CURRICULUM & SYLLABI

M.Tech GEOINFORMATICS

Effective from AY: 2024-25



NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

WARANGAL, TELANGANA

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Vision and Mission of the Institute
National Institute of Technology Warangal

VISION
Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION
- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product-oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

Vision and Mission of the Department
CIVIL Engineering

VISION
To be a knowledge nerve centre in civil engineering education, research, entrepreneurship and industry outreach services for creating sustainable infrastructure and enhancing quality of life.

MISSION
- Generate a specialized cadre of civil engineers by imparting quality education and training
- Attain international standards in teaching, research and consultancy with global linkages

M.Tech – GEOINFORMATICS

Program Educational Objectives

PEO-1	Apply principles of Geospatial Technologies to collect, map and retrieve spatial information
PEO-2	Plan, assess and evaluate natural and manmade systems using geospatial models and methods
PEO-3	Use geospatial tools and techniques for hazard mitigation and resource planning
PEO-4	Pursue research and develop capabilities to handle multi-disciplinary field projects
PEO-5	Work in teams and demonstrate leadership skills with professional ethics

Program Articulation Matrix

PEO / Mission Statements	PEO-1	PEO-2	PEO-3	PEO-4	PEO-5
Generate a specialized cadre of civil engineers by imparting quality education and training	3	2	2	3	2
Attain international standards in teaching, research and consultancy with global linkages	1	2	2	3	2

1 - Slightly; 2 - Moderately; 3 - Substantially

M.Tech – Geoinformatics

Program Outcomes

PO-1	Engage in critical thinking and pursue research/ investigations and development to solve practical problems.
PO-2	Communicate effectively on complex engineering activities with the engineering community and with society at large, write and present substantial technical reports.
PO-3	Demonstrate higher level of professional skills to tackle multidisciplinary and complex problems related to “Geospatial Technologies”
PO-4	Apply principles of Geospatial Technologies to collect, map and retrieve spatial information
PO-5	Plan, assess and evaluate natural and manmade systems using geospatial models and methods
PO-6	Develop geospatial models and tools to address the social and engineering problems

CURRICULUM
M.Tech Geoinformatics

1st Semester

S.No.	Code	Course Title	L-T-P	Credits
1	CE46001	Principles of Remote Sensing	3-0-0	3
2	CE46003	Geographical Information Systems	3-0-0	3
3	CE46005	Programming Methods for Geospatial Systems	3-0-0	3
4		Professional Elective – I	3-0-0	3
5		Professional Elective – II	3-0-0	3
6	CE46007	Remote Sensing and Image Processing Laboratory	0-1-2	2
7	CE46009	Geographical Information Systems Laboratory	0-1-2	2
			Total Credits	**19**

2nd Semester

S.No.	Code	Course Title	L-T-P	Credits
1	CE46002	Global Navigation Satellite System	3-0-0	3
2	CE46004	Geospatial Data Processing and Modeling	3-0-0	3
3	CE460XX	Professional Elective – III	3-0-0	3
4	CE460XX	Professional Elective – IV	3-0-0	3
5	CE460XX	Professional Elective – V	3-0-0	3
6	CE46006	GNSS and Photogrammetry Laboratory	0-1-2	2
7	CE46008	Geospatial Data Processing and Modeling Laboratory	0-1-2	2
8	CE46096	Minor Project	0-0-0	2
			Total Credits	**21**

3rd Semester

S.No.	Code	Course Title	L-T-P	Credits
1	CE46089	Seminar and Technical Writing	0-0-0	2
2	CE46091	Short Term Industrial / Research Experience	0-0-0	2
3	CE46093	Comprehensive Viva-Voce	0-0-0	2
4	CE46097	Dissertation Part - A	0-0-0	8
		Total Credits		**14**

4th Semester

S.No.	Code	Course Title	L-T-P	Credits
1	CE46098	Dissertation Part - B	0-0-0	12
		Total Credits		**12**

Professional Elective Courses:

Professional Elective - 1 (I Year, I Semester)		
S.No.	**Code**	**Course Title**
1	CE46021	Surveying Measurements and Adjustments
2	CE46023	Geospatial Statistics
Professional Elective - 2 (I Year, I Semester)		
3	CE46025	Database Management Systems
4	CE46027	AI and Machine Learning for Geospatial Systems

Professional Elective - 3 (I Year, II Semester)		
S.No.	**Code**	**Course Title**
1	CE46022	Photogrammetry
2	CE46024	Geospatial Applications for Earth Sciences
Professional Elective - 4 (I Year, II Semester)		
3	CE46026	Thermal, Microwave and Hyperspectral Remote Sensing
4	CE46028	Agro Remote Sensing
5	CE46030	Advanced Digital Image Processing
Professional Elective - 5 (I Year, II Semester)		
6	CE46032	Web and Mobile GIS
7	CE46034	Atmospheric Remote Sensing

Note: In addition to the above electives, students can choose electives from other programs of the department and institute based on the suggestions of faculty advisor/ supervisors

THE OVERALL CREDIT STRUCTURE

Cat. Code	Sem-I	Sem-II	Sem-III	Sem-IV	Total
PCC	13	10	0	0	23
PEC	6	9	0	0	15
STW	0	0	2	0	2
CVV	0	0	2	0	2
SIRE	0	0	2	0	0
MIN	0	2	0	0	2
DIS	0	0	8	12	20
Total	19	21	14	12	66

PCC: Professional Core Course

PEC: Professional Elective Course

STW: Seminar and Technical Writing

SIRE: Summer Internship/Research Experience

CVV: Comprehensive Viva Voce

MIN: Minor Project

DIS: Dissertation

SYLLABI

M.Tech. Geoinformatics

1st Semester

CE46001 **3-0-0 (3)**

Principles of Remote Sensing

Pre-Requisites: **None**

Course Outcomes:

CO-1	Select the type of remote sensing data for mapping earth surface features
CO-2	Analyze the energy interactions with the atmosphere and earth surface features
CO-3	Identify the earth surface features from satellite images
CO-4	Apply remote sensing techniques for natural resources evaluation

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	2	1	3	1	1
CO-2	3	2	2	1		1
CO-3	3	1	1	2	1	1
CO-4	1	3	2		2	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Chapter-1 Physics of Remote Sensing: Sources of Energy, Active and Passive Radiation, Electromagnetic Radiation - Reflectance, Transmission, Absorption, Thermal Emissions, Interaction with Atmosphere, Atmospheric windows, Spectral reflectance of Earth's surface features, and Multi concept of Remote Sensing

Chapter-2 Platforms and Sensors: Various types of platforms, different types of aircraft, manned and unmanned spacecrafts used for data acquisition - characteristics of different types of platforms - airborne and spaceborne, IRS Satellite Sensors, LANDSAT, SPOT, IKONOS, Quickbird, Geoeye, Kompsat, Worldview II & III, Microwave, ALOS, Planet Data, Sentinel, SMAP, MODIS etc.

Chapter-3 Data Acquisition Systems and Applications: Optical, Thermal and Microwave; Resolutions - spatial, spectral, radiometric and temporal, signal to noise ratio, LiDAR data acquisition and processing. Applications of Remote sensing in various Engineering and Science domains such as Agriculture, Forest, Soil, Geology, LU/LC, Water Resources, Urban, Disaster Management, etc.

Chapter-4 Data Products and Image Preprocessing: Data Products and Their Characteristics, Digital image formation, digital image display mechanism, image histograms, look up table data, Pre-processing – Atmospheric, Radiometric, Geometric Corrections - Basic Principles of Visual Interpretation, Ground Truth, Orthorectification, Applications. Supervised and Unsupervised Image Classification.

Learning Resources:

Text Books:

1. James B. Campbell & Randolph H. Wynne., Introduction to Remote Sensing, The Guilford Press, 2022, Sixth Edition
2. Lillesand T.M & Kiefer R.W., Remote Sensing and Image Interpretation, 2015, John Wiley and

Reference Books:

1. Chritian Matzler., Thermal microwave radiation: Applications for remote sensing, 2006, The institution of Engineering and Technology, London
2. Schowengerdt, R. A., Remote Sensing: Models and Methods for Image Processing, 2007, Academic Press
3. Cracknell, A.P., Introduction to Remote Sensing, 2007, Tylor & Francis, Second Edition, London
4. Freek D. van der Meer, Remote Sensing and Digital Image Processing, 2004
5. Introduction to the physics and techniques of Remote Sensing, Charles Elach & Jakob van Zyl., John Wiley & Sons publications, 2006

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/108/105108077/
2. https://nptel.ac.in/courses/105/101/105101206/
3. https://nptel.ac.in/courses/105/107/105107201/

CE46003 **3-0-0 (3)**

Geographical Information Systems

Pre-Requisites: **None**

Course Outcomes:

CO-1	Analyze the basic components of GIS
CO-2	Classify the maps, coordinate systems and projections
CO-3	Process spatial and attribute data and prepare thematic maps
CO-4	Identify and rectify mapping inaccuracies
CO-5	Conceptualize a GIS project

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1			3		2	
CO-2	3	3	2		1	
CO-3	3	2	2		1	2
CO-4	2	2	1			1
CO-5	3	2	2	2		

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Chapter- 1 Map: Mapping concepts, analysis with paper-based maps, limitations, Computer Automated Cartography – History and Developments, GIS- Definition, components, advantages of digital maps, projections and coordinate systems.

Chapter- 2 Fundamentals of GIS: Information Systems, Modelling Real World Features Data, Data Models – Spatial and Non-spatial, Components, Data Collection and Input, Data Conversion, Metadata. Vector and raster data models, TIN data model

Chapter- 3 Database Management: Database Structures, Files; Standard Data Formats, Compression Techniques, Hardware and Software. Introduction to popular GIS software like ArcGIS, QGIS.

Chapter- 4 Topology: Types of Errors, Editing and Error Rectification, Types of Topology, Modelling topological Relationships, Tolerances.

Chapter- 5 Spatial Analysis: Proximity Analysis, Overlay Analysis, Buffer Analysis, Network Analysis – Route alignment, Canal alignment; Digital Elevation Models. Map composition, Preparation of qualitative and quantitative maps, levels of maps, map elements and map scales, 3D Analyst, Interpolation Methods.

Chapter- 6 GIS Project Planning and Implementation: Understanding the Requirements, Phases of Planning, Specifications, and Procedure for analysis projects and design projects.

Learning Resources:

Text Books:

1. Kang Tsung Chang., Introduction to Geographic Information Systems, 9th Edition Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2018.
2. C.P.Lo & Albert K. W.Yeung, Concepts and Techniques of Geographic Information Systems, second Edition, Prentice Hall India Pvt.Ltd, 2016

Reference Books:

1. Burrough, P.A., Principles of GIS for Land Resource Assessment, Oxford Publications, 2005.
2. John E. Harmon & Steven J. Anderson., The design and implementation of Geographic Information Systems, John Wiley & Sons, 2003.
3. Paul Bolstad, GIS Fundamentals: A First Text on Geographic Information Systems, XanEdu Publishing Inc, 6th Edition, 2019.
4. Paul Longley., Geographic Information systems and Science, John Wiley & Sons, 4th Edition,2015.
5. Michael J De Smith (Author), Michael F Goodchild (Author), Paul a Longley, Geospatial Analysis: A Comprehensive Guide, Winchelsea Press, 6th Edition, 2018.

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/102/105102015/
2. https://nptel.ac.in/courses/105/107/105107155/
3. https://nptel.ac.in/courses/107/105/107105088/

CE46005 **3-0-0 (3)**

Programming Methods for Geospatial Systems

Pre-Requisites: **None**

Course Outcomes:

CO-1	Prepare the algorithms and programming syntax
CO-2	Develop programs in C++ and Java
CO-3	Apply the concepts of object-oriented programming
CO-4	Design and develop programs for geospatial systems

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	2	2	3	1	2
CO-2	1	3	1	2	1	
CO-3	1	1	1	3	2	1
CO-4	1	1	1	3	2	

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Chapter- 1 Oops Concepts: Classes, Objects, Polymorphism, Inheritance, Encapsulation, Overloading.

Chapter- 2 Basics of C++: Elements of C++, input and output statements, decision making, functions, iterations and loops. Objects and Classes.

Chapter- 3 Programming Methods in C++: Operator Overloading. Inheritance. Pointers. Virtual Functions and Other Subtleties; Streams and Files; Multi-file Programs, Templates and Exceptions, Object-Oriented Software Development.

Chapter- 4 Java Scripting Concepts: Data types, variables and arrays, operators, control statements, objects, functions, document object model, event handling, controlling windows and frames and documents, form handling and validations.

Learning Resources:

Text Books:

1. Object Oriented Programming with C++ - TMH, E. Balagurusamy., 7th Edition, 2017.
2. Thomas Powell, Fritz Schneider "JavaScript The Complete Reference" 3rd Edition, TATA McGraw Hill, 2013 ISBN-13: 9781259064685

Reference Books:

1. Object Oriented Programming in C++, Robert Lafore, 4th Edition, Pearson Pub., 2008
C++ The complete Reference, Herbert Schildt , 4th Edition, 2017.
2. JavaScript: The Good Parts: The Good Parts 1st Edition, Kindle Edition by Douglas Crockford (Author)

3. Eloquent JavaScript, 3rd Edition: A Modern Introduction to Programming by Marijn Haverbeke (Author)

Other Suggested Readings:

1. https://nptel.ac.in/courses/106/105/106105151/
2. https://onlinecourses.nptel.ac.in/noc21_cs03/preview
3. https://onlinecourses.nptel.ac.in/noc19_cs84/preview
4. https://www.w3schools.com/cpp/default.asp
5. https://www.w3schools.com/java/default.asp
6. https://www.geeksforgeeks.org/c-plus-plus/
7. https://www.geeksforgeeks.org/java/

CE 46007 **0-1-2 (2)**

Remote Sensing & Image Processing Laboratory

Pre-Requisites: **None**

Course Outcomes:

CO-1	Interpret remote sensing data
CO-2	Map earth surface features
CO-3	Perform orientation of photographs
CO-4	Generate ortho images and elevation models

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	3	2	2	1	1
CO-2	1	2	1	3		1
CO-3	1	2	2	2	1	1
CO-4	2	3	2	2	1	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

- Satellite Data downloading from different sources (Bhuvan, USGS, Earthdata etc.,)
- Radiometric data collection for the different features
- Spectral signature curves of various Land Use and Land Cover (LU/LC) features
- Geometric Correction and Mosaicking
- Image processing methods- enhancement, band ratioing etc.
- Spectral Indices
- LU/LC classification and accuracy assessment
- Change detection studies

Learning Resources:

Text Books:

1. Remote Sensing and Image Interpretation, Lillesand T.M and Kiefer R.W., John Wiley and Sons, 2015.
2. ERDAS Software manual 2018 user manuals
3. ArcGIS, QGIS, Python, R and MATLAB Help File

CE46009 **0-1-2 (2)**

Geographical Information Systems Laboratory

Pre-Requisites: **None**

Course Outcomes:

CO-1	Prepare the different geospatial layers
CO-2	Compute geometric measurements and perform spatial analysis
CO-3	Create high-quality maps and associated graphics
CO-4	Integrate different geospatial layers

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	3	2	2	1	1
CO-2	1	2	1	3		1
CO-3	1	2	2	2	1	1
CO-4	2	3	2	2	1	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

- Importing maps and layers from various sources
- Georeferencing and projection
- Creation of layers and data editing
- Attribute Data Entry and Manipulation
- Working on the topology of the layers
- Raster and Vector Data Analysis
- Applications of DEM and Interpolation methods
- Field data of geospatial data through mobile devices
- Network Analysis

Learning Resources:

1. ArcGIS user manuals,
2. QGIS User Manuals

Professional Electives -1, 2

CE46021 **3-0-0 (3)**

Surveying Measurements & Adjustments

Pre-Requisites: **None**

Course Outcomes:

CO1	Familiarize with modern surveying principles, methods and instruments
CO2	Operate and use different instruments and techniques to determine the positions
CO3	Identify and correct errors in field measurements
CO4	Demonstrate advanced equipment in preparing maps

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	P05	PO6
CO1	1	1	1	1	1	1
CO2	2	3	3	3	2	2
CO3	2	2	2	2	2	1
CO4	3	3	3	3	3	2

Syllabus:

Chapter-1: Basics of Surveying: Principles of surveying, Various maps and their scales, Symbols and colors, Generalisation of information, Surveying measuring equipment & techniques - Distance, Height, Angles and Directions. Compass Surveying: Bearings and Azimuths. Plane Table Surveys - Resection, Radiation, Intersection, Traversing

Chapter-2: Levelling and Triangulation: Levelling: Balancing of sights, Differential leveling, profile and cross-section leveling, reducing the levels- Height of Instrument and Rise & Fall method. Contouring. Tacheometric surveying. Methods of control establishment: Traversing, Traverse computations and adjustments. Triangulation and Trilateration.

Chapter-3: Theodolite and Tacheometric Surveying: Principle of theodolite survey, Theodolite component parts, observations, Traversing, traverse computations, Trigonometrical Surveying, Tacheometry, principle of tacheometry, methods of tacheometry.

Chapter-4: Adjustments and Correction: Errors in measurements, Mistakes, Sources of errors, Error propagation, Method of Weights, Least squares adjustment techniques, Adjustment by linear and non-linear functions in the model, Adjustment by observation equation (variation of parameters) and condition equation methods.

Chapter-5: Advanced Surveying Instruments: Modern surveying equipments- EDM, Total Station, Differential Global Positioning System (GPS), Unmanned Aerial Systems

Chapter-6: Control Surveys and Geodetic Reductions: Horizontal and Vertical Control Surveys. Triangulation, Trigonometrical Levelling, Boundary Surveys, Construction surveys

Learning Resources:

Text Books:

1. B.C. Punmia, Ashok Kumar Jain, Ashok Kr. Jain, Arun Kr. Jain., Surveying I & II, Laxmi Publications, 2015
2. Chandra A. M., Higher Surveying, New Age International Publishers, 2015

Reference Books:

1. James, M Anderson & Edward M., Surveying Theory and Practice, Tata Mc Graw Hill, 2012
2. Charles D. Ghilani and Paul R. Wolf Elementary Surveying: An Introduction to Geomatics, 15th Edition, 2018
3. Dr. K.R. Arora, Surveying Vo.I, 17th edition, 2019, Standard Book House
4. Dr. K.R. Arora, Surveying, Vol. II, 15h Edition, 2018, Standard Book House

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/107/105107122/
2. https://nptel.ac.in/courses/105/104/105104101/
3. http://sl-iitr.vlabs.ac.in/sl-iitr/

CE46023 **3-0-0 (3)**

Geospatial Statistics

Pre-Requisites: **None**

Course Outcomes:

CO1	Interpret remote sensing data
CO2	Map earth surface features
CO3	Perform orientation of photographs
CO4	Generate ortho images and elevation models

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	2	1	1
CO2	1	2	1	3		1
CO3	1	2	2	2	1	1
CO4	2	3	2	2	1	1

Syllabus:

Chapter-1 Statistical Modeling: Point and Interval Estimation, parametric Estimation, Method of Estimation (Maximum likelihood estimation, method of moments), Regression Analysis, Multivariate Techniques, Factor Analysis, Linear Discriminant Analysis. Principal component analysis (PCA) and Trend Surface Analysis (TSA)

Chapter-2 Geostatistical Applications: Expectations, Moment Generating and Characteristic Functions, Semi-variogram, Autocorrelation, Linear Estimation, Kriging & cokriging Equations, Nonlinear estimation, Semi- variogram and Normalized Data, Non-parametric Estimation, Conditional Simulation, Multivariate Simulation. Introduction to SPSS/ PAST/R

Chapter-3 Geostatistical Analysis and Modeling: Geospatial Models for presence and absence data, GARP Model, Maxent Model, Logistic Regression, Classification and Regression Tree (CART), Envelope Model

Chapter-4 Programming methods: R programming and MATLAB concepts, Free and open source GIS software and applications

Learning Resources:

Text Books:

1. Spatial statistics: geospatial information modelling and thematic mapping. Kalkhan, M. A. CRC press, 2011.
2. Concepts and Techniques of Geographic Information Systems, C.P.Lo & Albert K. W.Yeung, second Edition, Prentice Hall India Pvt.Ltd, 2016.

Reference Books:

1. How to Think Like a Computer Scientist: Learning with Python, Downey, A., Wentworth, P., Elkner, J. & Meyers, C., O'Reilly Media, Inc. 2016.
2. Introductory statistics with R, Dalgaard P., Springer, ISBN 978-0-387-79054-1(2008)
3. The Geospatial Desktop: Open Source GIS and Mapping, Sherman, G. Locate Press. 2012

4. Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies, Kelleher J.D., Namee B.M., and D'Arcy A., 2015

5. Applied Spatial Data Analysis with R, Roger S. Bivand • Edzer J. Pebesma Virgilio Gómez-Rubio, 2008 Springer Science+Business Media, LLC

6. Spatial Epidemiology Notes Applications and Vignettes in R, Charles DiMaggio, PhD Center for Injury Epidemiology and Prevention Columbia University, NY, July 25, 2014

7. Spatial Statistics and Geostatistics: Theory and Applications for Geographic Information Science and Technology (SAGE Advances in Geographic Information Science and Technology Series) 1st Edition, by Yongwan Chun (Author), Daniel A. Griffith (Author), January 30, 2013

Other Suggested Readings:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=265

CE46025 **3-0-0 (3)**

Database Management Systems

Pre-Requisites: **None**

Course Outcomes:

CO1	Analyze the components of Database management system and file management methods
CO2	Apply the concepts of SQL and its use to manage the databases
CO3	Carry out the Query, update database using SQL
CO4	Design and build a simple database system using DBMS software for GIS Databases

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1		3		
CO2	1	2		3		1
CO3	2	3	1	2	2	
CO4	1	2	1	3	2	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Chapter-1: Need for Data Base Management Systems (DBMS) Components of DBMS, Records and files, Data Models, Data Associations, Entities, Attributes and Associations, Relationships among entities, Data models classification

Chapter-2: Normalization File Organization, Constituents of file, Operations on files, Sequential files, Index- Sequential files, Direct files Relational Database

Chapter-3: Attributes and domains, Tuples, Relations and their schemes, Relation Representation, Relational operations, Relational algebra, Relational calculus, Implementation Relational Database Manipulation

Chapter-4: Structured Query Language (SQL), Query Language (QUEL) Query-by-Example (QBE), Data Manipulation and retrieval using SQL, QUEL and QBE

Chapter-5: Concepts of Relational database design. Geospatial databases, database management in GIS Introduction to Big Data Management, Data warehouse

Learning Resources:

Text Books:

1. Raghu Ramakrishnan & Jihannes Gehrke., Database Management Systems, McGraw-Hill Higher Education, 2000
2. Mukesh Negi., Fundamentals of Database Management Systems., BPB Publications, 2019
3. Atul Kahate., Introduction to Database Management Systems., Pearson, 2006

Reference Books:

1. Michael M. Gorman., Database Management Systems- Understanding and applying database technology., Butterworth-Heinemann Ltd., 2014
2. Philippe Rigaux, Michel Scholl & Agnes Voisard., Spatial Databases- With Application to GIS., Morgan Kaufmann Publishers, 2002

Other Suggested Readings:

1. https://gistbok.ucgis.org/bok-topics/spatial-database-management-systems
2. https://www.youtube.com/watch?v=qH2-xwUz3tU

CE46027 **3-0-0 (3)**

AI and Machine Learning for Geospatial Systems

Pre-Requisites: **None**

Course Outcomes:

CO1	Understand the key algorithms and theory of AI/ML.
CO2	Understand the Artificial Neural Networks
CO3	Design and implement machine learning solutions to classification, regression, and clustering problems
CO4	Evaluate and interpret the results of the algorithms for geospatial applications.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	2	1	1
CO2	1	2	1	3		1
CO3	1	2	2	2	1	1
CO4	2	3	2	2	1	1

Syllabus:

Chapter 1 Introduction to AI and Machine Learning: AI and Machine Learning Basics: Reasoning, problem solving, Knowledge representation, Planning, Learning, Perception, Motion and manipulation, Approaches to AI and ML.

Chapter 2 Classification and Regression: Classification: Decision tree, Random forest, Naive Bayes, Support vector machine. Regression: Logistic Regression, Support Vector Regression. Regression trees: Decision tree, random forest, K-Means, K-Nearest Neighbor (KNN). Applications of classification and regression algorithms in Mechanical Engineering, Bayesian Classification: Naive Bayes, Parameter Estimation (ML, MAP), Sequential Pattern Classification

Chapter 3 Fundamentals of Machine Learning and Deep Learning: Supervised Learning, Unsupervised Learning, Reinforcement Learning, Introduction to Deep Learning, Perceptron Algorithm, Multilayer Perceptron (Neural Networks), ML vs Deep Neural Networks. Forward and Back propagation in CNN, Classic CNN Architectures, Modern CNN Architectures, Deep RNN Architectures.

Chapter 4 Development of ML Model for Geospatial Systems: Steps in ML modeling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (understanding and interpretation of confusion matrix, Accuracy, Precision, Recall, True positive, false positive etc.), Hyper parameter Tuning, Predictions

Learning Resources:

Text Books:

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.

2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.

Reference Books:

1. Daniela Witten, Trevor Hastie, Robert Tibshirani, Introduction to Statistical Learning, Gareth James, Springer, 2013. Department of ECE Scheme and Syllabi w.e.f. 2021-22

2. Richard Duda, Peter Hart, David Stork, Pattern Classification, 2nd Ed., John Wiley & Sons, 2001.

3. Tom M. Mitchell, Machine Learning, Tata McGraw Hill Education(India) Edition 2013

2nd Semester

CE46002 **3-0-0 (3)**

Global Navigation Satellite System

Pre-Requisites: **None**

Course Outcomes:

CO-1	Identify GNSS components and their functions
CO-2	Interpret navigation messages and GNSS satellite signals
CO-3	Identify error sources and apply corrections in GNSS observations
CO-4	Process GNSS data for accurate positioning

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	2	2	1	1	1
CO-2	3	2	2	1	1	1
CO-3	2	2	1	1	2	1
CO-4	3	2	1	1	2	2

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Chapter-1 Introduction to GNSS: History of GNSS; GPS system - Services and Segments, GLONASS system- Services and Segments, Galileo System- Services and Segments, Regional Navigation Satellite Systems (RNSS), Augmentation Systems, GAGAN, IRNSS systems.

Chapter-2 Satellite Orbits and Signals: Orbit - Description, Determination and Dissemination. Structure of Signal, Navigation messages.

Chapter-3 Satellite Observables: Pseudo range measurements, Atmospheric effects, Antenna phase center offset and variation, Multipath, system accuracy characteristics, Data formats, Error budget.

Chapter-4 Surveying with GNSS: Planning a GNSS Survey, Positioning methods – point positioning, relative positioning, Static, Differential, RTK, and Field data collection.

Chapter-5 Data Processing: Ambiguity resolution, Post-processing, real-time processing, Accuracy measures, software modules, GIS and GNSS data integration, Applications of GNSS

Learning Resources:

Text Books:

1. Hofmann-Wellenhof, Lichtennegger, and Wasle., GNSS: Global Navigation Satellite Systems, Springer-Verlag Wein, New York, 2008.

2. Gunter Seeber., Satellite Geodesy: Foundations, Methods and Applications, 2003.

3. Shuanggen Jin, Estel Cardellach, and Feiqin Xie., GNSS Remote Sensing: Theory, Methods and Applications, Springer, London, 2017.

Reference Books:

1. Peter J.G. Teunissen, Oliver Montenbruck., Springer Handbook of Global Navigation Satellite Systems, Springer International Publishing, 2017.
2. B. Bhatta., GNSS: Insights into GPS, GLONASS, Galileo, Compass and Others, CRC Press, 2011.
3. Tan, S., GNSS Systems and Engineering: The Chinese Beidou Navigation and Position Location Satellite, John Wiley & Sons, Singapore, 2018.
4. Awange, J. L., Environmental Monitoring using GNSS: Global Navigation Satellite Systems, Springer, London, 2012.

Other Suggested Readings:

1. https://onlinecourses.nptel.ac.in/noc21_ce77/preview
2. https://nptel.ac.in/courses/105/107/105107194/
3. https://onlinecourses.swayam2.ac.in/aic23_ge20/preview

CE46004 **3-0-0 (3)**

Geospatial Data Processing & Modeling

Pre-Requisites: **None**

Course Outcomes:

CO-1	Apply advanced GIS tools
CO-2	Prepare GIS data for various elevation models
CO-3	Solve geospatial problems using programming tools
CO-4	Analyze GIS data using complex geospatial models

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	2	2	3	2	1
CO-2	2	3	3	2	2	1
CO-3	3	3	3	3	2	2
CO-4	2	2	2	2	1	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Chapter- 1 Interpolation Methods: Local and Global methods of Interpolation, Kriging methods, Geo-statistical Methods.

Chapter- 2 DTM Applications: Slope and aspect, viewshed and watershed analysis;

Chapter- 3 GIS Models: Modelling Process; Classification, Types of process models, creating conceptual models,, Model Building Tools GIS software, Cellular Automata Model

Chapter- 4 Programming Tools: Python, R and JavaScript programming concepts for geo-processing application development

Learning Resources:

Text Books:

1. Principles of GIS for Land Resource Assessment, Burrough, P.A., Oxford Publications, 2005.

2. Concepts and Techniques of Geographic Information Systems, C.P.Lo & Albert K. W.Yeung, second Edition, Prentice Hall India Pvt.Ltd, 2016.

3. Maguire, D., M. Batty, and M. Goodchild. 2005. GIS, spatial analysis, and modeling. ESRI Press, 2005

Reference Books:

1. Andrew Crooks, Nick Malleson, Ed Manley, Alison Heppenstall, Agent-Based Modelling and Geographical Information Systems: A Practical Primer (Spatial Analytics and GIS), 2018, 1st Edition, SAGE Publications Ltd

2. Python for Geospatial Data Analysis: Theory, Tools, and Practice for Location Intelligence, 2022 by Bonny P. McClain (Author)

3. Learning Geospatial Analysis with Python - Third Edition 2019 by Joel Lawhead (Author, Contributor)

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/102/105102015/
2. https://nptel.ac.in/courses/105/107/105107155/
3. https://nptel.ac.in/courses/107/105/107105088/

CE46006 **0-1-2 (2)**

GNSS & Photogrammetry Laboratory

Pre-Requisites: **None**

Course Outcomes:

CO1	Interpret remote sensing data
CO2	Map earth surface features
CO3	Perform orientation of photographs
CO4	Generate ortho images and elevation models

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	2	1	1
CO2	1	2	1	3	1	1
CO3	1	2	2	2	1	1
CO4	2	3	2	2	1	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

1. **GNSS Laboratory:**
    a. Determine position and navigate using RTK GNSS systems
    b. Correction of RTK data for achieving centi-meter level accuracy
    c. Interpretation of GNSS data using software tools
    d. Familiarization of Geospatial Data analysis and Geographic information systems process
    e. NMEA data Logging from GPS/GNSS Receiver.

2. **Photogrammetry Laboratory:**
    a. Importing Aerial data, performing interior and exterior orientation
    b. Automatic, Semi-Automatic feature extraction
    c. DEM generation from stereo satellite images, Editing, Accuracy aspects
    d. Ortho image generation
    e. Volume and Earthwork estimation from aerial imagery

Learning Resources:

Text Books:

1. Elliott D. Kaplan Christopher J. Hegarty; Understanding GPS/GNSS Principles and Applications, Third Edition.
2. Paul D. Groves; Principles of GNSS, Inertial, and Multisensor Integrated Navigation Systems, 2008.

Reference Manuals:

1. UAV data processing Manual
2. Agisoft Metashape Manual
3. Pix4D
4. GPS user Manual

CE46008 **0-1-2 (2)**

Geospatial Data Processing and Modeling Laboratory

Pre-Requisites: **None**

Course Outcomes:

CO-1	Model Geospatial data
CO-2	Perform advanced geospatial analysis
CO-3	Develop programming tools for geospatial applications
CO-4	Publish geospatial data in public domain

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	2	1	2	1	1
CO-2	1	1	2	3	1	1
CO-3	2	1	2	1	2	1
CO-4	2	1	1	2	1	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

1. Interpolation methods
2. Viewshed and watershed analysis
3. Modelling tools
4. Python and R programming geospatial tools
5. Web GIS Applications

Learning Resources:

1. ArcGIS Manual
2. QGIS Manual
3. Python and R Manuals

CE46096 **0-0-0 (2)**

Minor Project

Pre-Requisites: **None**

Course Outcomes:

CO-1	Apply engineering principles to real-world projects
CO-2	Plan and monitor project tasks individually or as a team
CO-3	Demonstrate practical experience in project execution
CO-4	Communicate project findings clearly through reports and presentations

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	3	3	3	3	
CO-2	2	2	2	2	2	
CO-3	2	2	2	2	2	
CO-4	1	1	1	1	1	

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Description:

Students are expected to choose real world or relevant problems and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel can decide the suitability and worthiness of the project

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria

Criteria	Description	Weightages
I	Identification of Problem Domain	Weightage for each criterion will be determined by the panel and will be informed to the students.
II	Study of Existing Systems and establishing clear objectives	
III	Planning of project and work distribution within the team	
IV	Proper Documentation and Technical Writing	
V	Presentation and Response to questions	

Evaluation Criteria-CO Mapping

CO / Criteria	CO1	CO2	CO3	CO4
I	X			
II	X			
III		X	X	
IV				X
V				X

Professional Electives -3, 4, 5

CE46022 **3-0-0 (3)**

Photogrammetry

Pre-Requisites: **None**

Course Outcomes:

CO1	Acquire, measure, and analyze aerial photographs
CO2	Interpret aerial photographs
CO3	Perform orientation of photos to generate orthophotos and mosaics using aerial photographs and UAV data
CO4	Analyze the point cloud data for documentation and archiving of features

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	2	2
CO2	1	2	2	3	2	1
CO3	1	1	1	2	3	2
CO4	2	2	3	2	2	3

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Chapter-1 Fundamentals of Aerial Photography Systems: Historical development – classification, application – analogue and digital cameras – geometry of vertical photographs – scale – coordinate transformations, relief displacement – tilted and oblique photographs, Flight Planning, Interpretation keys.

Chapter-2 Stereoscopy: Stereoscopes, stereoscopic view and its exaggeration – parallax equation – parallax measurement–parallax bar - measurement of heights and determination of slopes- stereoscopic plotting instruments.

Chapter-3 Analytical Photogrammetry: Concepts of orientation-interior, relative and absolute orientation of aerial photographs, Aerial triangulation, Block adjustment, Orthophotos, Kinds of mosaics- controlled, semi-controlled, uncontrolled.

Chapter-4 Digital Photogrammetry: Automatic DTM acquisition from stereo pairs or image blocks, Colour balancing, Digital image enhancement, Feature extraction. DEM Applications in Civil Engineering

Chapter-5 UAV: History of unmanned air vehicle (UAV) development. Classifications and components of UAVs – Design standards and Regulatory aspects – Environment, Budget & Time, Airframe Design & Payload, Flight planning, Mosaicing, Ground control, Feature detection and mapping, Point cloud, 3D Models, DEM generation, Orthophoto generation, UAV Applications.

Learning Resources:

Text Books:

1. Wolf P. R., Elements of Photogrammetry with Application in GIS, McGraw Hill International Book Company, 2014, Fourth Edition.
2. Moffitt, Francis H. & Mikhail, Edward M., Photogrammetry, Harper and Row Publishers,1980.
3. Sanjib K Ghosh., Fundamentals of Computational Photogrammetry, Concept Publishing Company, 2005
4. Paul Gerin F & Thomas James Gleason., Introduction to UAV Systems, Wiley Publications, 2012

Reference Books:

1. Wilfried Linder., Digital Photogrammetry Theory and Applications, Springer 2013
2. Reg Austin, Unmanned Aircraft Systems, Wiley Publications, 2010
3. Paine D. P., Kiser J. D., Aerial Photography and Image Interpretation, John Wiley & Sons, Inc., 2012.
4. Zorn H.C., Introductory Course in Photogrammetry, ITC, Netherlands, 1980, Sixth Edition.

Online Resources:

1. https://nptel.ac.in/courses/105/104/105104100/

CE46024 **3-0-0 (3)**

Geospatial Applications for Earth Sciences

Pre-Requisites: **None**

Course Outcomes:

CO-1	Analyze thermal and microwave remote sensing data
CO-2	Identify the working mechanism and applications of active and passive microwave systems
CO-3	Analyze thermal and microwave data for natural resources and disaster management
CO-4	Classify and analyze Hyperspectral data

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	1	1	2	1	1
CO-2	2		2	1		
CO-3	2	1	2	2	1	2
CO-4	3	2	2	1	1	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Chapter- 1 Introduction to Geospatial Science: Definition and scope of geospatial science, Historical development of geospatial technologies, Basic concepts: Geodesy, Cartography, and Remote Sensing. Overview of Geographic Information Systems (GIS) and Global Navigation Satellite Systems (GNSS), Electromagnetic spectrum and energy interaction with the atmosphere and Earth surface, Remote sensing platforms and sensors, Image acquisition, processing and interpretation.

Chapter- 2 Remote sensing in atmospheric pollution monitoring: Environmental pollution and identification, point source pollution and non-point source pollution, air pollution, water pollution, soil pollution, solid waste pollution, radiation pollution-Urban heat Island, thermal pollution, noise pollution, oil spillage pollution on ocean, estimation of atmospheric parameters by radio occultation methods

Chapter- 3 Climate change studies: Causes of Climate change, solar variability, orbital mechanics, greenhouse gasses, atmospheric and oceanic circulation, and volcanic and soil aerosols and on evidence for past and present climate change. discuss material consequences of climate change, including sea level change, variations in precipitation, vegetation, storminess, and the incidence of disease. Identification using remote sensing techniques, mitigation and adaptation proposals, GCM and applications, EIA studies

Chapter- 4. **Engineering geology**: Engineering properties of rocks, Strength and failure behaviour of rocks, Rock mass strength classification, and Construction materials. Mass movement types and classifications of landslides, Landslide causes; mapping and monitoring of landslides; Landslide hazard zonation; Landslide hazard mitigation and management, Assessment Dam and Reservoir site selection: Criteria for suitable dam/ reservoir site selection in different geological setting; study for dam/reservoir site selection

Chapter- 5 Geospatial Technologies in Water Resource Management: Role of geospatial technologies in water resource management, Satellite missions for hydrological studies: Landsat, MODIS, Sentinel, GRACE. Applications in monitoring surface water, groundwater, and soil moisture. Flood hazard mapping using GIS and remote sensing, Flood modeling and prediction, Role of geospatial technologies in irrigation management, Applications of GIS in watershed management, drought vulnerability assessment and management.

Chapter-6 Agro-Meteorological Applications of Optical, Microwave, Thermal and Hyperspectral Remote Sensing: Surface and vadose zone soil moisture estimation using microwave optical and hyperspectral remote sensing techniques; Soil mapping large-scale high spatial resolution mapping of soil texture information; Assessment, Prediction and Monitoring of Droughts through satellite retrieved causal variable information; Flood mapping and monitoring; Water resources mapping; Real-time weather monitoring.

Chapter-7 Crop condition and cropping system analysis using different sensors: Crop classification and crop area estimation using digital analysis; Crop stress assessment using satellite data; Crop parameter retrieval, cropping pattern & cropping indices analysis, Crop yield modelling and estimation. Crop water requirements, Irrigation water requirements**.**

Learning Resources:

Text Books:

1. K.-T. Chang., Introduction to Geographic Information Systems, McGraw-Hill Education, 2019.
2. T. Lillesand, R.W. Kiefer, and J. Chipman., Remote Sensing and Image Interpretation, Wiley, 2015.

Reference Books:

1. G. Stephens., Remote Sensing of the Lower Atmosphere, Oxford Univ. Press, New York, 1994.
2. G.M. Foody and P.J. Curran (Eds.)., Environmental Remote Sensing and GIS in the Monitoring and Management of Natural Resources, Wiley, 2004.
3. S.S. Dara., A Textbook of Environmental Chemistry and Pollution Control, 8th Edition, S. Chand and Sons, New Delhi, 2008.
4. A.M. Melesse (Ed.)., Applications of Remote Sensing/GIS in Water Resources and Environmental Engineering, Springer, 2015.
5. M.D. Steven and J.A. Clark., Applications of Remote Sensing in Agriculture, Butterworth Publisher, London, 1990.
6. S. Ustin., Manual of Remote Sensing: Remote Sensing for Natural Resource Management and Environmental Monitoring, 3rd Edition, Volume 4, Wiley Publishing, 2001.
7. M.G. Holmes., Application Radar in Agriculture: Remote Sensing Applications to Agriculture, Butterworth Publisher, London, 1990.
8. F.S. Marzano and G. Visconti (Eds.)., Remote Sensing of Atmosphere and Ocean from Space: Models, Instruments, and Techniques, Springer Science & Business Media, 2006.
9. C.S. Rao., Environmental Pollution Control Engineering, New Age International Pvt. Ltd., Publishers, 2006.
10. Ravi P. Gupta., Remote Sensing Geology, Springer Verlag Publications, 2017.
11. Manfred Owe and Guido D'Urso., Remote Sensing for Agriculture, Ecosystems, and Hydrology, Proceedings of SPIE Volume: 5976, 2005.

Other Suggested Readings:

1. https://www.nrsc.gov.in/sites/default/files/pdf/ebooks/Chap_10_Atmosphere.pdf
2. https://www.nrsc.gov.in/sites/default/files/pdf/ebooks/Chap_1_Agriculture.pdf
3. https://appliedsciences.nasa.gov/join-mission/training/english/arset-satellite-remote-sensing-agricultural-applications

CE46026 **3-0-0 (3)**

Thermal, Microwave and Hyperspectral Remote Sensing

Pre-Requisites: **None**

Course Outcomes:

CO1	Analyze thermal and microwave remote sensing data
CO2	Identify the working mechanism and applications of active and passive microwave systems
CO3	Analyze thermal and microwave data for natural resources and disaster management
CO4	Classify and analyze Hyperspectral data

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	1	1
CO2	2		2	1		
CO3	2	1	2	2	1	2
CO4	3	2	2	1	1	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Chapter- 1 Thermal Remote Sensing: Thermal sensors and characteristics, Interpretation of thermal images, Emissivity conservation, Thermal inertia considerations, Factors effecting analysis of thermal images. Estimation of land surface temperature, applications of thermal remote sensing for geological studies, evapotranspiration etc.

Chapter- 2 Microwave Remote Sensing: Microwave Remote Sensing and its advantages. Active and passive systems. Platforms and sensors. Polarimetry – complimentary, Hybrid

Chapter- 3 Active Microwave systems: Basic principles of radar, radar equation, Resolution, Range, Phase and Angular measurements, Microwave scattering and its measurement, Relationships between scene and sensor parameters. Imaging systems, Imagery – their characteristics and interpretation, Applications in various fields, Land use/Land cover, Soil/ Rock, Hydrology and flood disaster applications

Chapter- 4 SAR Interferometry for DEM generation: Differential SAR Interferometry for surface displacement studies. Applications in land subsidence, landslide movements, glacier movements etc. Polarimetry in Radar Remote Sensing. Basic equations. Propagation of waves and wave polarization. HH, VV, HV and VH polarization data and their applications.

Chapter- 5 Hyperspectral Remote Sensing: Principles of Hyperspectral Remote Sensing, Spectral Cube, Airborne and spaceborne hyperspectral sensors. Data correction – atmospheric, radiometric and geometric, Data visualization, animation, Multiple colour composites, Observing signatures of various features and comparing with spectral libraries, Comparison of PCA, MNF, ICA derived products, spectral mapping methods: Spectral Angle Mapper (SAM), Spectral Correlation mapper, Spectral Feature Filtering (SFF), Linear Spectral Unmixing (LSU).

Learning Resources:

Text Books:

1. Kuenzer, C., and Dech, S., Thermal infrared remote sensing: sensors, methods, applications (Vol. 17), Springer Science & Business Media, 2013.
2. Woodhouse, Iain H., Introduction to microwave remote sensing. CRC press, 2017.
3. Michael T, Eismann., Hyperspectral Remote Sensing, SPIE press, USA, 2012
4. Marcus Borengasser., William S Hungate and Russel Watkins., Hyperspectral Remote Sensing: Principles and Applications, CRC Press, 2008

Reference Books:

1. Liguo Wang and Chunhui Zhao., Hyperspectral Image Processing, Springer, 2016
2. Varshney, P. K and Arora, M. K., Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data, Springer, 2014
3. Claudia, K., Stefan, D., Quantitative Remote Sensing in Thermal Infrared, Springer, 2014

Online Resources:

1. https://radar.community.uaf.edu/module-2-imaging-radar-systems/
2. https://earth.esa.int/documents/973910/1002056/CK3.pdf/4e5b4e5a-d898-43b8-9e5c-ba7494aa58c8
3. https://nptel.ac.in/courses/105/103/105103193/

CE46028 **3-0-0 (3)**

Agro Remote Sensing

Pre-Requisites: **None**

Course Outcomes:

CO1	Acquire state of art sensor data to retrieve crop parameters
CO2	Analyze the basic vegetation parameter and their interaction with different parts of Electromagnetic Spectrum
CO3	Assess the role of sensor data to study the crop conditions during various stages of agricultural practices.
CO4	Apply different sensors to predict and forecast the variables affecting the agricultural production

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	2	2
CO2	1	2	2	3	2	1
CO3	1	1	1	2	3	2
CO4	2	2	3	2	2	3

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Chapter-1 Introduction: Satellite sensors and their characteristics, Principles, instrumentation and approaches of estimating crop water requirement/ crop ET, Remote sensing of water stress (thermal/optical approaches), various crop parameters: albedo, leaf area index, fAPAR and evapotranspiration.

Chapter-2 Agro-Meteorological Applications of Optical, Microwave, Thermal and Hyperspectral Remote Sensing: Surface and vadose zone soil moisture estimation using microwave optical and hyperspectral remote sensing techniques; Soil mapping large-scale high spatial resolution mapping of soil texture information; Assessment, Prediction and Monitoring of Droughts through satellite retrieved causal variable information; Flood mapping and monitoring; Water resources mapping; Real-time weather monitoring.

Chapter-3 Crop condition and cropping system analysis using different sensors: Crop classification and crop area estimation using digital analysis; Crop stress assessment using satellite data; Crop parameter retrieval, cropping pattern & cropping indices analysis, Crop yield modelling and estimation. Crop water requirements, Irrigation water requirements

Chapter-4 Crop Informatics: ICT application in agriculture at village/ block scale, Demonstration on DSS in agriculture; Precision farming.

Learning Resources:

Text Books:

1. M.D. Steven, J.A. Clark, Applications of remote sensing in agriculture., Butterworth publisher, London, 1990
2. Ustin, S, Manual of Remote Sensing, Remote Sensing for Natural Resource Management and Environmental Monitoring, Volume 4, Willey Publishing. 2001, 3rd Edition.
3. M.V.K. Sivakumar, R. Gommes, W. Baier, Agrometeorology and sustainable agriculture, Agricultural and Forest Meteorology, 2000
4. Holmes M.G., Application radar in Agriculture, Remote sensing applications to agriculture, Butterworth publisher, London, 1990.

Reference Books:

1. H.S. Mavi, Introduction to Agrometeorology, Oxford & IBH Publishing Co. Pvt. Ltd., 1994, Second edition.
2. Manfred Owe, Guido D'Urso, Remote Sensing for Agriculture, Ecosystems, and Hydrology, Proceedings of SPIE, 2005

Online Resources:

1. https://appliedsciences.nasa.gov/join-mission/training/english/arset-satellite-remote-sensing-agricultural-applications
2. https://www.nrsc.gov.in/sites/default/files/pdf/ebooks/Chap_1_Agriculture.pdf
3. https://www.nrsc.gov.in/sites/default/files/pdf/ebooks/Chap_13_AgricultureDroughtMonitoring.pdf

CE46030 **3-0-0 (3)**

Advanced Digital Image Processing

Pre-Requisites: **None**

Course Outcomes:

CO-1	Analyze thermal and microwave remote sensing data
CO-2	Identify the working mechanism and applications of active and passive microwave systems
CO-3	Analyze thermal and microwave data for natural resources and disaster management
CO-4	Classify and analyze Hyperspectral data

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	1	1	2	1	1
CO-2	2		2	1		
CO-3	2	1	2	2	1	2
CO-4	3	2	2	1	1	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Chapter-1 Image Analysis and Classification Techniques: Supervised Classification, Training set - Statistical computation, understanding feature space & scatter plots, signature purity & separability,

Chapter-2 Signature Baye's decision rule, non-parametric & parametric classification techniques, minimum distance rule, Parallelepiped algorithm, maximum like-hood method, unsupervised and hybrid classification techniques, classification analysis - confusion matrix, error analysis & kappa coefficient, Analysis of Multi-Temporal series and change detection; Object based Fuzzy, AI/ML classification techniques.

Chapter-3 Image Enhancements: Image Rectification and Restoration. Image enhancement - Contrast Manipulation, Gray-Level Thresholding, Level Slicing, Contrast Stretching. Convolution, Edge Enhancement, Spatial feature manipulation. Image transformations; Pattern recognition, Image classification, Image fusion and change detection; PCA, data fusion techniques.

Chapter-4 Colour representations and transforms, Image Histograms and statistics, Geometric transformations /Georeferencing Technique, Image enhancement techniques –I & II. Multispectral transforms: scatter plot, principal component analysis and decorrelation stretch, Spatial filtering techniques, Frequency domain - Fourier transformation, Basic Image Compression techniques and different image file formats, Image classification techniques. Principles of image interpretation, SAR Interferometry (InSAR) Technique, Image merging and mosaicking techniques, Applications of Image Analysis, Limitations and future of Digital Image Processing Technique.

Learning Resources:

Text Books:

1. James B. Campbell & Randolph H. Wynne., Introduction to Remote Sensing, The Guilford Press, 2011.
2. Charles Elachi & Jakob van Zyl., Introduction to the Physics and Techniques of Remote Sensing, John Wiley & Sons, 2006.

Reference Books:

1. Christian Mätzler., Thermal Microwave Radiation: Applications for Remote Sensing, The Institution of Engineering and Technology, London, 2006.
2. R.A. Schowengerdt., Remote Sensing: Models and Methods for Image Processing, Academic Press, 2007.
3. T.M. Lillesand & R.W. Kiefer., Remote Sensing and Image Interpretation, John Wiley and Sons, 2015.

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/108/105108077/
2. https://nptel.ac.in/courses/105/101/105101206/
3. https://nptel.ac.in/courses/105/107/105107201/

CE46032 **3-0-0 (3)**

Web and Mobile GIS

Pre-Requisites: **None**

Course Outcomes:

CO1	Publish geospatial data in web environment
CO2	Analyze the geospatial layers in web environment
CO3	Prepare and publish geospatial data in mobile applications
CO4	Develop applications in web and mobile platforms

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	3	2	1
CO2	1	2	2	2	3	1
CO3	2	2	1	1	3	2
CO4	3	2	3	2	2	3

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Chapter- 1 Web GIS Fundamentals: Definition, Concept of Web GIS, Web GIS Architecture and Components – Web Server – GIS Server / Application Server – Database Server, Open Server Standards - Protocols: HTTP, FTP, SMTP, Service Oriented Architecture - REST / SOAP service Protocols.

Chapter- 2 Web Programming Methods: HTML Elements - Formatting and Fonts – Anchors – Backgrounds – Images – Hyperlinks – Lists – Tables – Frames - HTML Forms – CSS: Introduction to CSS – Basic syntax and styles - Inline Styles – Embedding Style Sheets - Linking External Style Sheets – Margins and Padding - Positioning using CSS – Javascript: Data types and Variables - Operators, Expressions, and Statements - Functions - Objects - Array, Date and Math related Objects - Document Object Model - Event Handling - Controlling Windows & Frames and Documents - Form handling and validations, XML and GML concepts

Chapter -3: Servers for Handling Geospatial Data: PHP Introduction –Basic Program Structures and Syntax - Print/echo - Variables and constants – Strings and Arrays – Operators, Control structures and looping structures – Functions – Reading Data in Web Pages - Embedding PHP within HTML – Establishing connectivity with database. Geo Server Introduction – Web Administration – Geo server data directory – loading and working with data – shape file – PostGIS file – other web format data - styling the layers – publishing map services – Spatial functions, security – demos and case studies on Geo server.

Chapter- 4: Web-GIS Application Development: Basic file formats (vector, raster) – JSON, GeoJSON, Geodatabase, Projections and EPSG Co-ordinate Systems, OGC Web Map services - WMS, WFS, WCS, WPS – Styling, tiling & caching, Application development with OpenLayers, Leaflet, ArcGIS API, Mobile applications for location-based services.

Learning Resources:

Text Books:

1. Web GIS: Principles and Applications, Pinde Fu and Jiulin Sun, ESRI Press, 2011

2. GIS for Web Developers. Adding where to your web applications, Davis, S, First Edition, The Pragmatic Programmers LLC, 2007.

Reference Books:

1. Steven Holzner, "PHP: The Complete Reference" 1st Edition TATA McGraw Hill ,2008 ISBN: 9780070223622

2. Stefano Iacovella, Brian Youngblood "GeoServer Beginner's Guide" Packt Publishing , 2nd Revised Edition, 2017, ISBN-13: 978-1849516686

3. Anuj Tiwari, Kamal Jain, Concepts and Applications of WEBGIS, Nova Science Publishers,2017, ISBN-1536127795.

Online Resources:

1. https://felix-rz.github.io/pdf/2013_Tutorial_GIS.pdf

CE46034 **3-0-0 (3)**

Atmospheric Remote Sensing

Pre-Requisites: **None**

Course Outcomes:

CO-1	Identify atmospheric parameters and its significance on climate change
CO-2	Analyse atmospheric parameters from satellite images
CO-3	Interpret satellite imageries for climate change
CO-4	Assess atmospheric changes from satellite images

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	1	2	3	2	1
CO-2	2	1	3	3	2	1
CO-3	2	1	3	2	2	2
CO-4	1	1	3	2	1	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Chapter-1 Introduction: Characteristics of the atmosphere, satellite platforms and orbits, atmospheric inversion, Spectroscopy of atmospheric molecules, absorption and emission of radiation, blackbody emission, radiative transfer equation, polarization, refractive index, reflection and transmission at a plane boundary, particle scattering and extinction, Earth radiation budget, extinction and scattering based passive remote sensing of aerosol, ozone, trace gases, cloud properties, ocean color, sea-surface temperature, vertical profiles of temperature and humidity, limb sounding techniques

Chapter-2 Satellite datasets: Types of parameters and its wavelengths, Earth observatory satellites, microwave remote sensing, hyperspectral remote sensing, Ground based sensors, interpretation strategies for atmospheric parameters, validation principles and validation errors, atmospheric sensors validation, advanced ground based instruments.

Chapter-3 Remote sensing in atmospheric pollution monitoring: Environmental pollution and identification, point source pollution and non-point source pollution, air pollution, water pollution, soil pollution, solid waste pollution, radiation pollution-Urban heat Island, thermal pollution, noise pollution, oil spillage pollution on ocean, estimation of atmospheric parameters by radio occultation methods

Chapter-4 Climate change studies: Causes of Climate change, solar variability, orbital mechanics, greenhouse gases, atmospheric and oceanic circulation, and volcanic and soil aerosols and on evidence for past and present climate change. discuss material consequences of climate change, including sea level change, variations in precipitation, vegetation, storminess, and the incidence of disease. Identification using remote sensing techniques, mitigation and adaptation proposals, GCM and applications, EIA studies.

Learning Resources:

Text Books:

1. F.S. Marzano and G. Visconti (Eds.)., Remote Sensing of Atmosphere and Ocean from Space: Models, Instruments and Techniques, Springer Science & Business Media, 2006.
2. D. Lubin and R. Massom., Polar Remote Sensing: Volume I: Atmosphere and Oceans, Springer Science & Business Media, 2006.

Reference Books:

1. C. Elachi and J. Van Zyl., Introduction to the Physics and Techniques of Remote Sensing, John Wiley & Sons, 2021.
2. C.S. Rao., Environmental Pollution Control Engineering, New Age International Pvt. Ltd., Publishers, 2006.
3. G. Stephens., Remote Sensing of the Lower Atmosphere, Oxford Univ. Press, New York, 1994.
4. S.S. Dara., A Textbook of Environmental Chemistry and Pollution Control, 8th Edition, S. Chand and Sons, New Delhi, 2008.

Other Suggested Readings:

1. https://www.nrsc.gov.in/sites/default/files/pdf/ebooks/Chap_10_Atmosphere.pdf

3rd Semester

CE46089 **0-0-2 (2)**

Seminar & Technical Writing

Pre-Requisites: **None**

Course Outcomes:

CO-1	Identify a domain specific and contemporary topic
CO-2	Review literature to identify gaps and define objectives & scope of the work.
CO-3	Develop a prototype/model, experimental set-up or software systems to meet the objectives
CO-4	Analyze the results to draw valid conclusions

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	2			2	1
CO-2	2	2			1	2
CO-3	2	2	3	3	3	2
CO-4	2	2		3	3	

Description:

Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project

The method of evaluation should be as per the guidelines stipulated for the M.Tech. Project evaluation. The template for preparation of the project report may be downloaded from (https://www.nitw.ac.in/path/?dept=/nitwForms) under PG Forms. The students are required to submit a report showing that plagiarism is within 30%. The M.Tech. Project work will be evaluated for 100 marks, with the following weightages:

Component	**Weightage**
Periodic evaluation by Guide	40 marks
Mid-term review	20 marks
End Semester viva-voce examination	40 marks
Total	100 marks

The midterm review and the end semester viva-voce examination will be conducted by a committee constituted by the Head of the Department. If the performance of a student is not satisfactory, he/ she can be awarded ‘F’ grade. Such a student will be given a maximum time of three months to improve his/her performance. If the performance of such a student is not satisfactory even after the extended time period, he/ she will have to repeat the project work in the next academic year.

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	Description	Weightages
I	Selection of Topic	Weightage for each criterion will be determined by the panel and will be informed to the students.
II	Literature Survey	
III	Objectives and Solution Methodology	
IV	Performance of the Task and clarity on the work	
V	Report Preparation	
VI	Presentation and Response to questions	

Evaluation Criteria-CO Mapping

CO / Criteria	CO1	CO2	CO3	CO4
I	X			
II		X		
III		X		
IV			X	
V				X
VI				X

CE46093 **0-0-0 (2)**

Comprehensive Viva Voce

Pre-Requisites: **None**

Course Outcomes:

CO-1	Comprehend the knowledge gained in the course work
CO-2	Demonstrate the ability in problem solving
CO-3	Communicate effectively using engineering terminology

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	3	3	3		
CO-2	3	3	3	3		
CO-3	2	2	2	2		

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Description:

In Comprehensive viva-voce each student will be evaluated for their overall comprehension of the course work and laboratory training that they have undergone. The students will be expected to answer questions orally, write down simple equations, draw plots, schematics, write simple code etc. as questioned by the panel. Assessment will be done by the panel based on the student response.

CE46091 **0-0-2 (2)**

SHORT TERM INDUSTRIAL / RESEARCH EXPERIENCE

Pre-Requisites: **None**

Course Outcomes:

CO-1	Apply engineering principles to real-world problems, gaining practical experience
CO-2	Plan, manage and execute the work with ethical consideration
CO-3	Review the social and environmental impact of the work
CO-4	Communicate the learnings through report and presentation

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	3	3	3	3	
CO-2	2	2	2	2	2	
CO-3						3
CO-4						

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Description:

Every student has to undergo either a Summer Internship / EPICS / Research project. The summer internship may be undergone in an Industry/Research organization or any premier academic Institution, including NIT Warangal for 6-8 weeks. The EPICS/research project shall be registered under the guidance of any faculty member in the institute. The student is required to submit a report and present the work before an evaluation committee, nominated by the Head of the Department.

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	Description	Weightages
I	Relevance of the area of work	Weightage for each criterion will be determined by the panel and will be informed to the students.
II	Performance of the Task	
III	Crucial learnings from the work	
IV	Report Preparation	
V	Presentation and Response to questions	

Evaluation Criteria-CO Mapping

CO / Criteria	CO1	CO2	CO3	CO4
I	X			
II		X		
III			X	
IV				X
V				X

CE46097 **0-0-0 (8)**

DISSERTATION: PART-A

Pre-Requisites: **None**

Course Outcomes:

CO-1	Identify a topic in advanced areas of Geoinformatics.
CO-2	Review literature to identify gaps and define objectives and scope of the work.
CO-3	Employ the ideas from literature and develop research methodology.
CO-4	Develop a model, experimental set-up and / or computational techniques necessary to meet the objectives.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	2	3	1		3
CO-2	3	2	3	1		3
CO-3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Description:

Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project

Dissertation Evaluation:

i. The dissertation shall be submitted as per the schedule given in the academic calendar.
ii. The dissertation supervisor will periodically review the progress of the student and finally give his/her assessment of the work done by the student.
iii. The Dissertation Part – A will be evaluated for 100 marks, with the following weightages:

Sub-component	**Weightage**
a) Periodic evaluation by Guide	40 marks
b) Mid-term review	20 marks
c) End Semester viva-voce examination	40 marks

The midterm review and the end semester viva-voce examination will be conducted by a committee constituted by the Head of the Department.

iv. The marks may be distributed among various components like selection of topic, problem statement, literature review, methodology, oral and written presentation of the work done and performance in viva-voce examination.
v. If the performance of the student in Dissertation Part-A is not satisfactory, he/ she will be awarded ‘F’ grade. The student has to repeat the dissertation work by registering in the next semester. Such students may be given an option either to continue with the same topic and with the same guide or change the guide and the topic of his/ her dissertation.

Evaluation Criteria

The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	Description	Weightages
I	Selection of Topic	Weightage for each criterion will be determined by the panel and will be informed to the students.
II	Literature Survey	
III	Defining the Objectives and Solution Methodology	
IV	Performance of the Task	

Evaluation Criteria - CO Mapping:

CO / Criteria	CO1	CO2	CO3	CO4
I	X			
II		X		
III			X	
IV				X

4th Semester

CE46098 **0-0-0 (12)**

DISSERTATION – B

Pre-Requisites: **CE46097**

Course Outcomes:

CO-1	Identify the materials and methods for carrying out experiments/develop a code.
CO-2	Execute the research methodology with a concern for society, environment and ethics
CO-3	Analyse, discuss and justify the results/trends and draw valid conclusions.
CO-4	Prepare the report as per recommended format and present the work orally adhering to stipulated time.
CO-5	Explore the possibility to publish/present a paper in peer reviewed journals/conference proceedings without plagiarism.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2		3	3	2	3
CO-2	2		3	3	2	3
CO-3	3		3	3	2	3
CO-4	3	3	3	3	3	3
CO-5	3	3	3			3

1 - Slightly; 2 - Moderately; 3 - Substantially

Description:

Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project.

Dissertation Evaluation:

i. The dissertation shall be submitted as per the schedule given in the academic calendar.
ii. The dissertation supervisor will periodically review the progress of the student and finally give his/her assessment of the work done by the student.
iii. The Dissertation Part – B will be evaluated for 100 marks, with the following weightages:

Sub-component	**Weightage**
a) Periodic evaluation by Guide	40 marks
b) Mid-term review	20 marks
c) End Semester viva-voce examination	40 marks

The midterm review will be conducted by a committee constituted by the Head of the Department. The end semester examination will be conducted by an External Examiner along with the evaluation committee constituted by the Head of the Department.

iv. A student will be permitted to submit the dissertation only if he/she completes all the courses as required in the program.

v. The marks may be distributed among various components like selection of topic, problem statement, literature review, methodology, oral and written presentation of the work done and performance in end semester examination.
vi. Dissertation and Viva-Voce: A student shall be required to submit a report on the Dissertation work carried out by him/her. The template for the dissertation report may be downloaded from (https://www.nitw.ac.in/main/PGForms/NITW/). The students are required to submit a report showing that the plagiarism is within 20%. Three/four bound copies along with a soft copy of the dissertation shall be submitted to the Head of the Department/Centre within the last date prescribed in the Academic Calendar for the purpose. Dissertation viva - voce will be held within the date fixed in the academic calendar and the grades will be finalized by the committee.
vii. If the performance of the student in Dissertation Part-B is not satisfactory, he/ she will be awarded 'F' grade. The student has to repeat the dissertation work by registering in the next semester.
viii. Extension of dissertation work (Part-B) beyond the deadline of submission in very special case may be granted by the Dean (Academic) on recommendation of the department/center for a maximum period of 3 months and he/she will be awarded "I" Grade. The viva-voce has to be completed within the extension period. The student shall not be eligible either for award of scholarship during the extension period or any medal/prize. However, if the student had been absent on medical grounds and his/her dissertation had been extended, he/she may be eligible for award of medal or prize, if any. If the above-mentioned extension period encroaches into the next semester, the student will have to pay the tuition fee on par with full time student.

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria as a continuation of Dissertation Part A.

Task	Description	Weightages
IV	Performance of the Task	Weightage for each criterion will be determined by the panel and will be informed to the students.
V	Dissertation Preparation	
VI	Review (Presentation & Understanding)	
VII	Viva-Voce	
VIII	Publications /Possibility of publication	

Evaluation Criteria-CO Mapping:

CO / Criteria	CO1	CO2	CO3	CO4	CO5
IV	X	X			
V				X	
VI			X		
VII				X	
VIII					X