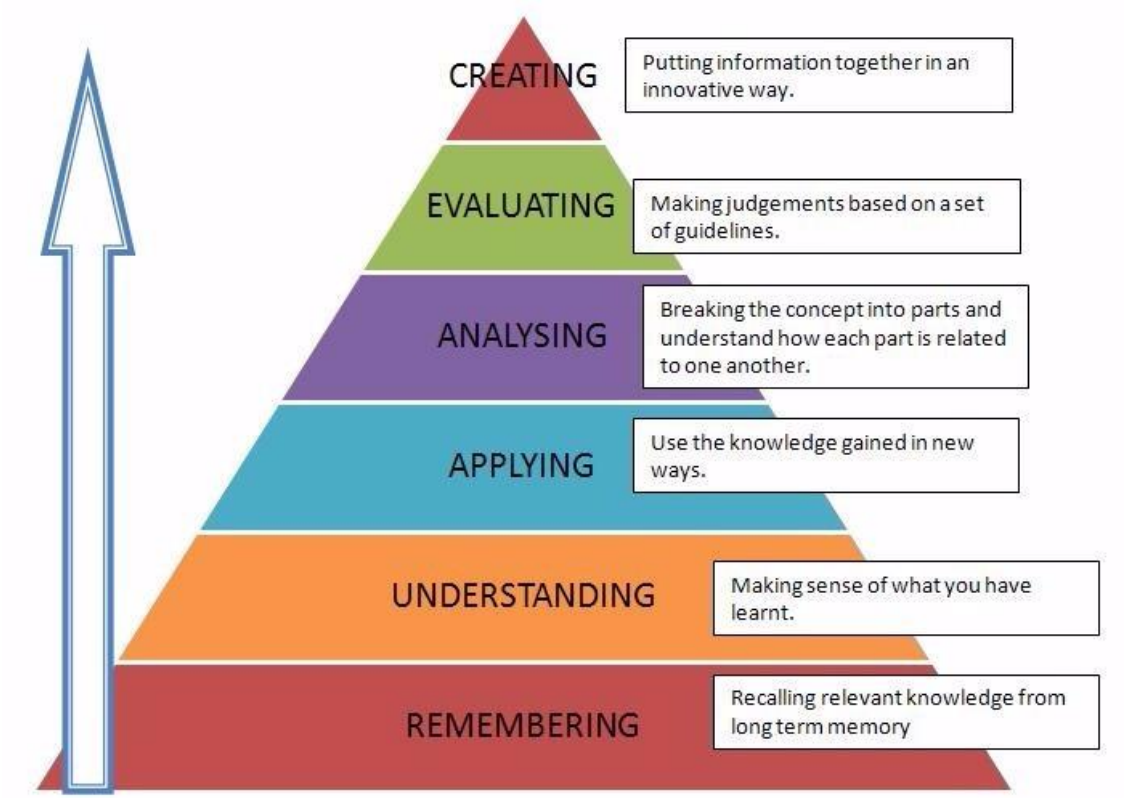
**Thesis (Part – I) –** Focus on Problem definition, Literature Review, Data Collection, Objectives and Research Qeustions Formulation and Detailed Work Plan, and partial fulfillment of initial objectives.

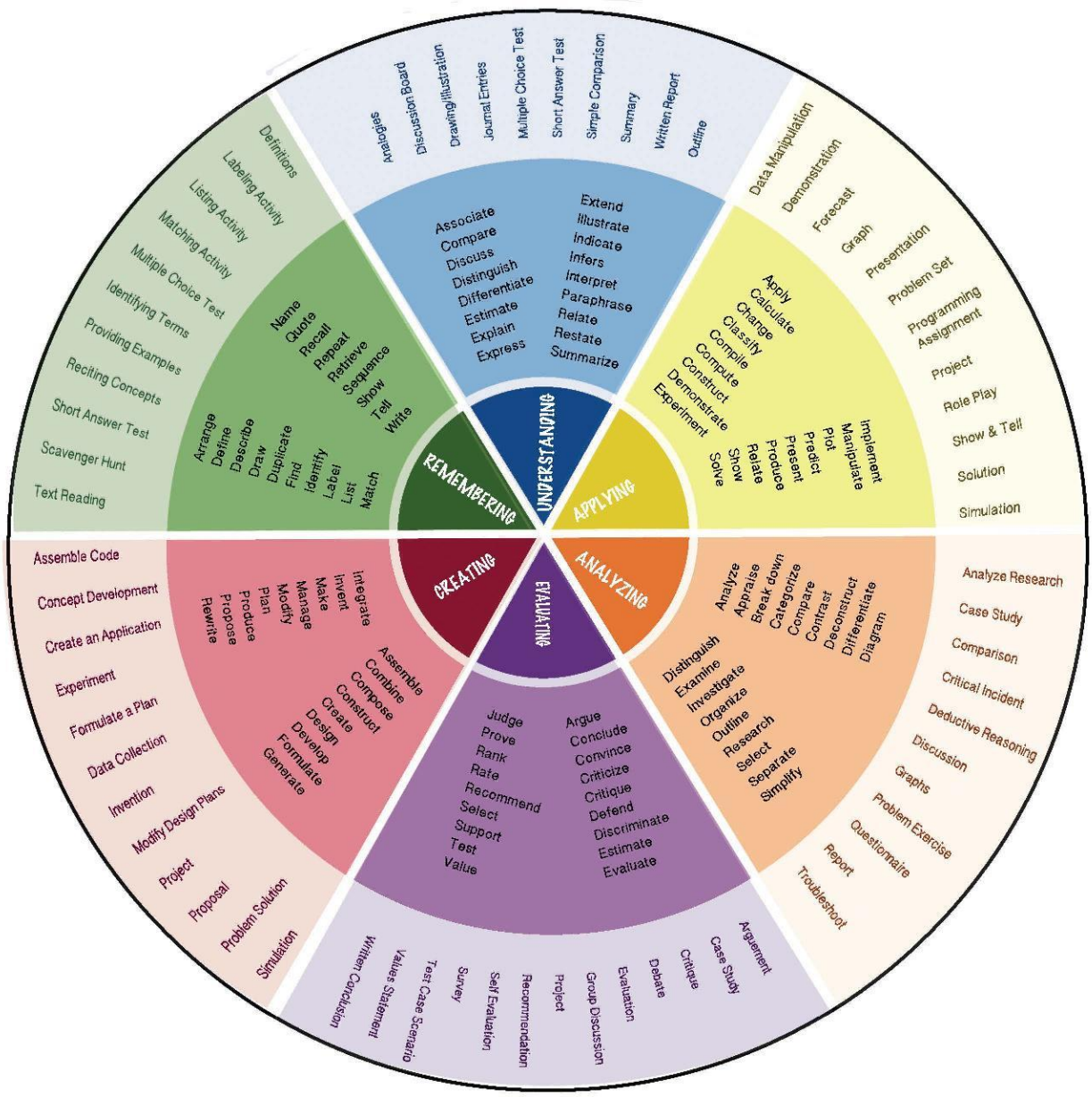
**Thesis (Part – II) –** Focus on systematic execution of work plan, data processing, analysis, interpretation, inferences and fulfillment of objectives and research questions, and report preparation, and finally leading to a research publication in peer reviewed journals.

**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
Name
Quote
Recall
Repeat
Retrieve
Sequence
Show
Tell
Write
Arrange
Define
Describe
Draw
Duplicate
Find
Identify
Label
List
Match
Definitions
Labeling Activity
Listing Activity
Matching Activity
Multiple Choice Test
Identifying Terms
Providing Examples
Reciting Concepts
Short Answer Test
Scavenger Hunt
Text Reading
Associate
Compare
Discuss
Distinguish
Differentiate
Estimate
Explain
Express
Extend
Illustrate
Indicate
Infers
Interpret
Paraphrase
Relate
Restate
Summarize
Analogies
Discussion Board
Drawing/Illustration
Journal Entries
Multiple Choice Test
Short Answer Test
Simple Comparison
Summary
Written Report
Outline
Apply
Calculate
Change
Classify
Compile
Compute
Construct
Demonstrate
Experiment
Implement
Manipulate
Plot
Predict
Present
Produce
Relate
Show
Solve
Data Manipulation
Demonstration
Forecast
Graph
Presentation
Problem Set
Programming Assignment
Project
Role Play
Show & Tell
Solution
Simulation
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

## COURSE INFORMATION SHEET

**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. |

**SYLLABUS:**

| MODULE | (NO. OF LECTURE HOURS) |
|---|---|
| **Module – I Environmental Mapping& Interpretation**<br>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. | **8** |
| **Module – II Geometry of Aerial Photographs**<br>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. | **9** |
| **Module – III Analytical Photogrammetry**<br>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, analyticalaero-triangulation, bundle adjustment with GNSS, Aero-triangulation with Satellite images, strategies for aero-triangulation. | **9** |
| **Module – IV Digital Photogrammetry**<br>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** |
| **Module – V Terrain modeling with UAV** | **7** |

| | |
|---|---|
| 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 Course Outcome

**Course Evaluation:**

Individual assignment, Quizes, Mid and End semester examinations

**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 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Course Delivery (CD) methods**

| **CD Code** | **Course Delivery Methods** |
|---|---|
| CD1 | Lecture by use of Boards/LCD Projectors |
| CD2 | Tutorials/Assignments |
| CD3 | Seminars |
| CD4 | Mini Projects/Projects |
| CD5 | Laboratory Experiments/Teaching Aids |
| CD6 | Industrial/Guest Lectures |
| CD7 | Industrial Visits/In-plant Training |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |
| CD9 | Simulation |

## MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1, CD2, CD3, CD8 |
| CO2 | CD1, CD2, CD3, CD8 |
| CO3 | CD1, CD2, CD3, CD8 |
| CO4 | CD1, CD2, CD3, CD5, CD6, CD8 |
| CO5 | CD1, CD2, CD3, CD5, CD6, CD8 |

**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 RS502**
**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:**

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

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

**SYLLABUS:**

| MODULE | (NO. OF LECTURE HOURS) |
|---|---|
| **Module – I Advances in Thermal and Microwave Remote sensing**<br>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, coal fire extent, energy balance, etc. | **8** |
| **Module – II Hyperspectral and LASER Remote sensing**<br>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.. | **8** |
| **Module – III Spatial Patterns, Processes and Uncertainty Modelling**<br>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** |
| **Module – IV Geo-spatial Modelling and Time Series Analysis**<br>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. | **9** |
| **Module – V Web GIS**<br>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, Application Programming Interfaces (APIs), GeoServer, NSDI, Census GIS, BHUVAN, Crowd Sourcing. | **8** |

**TEXT BOOKS:**


1. Floyd M. Hendersonet.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.


**REFERENCES:**


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 Course Outcome

### Course Evaluation:

Individual assignment, Quizes, Mid and End semester examinations

### 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 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Course Delivery (CD) methods**

| CD Code | Course Delivery Methods |
|---|---|
| CD1 | Lecture by use of Boards/LCD Projectors |
| CD2 | Tutorials/Assignments |
| CD3 | Seminars |
| CD4 | Mini Projects/Projects |
| CD5 | Laboratory Experiments/Teaching Aids |
| CD6 | Industrial/Guest Lectures |
| CD7 | Industrial Visits/In-plant Training |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |
| CD9 | Simulation |

## MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1, CD2, CD3, CD8 |
| CO2 | CD1, CD2, CD3, CD8 |
| CO3 | CD1, CD2, CD3, CD8 |
| CO4 | CD1, CD2, CD3, CD5, CD6, CD8 |
| CO5 | CD1, CD2, CD3, CD5, CD6, CD8 |

## 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:**

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

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

**Syllabus**

| MODULE | (NO. OF LECTURE HOURS) |
|---|---|
| **Module – I Glacial Geomorphology**<br>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 | **9** |
| **Module – II Hydrological aspects of glaciers**<br>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. | **7** |
| **Module – III Spatial snow, ice and glaciers**<br>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. | **7** |
| **Module – IV Measurement of depth, water equivalent and area of snow cover**<br>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. | **8** |
| **Module – V Remote Sensing based snowmelt estimation, snowmelt runoff modeling and forecasting**<br>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. | **9** |

**TEXT BOOKS:**


1. Tedesco, M. (2015). Remote Sensing 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 Course Outcome

**Course Evaluation:**
Individual assignment, Quizes, End semester examinations

**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 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Course Delivery (CD) methods**

| CD Code | Course Delivery Methods |
|---|---|
| CD1 | Lecture by use of Boards/LCD Projectors |
| CD2 | Tutorials/Assignments |
| CD3 | Seminars |
| CD4 | Mini Projects/Projects |
| CD5 | Laboratory Experiments/Teaching Aids |
| CD6 | Industrial/Guest Lectures |
| CD7 | Industrial Visits/In-plant Training |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |
| CD9 | Simulation |

## MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1, CD2, CD3, CD8 |
| CO2 | CD1, CD2, CD3, CD5, CD8 |
| CO3 | CD1, CD2, CD3, CD6, CD8 |
| CO4 | CD1, CD2, CD3, CD5, CD6, CD8 |

**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 modeling using remote sensing and GIS. |

**Course Outcomes:**

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 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 water bodies, glaciers, and drought impact from satellite imageries. |
| **CO4** | Describe global policies and EIA methods, and link them with local, regional and national developmental initiatives and generate report. |

**SYLLABUS**

| MODULE | (NO. OF LECTURE HOURS) |
|---|---|
| **Module – I Introduction to Weather and Climate**<br>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. | **10** |
| **Module – II Agriculture, Forest and Climate**<br>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. | **10** |
| **Module – III Snow, Glacier Water and Climate**<br>Surface water mapping and monitoring; snow cover mapping; snowmelt runoff forecasting; Glaciers Inventory; Glacial Mass Balance and Glacial retreat with changing climate. | **7** |
| **Module – IV Environmental Impact Assessment**<br>Scope of EIA; EIA Methods and Mitigation; Criteria and Indicators; Certification; Ecological, Economical and Demographic impact assessment. | **6** |
| **Module – V Global Policies**<br>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** |

**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 Course Outcome

**Course Evaluation:**
Individual assignment, Quizes, and End semester examinations

### 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**

### Course Delivery (CD) methods

| CD Code | Course Delivery Methods |
|---|---|
| CD1 | Lecture by use of Boards/LCD Projectors |
| CD2 | Tutorials/Assignments |
| CD3 | Seminars |
| CD4 | Mini Projects/Projects |
| CD5 | Laboratory Experiments/Teaching Aids |
| CD6 | Industrial/Guest Lectures |
| CD7 | Industrial Visits/In-plant Training |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |

| | |
|---|---|
| CD9 | Simulation |

## MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

| Course Outcomes | Course Delivery Method |
|---|---|
| CO1 | CD1, CD2, CD3, CD8 |
| CO2 | CD1, CD2, CD3, CD5, CD8 |
| CO3 | CD1, CD2, CD3, CD5, CD8 |
| CO4 | CD1, CD2, CD3, CD6, CD8 |

# Laboratory related subjects

**Course code: RS 513**
**Course title: AERIAL AND SATELLITE PHOTOGRAMMETRY &IMAGE INTERPRETATIONLABORATORIES**
**Pre-requisite(s): Basic theoretical knowledge of RS, GIS and associated software**
**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 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 manually and using computers. |

**Course Outcomes:**

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 land cover 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 HighSpatial 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 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 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Course Delivery Methods**

| | |
|---|---|
| CD1 | Laboratory experiments |

**Course code: RS 514**
**Course title: AdvanceD Remote Sensing and Geospatial ModellingLaboratory**
**Pre-requisite(s): Basic theoretical knowledge of RS, GIS and associated software**
**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:**

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

| | |
|---|---|
| **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. |

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 Kriging technique
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 Smoothing and information extraction using Time Series Data
Lab 13 WebGIS relatedservices, programming and 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 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 Delivery Methods

| | |
|---|---|
| CD1 | Laboratory experiments |

**Course code: RS 515**
**Course title: PROGRAMMING AND CUSTOMISATION IN GEOSPATIAL DOMAIN LABORATORY**
**Pre-requisite(s): Computer skills**
**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 following practical knowledge to students:

| | |
|---|---|
| A. | Practically carry out programming concepts learned in theory class. |
| B. | Write simple to advanced programming in different languages. |

**Course Outcomes:**

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

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

Lab 1. Introduction to computers & programming concept
Lab 2. Programming using concepts of Variables, Operators
Lab 3. Programming using Control Structures
Lab 4. Programming using Decision Making
Lab 5 Programming using Functions
Lab 6 Programming using Arrays& Strings
Lab 7, 8,9 &10 Basic and Advanced Geospatial Programming using R
Lab 11 Programming using concepts Python
Lab 12 Using Python to deal with Functions and Objects
Lab 13. Using Python to deal with Arrays and Satellite Images

## COURSE 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 Course Outcome

### Mapping Course Outcome with Programme Outcome

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

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

### Course Delivery Methods

| | |
|---|---|
| CD1 | Laboratory experiments |

**Course code: RS 518**
**Course title: REMOTE SENSING IN SNOW AND GLACIER HYDROLOGY LABORATORY**
**Pre-requisite(s): Basic theoretical knowledge of RS, GIS and associated software**
**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:**

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 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 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Course Delivery Methods**

| | |
|---|---|
| CD1 | Laboratory experiments |

**Course code: RS 519**
**Course title: Remote Sensing in Climate Change and Environmental Impact LABORATORY**
**Pre-requisite(s): Basic theoretical knowledge of RS, GIS and associated software**
**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:**

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 Shoreline change mapping of Waterbodies
Lab 3 Biomass and Carbon Accounting using RS & GIS
Lab 4 To identify El-Nino and La-Nina years using ONI and SST/Temperature anamoly
Lab 5& 6 Drought Condition Assessment using RS based indices and meteorological data
Lab 7 & 8 Exploring Climatic Research Unit **(**CRU) data set and its utilization of climate change related studies
Lab 9 Evaluation of atmospheric dynamics using virtual ballooning
Lab 10 TRMM based Rainfall Mapping and relating with Ground Meteorological Data
Lab 11 Glacier Condition and Change Assessment using Temporal RS data
Lab 12 Vegetation Phenology using Time-Series RS data
Lab 13 Explore scenarios for future climate using the simple online climate model

## 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 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 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Course Delivery Methods**

| | |
|---|---|
| CD1 | Laboratory experiments |