Course Structure & Syllabus

(w.e.f. Session 2022-23)

Master of Technology (Remote Sensing)

SPECIALISATIONS OFFERED:

I. Earth Resources II. Environment & Climate

DEPARTMENT OF REMOTE SENSING

BIRLA INSTITUTE OF TECHNOLOGY

Mesra, Ranchi- 835215

Jharkhand, INDIA

2022

Institute Vision

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

Institute Mission

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

Department Vision

Be a centre of excellence in the field of Geospatial Technology education and research in the areas of Earth Resources, Environment & Climate to meet the needs of ever increasing requirement of human resources in these fields and to cater to the larger interest of the Society and Nation.

Department Mission

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

Programme Educational Objectives (PEOs)	**Programme Outcomes (POs)**
1. To prepare the students in identifying, analysing and solving geospatial problems.	1. An ability to independently carry out research/ investigation and development work to solve real life geospatial problems.
2. To train the students in developing practical and executable solutions to the challenges of growing field of Remote Sensing and GIS.	2. An ability to write and present a substantial technical report/document and publish international level research articles.
3. To impart the students with strong base of knowledge that makes them suitable both for industries as well as for teaching and research.	3. Students should be able to demonstrate a degree of mastery over the areas of Remote Sensing and GIS technology. The mastery should be at a level higher than the requirements in the appropriate bachelor program. .
4. To inculcate the students with the sensitivity towards ethics, public policies and their responsibilities towards the society.	4. An ability to share theoretical and practical knowledge in both teaching and research as well as in industries.
	5. An ability to apply professional ethics, accountability and equity.

M.Tech. (Remote Sensing)

PROGRAMME SCHEME - SEMESTER WISE DISTRIBUTION

S. No	Semester	Course Category	Credits	Total
1	FIRST	3 Programme Core (PC)	9	21.5
		1 Progammet Elective (PE)	3	
		5 LABS (4 PC + 1 PE)	9.5	
2	SECOND	3 Programme Core (PC)	9	19.5
		1 Progamme Elective (PE)	3	
		4 LABS (3 PC + 1 PE)	7.5	
3	THIRD	Research Project - Thesis (Part – I)	8	14
		1 Open Elective (OE-I)/ MOOC	3	
		1 Open Elective (OE-II)/ MOOC	3	
4	FOURTH	Research Project - Thesis (Part – II)	16	16
TOTAL				**71**

PROGRAMME CORE (PC) for both i. EARTH RESOURCES ii. ENVIRONMENT & CLIMATE (*offered in* MO session *only*)

S. No	Course Code	Course Title	Pre requisites / Co requisites	Credits
1	RS 501	Principles of Remote Sensing and Digital Satellite Image Processing	Basic Physics/Science Computer Knowledge	3
2	RS 502R2	Geographic Information System and Satellite Navigation System	Basic Sciences/ Basic Computing	3
3	RS 511	Aerial and Satellite Photogrammetry & Image Interpretation	RS 501	3
4	RS 503	Remote Sensing and Digital Satellite Image Processing Laboratory	RS 501	2
5	RS 504	GIS &Satellite Navigation System Laboratory	RS 502R2	2
6	RS 513	Aerial and Satellite Photogrammetry & Image Interpretation Laboratory	RS 511	2
7	MT 132	Communication Skills I		1.5

PROGRAMME CORE (PC) FOR EARTH RESOURCES (*offered in* SP session *only*)

S. No	Course Code	Course Title	Pre requisites / Co requisites	Credits
1	RS 512R1	Advanced Remote Sensing and Geospatial Modelling	RS 501, RS 502R2	3
2	RS 521	Data Sources, Statistics and Research Methods in Geospatial Domain	RS 501, RS 502R2	3
3	RS 522	Programming concepts for spatial data handling	RS 501, RS 502R2	3
4	RS 514	Advance Remote Sensing and Geospatial Modelling Laboratory	RS 512	2
5	RS 515R1	Programming and Customisation in geospatial domain Laboratory	RS 501, RS 502R2	2
6	MT 133	Communication Skills II		1.5

PROGRAMME CORE (PC) FOR ENVIRONMENT & CLIMATE (*offered in* SP session *only*)

S. No	Course Code	Course Title	Pre requisites / Co requisites	Credits
1	RS 523	Physical Meteorology	RS 501, RS 502R2	3
2	RS 521	Data Sources, Statistics and Research Methods in Geospatial Domain	RS 501, RS 502R2	3
3	RS 522	Programming concepts for spatial data handling	RS 501, RS 502R2	3
4	RS 525	Meteorological Laboratory	RS 512	2
5	RS 515R1	Programming and Customisation in geospatial domain Laboratory	RS 501, RS 502R2	2
6	MT 133	Communication Skills II		1.5

PROGRAMME ELECTIVE (PE) (Theory & Laboratory)

S. No	Course Code	Course Title	Pre requisites / Co requisites	Credits
EARTH RESOURCES: MO SESSION 'GROUP-A'				
1	RS 505	Remote Sensing in Agriculture & Forestry	RS 501 & RS 502R2.	3
2	RS 507	Remote Sensing in Hydrology & Water Resources		3
3	RS 508	Remote Sensing in Agriculture & Forestry Laboratory	RS 503, RS 504 & RS 505	2
4	RS 510	Remote Sensing in Hydrology & Water Resources Laboratory	RS 503, RS 504 & RS 507	2
ENVIRONMENT & CLIMATE: MO SESSION 'GROUP-A'				
1	RS 517	Remote Sensing in Climate Change and Environmental Impact Assessment	RS 501 & RS 502R2.	**3**
2	RS 519	Remote Sensing in Climate Change and Environmental Impact Assessment Laboratory	RS 503, RS 504 & RS 506	2
EARTH RESOURCES: SP SESSION 'GROUP-B'				
1	RS 516	Remote Sensing in Snow and Glacier Hydrology	RS 501, RS 502R2	3
2	RS 506	Remote Sensing in Disaster Management	RS 501 & RS 502R2	3
3	RS 518	Remote Sensing in Snow and Glacier Hydrology Laboratory	RS 503, RS 504 & RS 516	2
4	RS 509	Remote Sensing in Disaster Management Laboratory	RS 503, RS 504 & RS 517	2
ENVIRONMENT & CLIMATE: SP SESSION 'GROUP-B'				
1	RS 524	Dynamic Meteorology	RS 501, RS 502R2	3
2	RS 526	Numerical Modelling Laboratory	RS 501 & RS 502R2	2
3	RS 527	Remote Sensing of Environment	RS 503, RS 504 & RS 516	3
4	RS 528	Remote Sensing of Environment Laboratory	RS 503, RS 504 & RS 517	2

Students should complete *Programme Electives* and *Open electives* as per the semester-wise **course structure** below:

COURSE STRUCTURE

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

	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 502R2	Geographic Information System and Satellite Navigation System	3	0	0	3
		RS 511	Aerial and Satellite Photogrammetry & Image Interpretation	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
		RS 513	Aerial and Satellite Photogrammetry & Image Interpretation Laboratory	0	0	4	2
		MT 132	Communication Skills I	0	0	3	1.5
	PE	RS *	ELECTIVE – I	3	0	0	3
		RS *	ELECTIVE – I Laboratory	0	0	4	2
	Total Credits (1st Semester)						**21.5**

SEMESTER – II EARTH RESOURCES

	Course Category	Course Code	Subjects	L	T	P	Credit
SEMESTER-II	PC	RS 512	Advanced Remote Sensing and Geospatial Modelling	3	0	0	3
		RS 521	Data Sources, Statistics and Research Methods in Geospatial Domain	3	0	0	3
		RS 522	Programming concepts for spatial data handling	3	0	0	3
		RS 514	Advanced Remote Sensing and Geospatial Modelling Laboratory	0	0	4	2
		RS 515R1	Programming and Customisation in geospatial domain Laboratory	0	0	4	2
		MT 133	Communication Skills II	0	0	3	1.5
	PE	RS *	ELECTIVE – II	3	0	0	3
		RS *	ELECTIVE – II Laboratory	0	0	4	2
	Total Credits (2ndSemester)						**19.5**

SEMESTER – II ENVIRONMENT & CLIMATE

	Course Category	Course Code	Subjects	L	T	P	Credit
SEMESTER-II	PC	RS 523	Physical Meteorology	3	0	0	3
		RS 521	Data Sources, Statistics and Research Methods in Geospatial Domain	3	0	0	3
		RS 522	Programming concepts for spatial data handling	3	0	0	3
		RS 525	Meteorological Laboratory	0	0	4	2
		RS 515R1	Programming and Customisation in geospatial domain Laboratory	0	0	4	2
		MT 133	Communication Skills II	0	0	3	1.5

	PE	RS *	ELECTIVE – II	3	0	0	3
		RS *	ELECTIVE – II Laboratory	0	0	4	2
	Total Credits (2nd Semester)						**19.5**

SEMESTER – III

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

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 (41+30) = 71 credits

***PROGRAM ELECTIVES:**

'GROUP - A' MO SESSION

Semester-I EARTH RESOURCE

Course No. **Course Title**

RS 505 Remote Sensing in Agriculture & Forestry
RS 507 Remote Sensing in Hydrology & Water Resources
RS 508 Remote Sensing in Agriculture & Forestry Laboratory
RS 510 Remote Sensing in Hydrology & Water Resources Laboratory

Semester-I ENVIRONMENT & CLIMATE

RS 517 Remote Sensing in Climate Change and Environmental Impact Assessment
RS 519 Remote Sensing in Climate Change and Environmental Impact Assessment Laboratory

'GROUP - B' SP SESSION

Semester- II EARTH RESOURCES

RS 516 Remote Sensing in Snow and Glacier Hydrology
RS 506 Remote Sensing in Disaster Management
RS 518 Remote Sensing in Snow and Glacier Hydrology Laboratory
RS 509 Remote Sensing in Disaster Management Laboratory

Semester- II ENVIRONMENT & CLIMATE

RS 524 Dynamic Meteorology
RS 526 Numerical Modelling Laboratory
RS 527 Remote Sensing of Environment
RS 528 Remote Sensing of Environment Laboratory

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

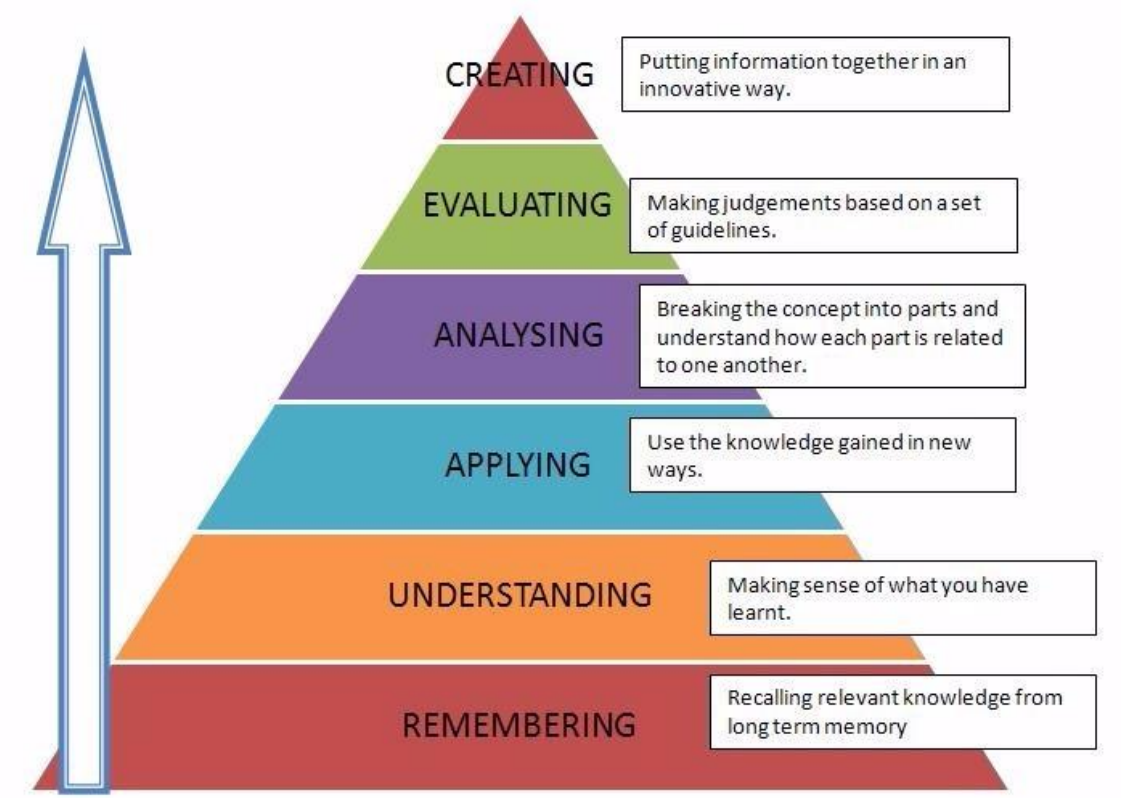
Thesis (Part – II) Semester IV – Focus on systematic execution of work plan, data processing, analysis, interpretation, inferences and fulfillment of objectives and research questions, and report preparation, and finally leading to a research publication in peer reviewed journals.

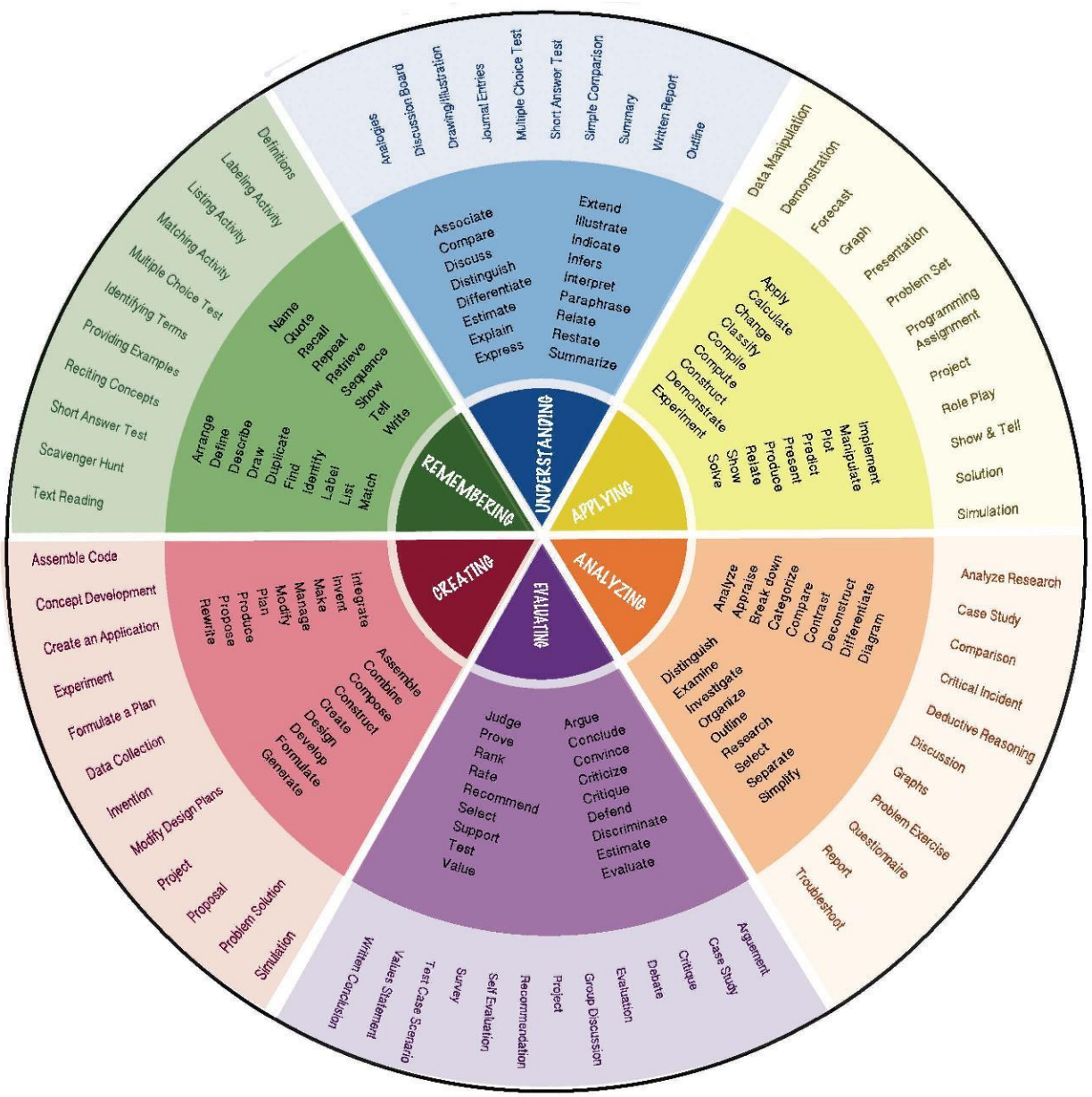
OE+ - OPEN ELECTIVE /MOOC – To be opted as offered by other Departments/ SWAYAM or NPTEL

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
Pilot
Predict
Present
Produce
Relate
Show
Solve
Assemble Code
Concept Development
Create an Application
Experiment
Formulate a Plan
Data Collection
Invention
Modify Design Plans
Project
Proposal
Problem Solution
Simulation
Integrate
Invent
Make
Manage
Modify
Plan
Produce
Propose
Rewrite
Assemble
Combine
Compose
Construct
Create
Design
Develop
Formulate
Generate
Analyze Research
Case Study
Comparison
Critical Incident
Deductive Reasoning
Discussion
Graphs
Problem Exercise
Questionnaire
Report
Troubleshoot
Analyze
Appraise
Break down
Categorize
Compare
Contrast
Deconstruct
Differentiate
Diagram
Distinguish
Examine
Investigate
Organize
Outline
Research
Select
Separate
Simplify
Written Confession
Values Statement
Test Case Scenario
Survey
Self Evaluation
Recommendation
Project
Group Discussion
Evaluation
Debate
Critique
Case Study
Argument
Judge
Prove
Rank
Rate
Recommend
Select
Support
Test
Value
Argue
Conclude
Convince
Criticize
Critique
Defend
Discriminate
Estimate
Evaluate

SEMESTER II: PROGRAMME CORE
ENVIRONMENT & CLIMATE

Course code: RS 523
Course title: PHYSICAL METEOROLOGY
Pre-requisite(s): (i) Knowledge of Basic Sciences
(ii) RS 501 and 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

Course Objectives

This course aims to make the students:

1.	Learn basic concepts of Atmospheric Phenomenon
2.	Understand Thermodynamic energy and its role in weather
3.	Learn the radiative balance and its importance
4.	Acquire the knowledge of clouds and importance of Indian Monsoon

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

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

MODULE 1: ELEMENTARY CONCEPTS OF ATMOSPHERIC SCIENCES:
Structure of the atmosphere and its composition, pressure and its variation with height, variation of temperature with height, Equation of state for dry and moist air, Adiabatic and Isothermal Processes, Humidity Parameters, Virtual Temperature, Standard Atmosphere. Atmospheric Boundary Layer Structure and evolution, turbulence etc.

MODULE 2: ATMOSPHERIC THERMODYNAMICS:-
Laws of thermodynamics, Entropy, Potential Temperature, Pseudo- adiabatic Process, Equivalent Temperature, Equivalent Potential Temperature, Claussius – Clapeyron Equation, Stability and Instability, Thermodynamic Diagram: T - gram, Uses of thermodynamic diagrams, Precipitable Water Vapor, Rate of Precipitation, Role of Convective Available Potential Energy (CAPE) and Convective Inhibition Energy (CINE) in thunderstorm development. Dew, Frost, Fog, Clouds, Precipitation, Airmass, Fronts, Tornado, Cyclones, Dust Storm.

MODULE 3: RADIATIVE TRANSFER IN THE ATMOSPHERE-
The fundamental physics of radiation: solar and terrestrial radiation, radiation laws; absorption, emission and scattering in the atmosphere, Schwarzchild's equation; Radiation in the earthatmosphere system:

Geographical and seasonal distribution, Radiative heating and cooling of the atmosphere, Surface energy budget, The mean annual heat balance.

MODULE 4: WEATHER AND CLIMATE:-

Definition of weather and climate, physical factors of climate, earth-sun relationship, ecliptic and equatorial plane, rotation of the earth, seasons, climatic controls. Climatic classification: methods of Koppen and Thornthwaite. Microclimate- basic concepts. Indian climatology: Climate zones of India; pressure, wind, temperature and rainfall distribution during the four seasons. Cloud types; cloud formation; cloud dynamics, homogeneous and heterogeneous nucleation; CCN, fundamental equations governing cloud processes

MODULE 5: INDIAN MONSOONS:-

Land and sea breezes – Definition of monsoon – Synoptic features of southwest monsoon and north east monsoon, Global perspective of monsoons, ITCZ over Indian Ocean - Structure and movement, Intraseasinal oscillation, Interannual and decadal time scales, Atmospheric -Ocean surface patterns of Southern Oscillation, El-Nino, La Nina, ENSO, Indian Ocean dipole mode, Walker circulation, Hadley circulation, Tropical Biennial Oscillation. Tropical cyclones: Formation, movement, life cycle.

TEXT BOOKS:-

1. Atmospheric Science: An Introductory Survey: J.M Wallace and P.V. Hobbs, 2nd edition, Academic Press, 2006
2. Introduction to Theoretical Meteorology by S.L. Hess**.**

REFERENCE BOOKS:-

1. An Introduction to Atmospheric radiation: K.N. Liou 2dn edition Academic Press, 2002
2. Dynamic and Physical Meteorology by G.L. Haltiner and F.L. Martin, Mc Graw Hill.
3. The Physics of the Atmosphere by Houghton
4. The Physics of Monsoons R.N. Keshava Murthy and M.Shankar Rao, Allied Publishers, 1992.

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 521
Course title: DATA SOURCES, STATISTICS AND RESEARCH METHODS IN GEOSPATIAL DOMAIN
Pre-requisite(s): Knowledge of statistics
Co- requisite(s): Knowledge of RS & GIS

Credits:	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 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

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
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Assignment (s)	10
Seminar before a committee	10

Indirect Assessment –

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

Course Evaluation:

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Course Delivery Methods

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CD3	Laboratory experiments/teaching aids
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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

Course code: RS 522
Course title: PROGRAMMING CONCEPTS FOR SPATIAL DATA HANDLING
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

Course Objectives:

This course aims to:

1.	Enhance the student's understanding of logic development and its transformation into programs
2.	Make the student learn to solving complex problems through R and Python
3.	Utilize programming to solve problems of various application areas of Earth Science.

Course Outcomes:

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

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

MODULE 1: - BASICS OF C PROGRAMMING
Syntax, and constructs of C; variables, assignment, declarations, expressions, statements, input/output, conditionals, branching, iteration. Arrays, pointers, static and dynamic structures, dynamic allocation, file structures. Functions and recursion: Parameter passing in a function, procedure call, call by value and reference, function prototypes; recursion; library functions, static functions.

MODULE 2: - CONCEPTS OF R
Introduction and Overview of R, Data Types - R Objects and Attributes, Vectors and Lists, Matrices, Factors, Missing Values, Data Frames, Names Attribute, Reading Tabular Data, Reading Large Tables, Textual Data Formats, Connections: Interfaces to the Outside World, Subletting - Basics, Lists, Matrices, Partial Matching, Removing Missing Values, Vectorized Operations, Control Structures, Functions, Scoping Rules, Coding Standards, Loop Functions, Debugging Tools, and Simulation,Problem solving with spatial data

MODULE 3: - CONCEPTS OF PYTHON
Introduction to Python, Basics of Python Syntax, Data Types of Pythons, Basic Operations of Python, Functions, Modules, and Packages of Python, Extension: Building a Python Environment, conditions, range, Loops, break, continue, and else in Loops, Self-defined Functions, Recursion, Scope of Variable, Standard Library Functions, Exceptions,Handling spatial data with Python

MODULE 4: - MATLAB
Introduction to MATLAB, MATLAB Functions, Graphics with MATLAB, Programming with MATLAB, Mathematical Computing with MATLAB, Elements of Digital Image Processing, Digital Image Basics, Image Enhancement Techniques, Multiband Image Processing and Feature Detection and Extraction, Image Classification Techniques and Visual interpretation of Multispectral Data.

MODULE 5: - GOOGLE EARTH ENGINE FOR GEOSPATIAL APPLICATIONS

Introduction to JavaScript for Earth Engine, Basic JavaScript data types, Earth Engine Objects and Methods, Functional Programming Concepts, Introduction to the Earth Engine JavaScript API, Visualizing Images and Image Bands, Computations using Images, Image Collections, Compositing, Masking, and Mosaicking, NDVI, mapping a Function over a Collection, Quality Mosaicking, Exporting Charts and Images, Case Studies using Global Forest Change and Global Surface Water (GSW) datasets.

TEXT BOOKS:

1. B. W. Kernighan and D. M. Ritchie: The 'C' Programming Language.
2. Mark Lutz: Learning Python
3. Hadley Wickham, Garrett Grolemund: R for Data Science
4. Mikhailov, Eugeniy E: Programming with MATLAB for Scientists: A Beginner's Introduction
5. Lalit Kumar, Onisimo Mutanga: Google Earth Engine Applications

REFERENCE BOOKS:

1. B. Gottfried: Programming in C.
2. Wes McKinney: Python for Data Analysis
3. Colin Gillespie, Robin Lovelace: Efficient R Programming
4. Stormy Attaway: Matlab A Practical Introduction to Programming and Problem Solving

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	1	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

SEMESTER II: PROGRAMME ELECTIVES

ENVIRONMENT & CLIMATE

Course code: RS 524
Course title: DYNAMIC METEOROLOGY
Pre-requisite(s): (i) Elementary knowledge about differential equation
(ii) RS 501 and 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

Course Objectives

This course aims to provide:

1.	Basic concepts of different frames of reference and evolution of Apparent Forces
2.	Basic Conservation Laws of momentum, thermodynamic energy and continuity equations
3.	Diagnostic and prognostic equations in different coordinate systems
4.	Atmospheric circulation, vorticity and different types of flow

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

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

MODULE 1: - BASIC CONCEPT OF DIFFERENT FORCES ALONG WITH DIFFERENT FRAMES OF REFERENCE
Natural Co-ordinate System,Lagrangian and Eulerian frames of references, Inertial and non inertial frames of reference. Pressure Gradient Force, Viscous Force, Gravitational Force, Frictional Force, Coriolis force, Centripetal and centrifugal force, Stream function, velocity potential

MODULE 2: - BASIC CONSERVATION LAW - I
Conservation of momentum, Vectorial form of the momentum equation, Scale analysis of equation of motion, Introduction to Diagnostic and prognostic equation, Hydrostatic Approximation, Geostrophic Approximation, Geostrophic wind, Rossby number

MODULE 3: - BASIC CONSERVATION LAW - II
Continuity equation in Eularian and Lagrangian coordinate system. Scale analysis of Continuity equation, Thermodynamic energy equation, Scale analysis of Thermodynamic energy equation,Thermodynamics of the dry and moist air, Adiabatic and Pseudoadibatic lapse rate, Potential and equivalent potential temperature, different type of stability

MODULE 4: - APPLICATION TO UNDERSTAND THE WEATHER SYSTEM

Momentum, Continuity, Thermodynamic energy equations in isobaric coordinates; Geostrophic Flow, Inertial Flow, Cyclostrophic flow; Gradient wind; Thermal wind; Kinematic Method; Adiabatic Method, Surface pressure and its influence

MODULE 5:- CIRCULATION AND VORTICITY

Trajectory and Streamlines, Differential equation for streamlines, Circulation, vorticity, divergence, Stokes Theorem, Divergence Theorem, Circulation theorems – Kelvin's Theorem and Bjerknes Theorem and applications of Circulation theorems – Sea Breeze and Land Breeze; Solenoidal Vector, split of vorticity and divergence equations into rotational and irrotational terms.

TEXT BOOKS:-

1. An Introduction to Dynamic Meteorology, J.R. Holton, Academic Press.
2. Dynamic Meteorology, Askel Wiin Nelson, WMO Publication.

REFERENCE BOOKS:-

1. Weather Forecasting Vol I and II by S. Pettersen
2. Dynamic Meteorology, A Basic Course By Adrian Gordon, Warwick Grace, Roland Byron-Scott, Peter Schwerdtfeger
3. Dynamic Meteorology by S. Panchev

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 527
Course title: REMOTE SENSING OF ENVIRONMENT
Pre-requisite(s): (i) Elementary knowledge about geography and environment
(ii) RS 501 and 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

Course Objectives

This course aims to provide:

1.	Basic understanding of sustainable development and its need in current scenario
2.	Concepts of Ecosystem functions and environmental pollution monitoring
3.	Insights of EIA and EMP

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

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

MODULE 1: RS & SUSTAINABLE DEVELOPMENT:

Sustainability and Sustainable Development
Ecological and Biological Aspects of Environment: Hydrosphere, Lithosphere, Cryosphere Biosphere, Spectral Properties of Air, Land (Soil), Vegetation and Water
Remote Sensing for Assessment of Air, Land (Soil) and Water Quality Parameters, Sustainable Forest Management, Forest Change Detection, Forest Modelling and GIS.

MODULE 2: ECOSYSTEM STRUCTURE AND FUNCTION:

Kinds of Ecosystem, Structure of Ecosystem, Function of Ecosystem, Energy Flow in Ecosystem, Cycles in Ecosystems, Major Ecosystems, Productivity of Different Ecosystems, Ecosystem Modelling, Introduction to Landscape Ecology, Theories and Models into the Landscape Ecology, Scaling Patterns and Processes across Landscapes, Emerging Processes in the Landscape

MODULE 3: POLLUTION MONITORING:

Types of Pollution, Chemistry of Pollutants: Air, Land (Soil) and Water
Acid Rain, Smog, Green House Effect and Global Warming
Eutrophication, Water logging and Salinization.

MODULE 4: ENVIRONMENTAL ASSESSMENT:

Selection of Disposal Sites for Industrial and Municipal Wastes, Air, Land, and Water Quality Management, Solid Waste Management, EIA Methods and Mitigation; Criteria and Indicators; Certification, Remote Sensing and GIS in EIA and EMP (Environmental Management Plan)

MODULE 5: CLIMATE CHANGE AND POLICIES:

Climate Change, Energy Balance and Climate, Green House Gases and Green House Effect, Carbon Cycle, Past Climate, Climate Models, Future Climate Change, United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Intergovernmental Panel on Climate Change (IPCC).

TEXT BOOKS:-

1.Lillesand, T. M. and Kiefer, R.W., 2007, Remote Sensing and Image Interpretation, Wiley and Sons

REFERENCE BOOKS:-

1. Sabins, F.F. Jr., 2007, (2nd) Edition, 'Remote Sensing – Principles and Interpretation", W.H. Freeman & Co.
2. Reeves, Robert G., 1991, "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, USA.
3. Jensen, J.R., 2004, Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall

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

SEMESTER II: LABORATORIES
ENVIRONMENT & CLIMATE

Course code: RS 525
Course title: METEOROLOGICAL LABORATORY
Pre-requisite(s): Basic Science
Co- requisite(s):

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

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

Course Objectives
This course aims to make the student:

A.	Familiarize with atmospheric data variables and their variability
B.	Enriching knowledge in atmospheric data and its relationships
C.	Knowledge on the methods of analysis of atmospheric/climate data

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

CO1	Generate the interest on atmospheric data methods
CO2	Provide basic analytical techniques for atmospheric data
CO3	Prepare the students with necessary atmospheric background
CO4	Enhance the basic knowledge of meteorological information from satellites
CO5	Enhancing the skills on statistical data analysis

Lab 1 and 2:- Clouds classification and Observations: Students would be shown slides of all 10 major types of clouds and by end of the Lab training it is expected from students to be able to identify real weather clouds.

Lab 3:- Plot and analysis of the variation of vertical temperature by Radiosonde data from https://weather.uwyo.edu/upperair/sounding.html or any other data source.

Lab 4:- To determine the vertical lapse rate of the standard atmosphere

Lab 5:- Priciple and working of the sun photometer

Lab 6:- Estimation and analysis of Sea surface temperature with satellite data in different latitudes.

Lab 7 and Lab 9:- Statistical analysis for one month data of atmospheric parameters (Temperature, Relative humidity)

Lab 9 and 10:- Plot the back trajectory and forward trajectory for different height/pressure level from https://www.ready.noaa.gov/HYSPLIT.php or any other online sources

Lab 11:- Estimation and analysis of Outgoing longwave radiation with satellite data for different atmospheric condition

Lab 12 and 13 :- Climatic classification of koppen and the difference with thornthwaite

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
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		3	2	
CO2	2	2	2	2	2
CO3	3	2	3	3	3

Low = 1, Medium = 2, High= 3

Course code: RS 515R1

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 C Compiler programming Environment
CO2	Understand and appropriately Utilise various libraries, Fuction and Syntaxes in R and Pyhton
CO3	Write a simple to complicated Programming Codes in MATLAB & Google Earth Engine.

Lab 1. Programming in C: environment, variables, operators &controls

Lab 2. Programming using Functions, Decision making & Arrays in C

Lab 3. Programming Environment and Libraries in R

Lab 4. Programming for Reading, Writing from/to file, and Plotting

Lab 5. Programming for Handling & Processing Images in R

Lab 6, 7, 8 Programming in Python

Lab 9, 10 Programming in MATLAB

Lab 11,12, 13 Programming in Google Earth Engine

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
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	
CO2	2	2	3	3	1
CO3	3	3	3	3	1

Low = 1, Medium = 2, High= 3

Course code: RS 526
Course title: NUMERICAL MODELLING LAB
Pre-requisite(s): Knowledge of differential equation
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:

A.	Familiarize with atmospheric data variables and their variability
B.	Enriching knowledge in atmospheric data and its relationships
C.	Knowledge on the methods of analysis of atmospheric/climate data

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

CO1	Generate the interest on atmospheric data methods
CO2	Provide basic analytical techniques for atmospheric data
CO3	Prepare the students with necessary atmospheric background
CO4	Enhance the basic knowledge of meteorological information from satellites
CO5	Enhancing the skills on statistical data analysis

Lab 1 Demonstration and detailed instructions of High-Performance Computing (HPC) Facility and its use in Atmospheric Science.

Lab 2 Simulation of Weather/climate data.

Lab 3 Field observation of meteorological parameters.

Lab 4 Visualization and Display of Atmospheric Data: Grid Analysis and Display System(GrADS)

a) Introduction of Grid Analysis and Display System

b)Reading writing control files for data display

c) Data display, reading and plotting of binary and netcdf data from model output.

d) OpenGrADS

Lab 5 To read and write data in the different format like NetCDF, HDF files using Matlab/Python

Lab 5 Plot horizontal velocity (U and V)

Lab 6 Calculate divergence

Lab 7 Calculate Vorticity

Lab 8 Plot temperature and overlay horizontal velocity (U and V)

Lab 9 Visualization using NCAR Command Language(NCL)

Lab 10 Masking NetCDF data and drawing plot by shapefile in NCL

Lab 11 Wind Rose Analysis of given data using WRPLOT view

Lab 12 and Lab 13:- Visualize two extreme seasons(winter and summer) from https://www.windy.com/ or any other site and analyze

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
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		3	2	
CO2	2	2	2	2	2
CO3	3	2	3	3	3

Low = 1, Medium = 2, High= 3

Course code: RS 528
Course title: REMOTE SENSING OF ENVIRONMENT LABORATORY
Pre-requisite(s): Basic geography and environment
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.	Utilise Hand held Spectroradiometer for extracting spectral information associated with soil, vegetation and water
B.	Execute various information extraction approach for monitoring of environmental pollution

Course Outcomes:

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

CO1	Take In-situ measurement of spectral response of different earth surface feature with Handheld Spectroradiometer
CO2	Measure Aerosol using Sun Photometer and its comparison with satellite derived AOD
CO3	Apply integrated geospatial approach for EIA

Lab 1- Generating spectra of different soil types using Hand held Spectroradiometer and analyze with satellite data

Lab 2 - Generating spectra of different water body conditions using Hand held Spectroradiometer and analyze with satellite data

Lab 3 Generating spectra of different vegetation types using Hand held Spectroradiometer and analyze with satellite data

Lab 4 Analysis of satellite derived AOD

Lab 5 Measurement of AOD using Sun Photometer

Lab 6 Calculation of AQI using CPCB data

Lab 7 Generating Landscape indices using satellite data

Lab 8 Delineation of seasonal and permanent waterlogged areas and soil salinity

Lab 9 Generating UHI zonation map using satellite data

Lab 10 Derivation of terrain attributes for selection of Disposal Sites for Municipal Wastes

Lab 11 Mapping of point pollution sources using satellite data

Lab 12 Land Degradation assessment using satellite data

Lab 13 Environmental assessment for siting of any infrastructural project

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
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	
CO2	2	2	3	3	1
CO3	3	3	3	3	1

Low = 1, Medium = 2, High= 3