

Minor Programme

IN

GEOINFORMATICS

Jointly Offered by

Department of Civil Engineering

&

Department of Architecture and Planning

(Applicable from 2023 Admission onwards)

**NATIONAL INSTITUTE OF TECHNOLOGY CALICUT
Kozhikode - 673601, KERALA, INDIA**

Brief summary of the Programme

The minor programme in Geoinformatics will cover 90% syllabus required for the Graduate Aptitude Test in Engineering (GATE) under the Geomatics Engineering paper. The graduates who opt for this Minor programme will have job and research opportunities in the government sector: Department of Space (ISRO-NRSC, ISRO-RRSCs, ISRO-SAC), State Remote Sensing Centers, Geology and Mining, etc. The graduates will also have opportunities in private sector: ESRI-India, ERDAS India, RMSI, Rolta India, and geospatial industries like Aarav Unmanned Systems Pvt. Ltd, Tech Mahindra, GeoknoPvt Ltd, Satsure etc. The graduates of this Minor programme can also opt for higher studies: M.Tech in Geomatics / Remote Sensing (IITs [IIT Bombay, IIT Kanpur, IIT Kharagpur, IIT Roorkee, etc.]; IIRS, Dehradun; IIST, Trivandrum; NITs [NIT Surathkal, NIT Allahabad, NIT Warangal, NIT Bhopal etc.])

Name of the Coordinators for the Programme (at least one faculty from each Department/ School proposing the Programme)

Dr. Agilan V., Assistant Professor, CED, NITC

Dr. Bimal P., Assistant Professor, CED, NITC

Number of seats expected for the Programme: 10

BASKET OF COURSES

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Additional Categories		
								EI	DA	HM
1.	CE2014E	Introduction to Geomatics	3	0	0	6	3	N	N	N
2.	CE3022E	Remote Sensing and GIS	2	0	2	5	3	N	Y	N
3.	CE3052E	Digital Image Analysis for Remote Sensing	3	0	0	6	3	N	N	N
4.	CE4030E	Geoinformatics	2	0	2	5	3	N	N	N
5.	AP3031E	Introduction to Geostatistics	2	0	2	5	3	N	N	N
6.	AP3032E	Automating Geospatial Processes	2	0	2	5	3	N	Y	N
7.	AP3033E	Remote Sensing Applications for Spatial Analysis	2	0	2	5	3	N	N	N
8.	AP3034E	Specialised Applications in Remote Sensing	3	0	0	6	3	N	N	N

CE2014E INTRODUCTION TO GEOMATICS

L	T	P	O	C
3	0	0	6	3

Total lecture sessions: 39

Course Outcomes:

CO1: Apply geospatial tools to solve real world problems

CO2: Analyze and correct errors in the geospatial data

CO3: Select appropriate geospatial tools for engineering applications

Introduction: Components of geomatics (Computer Science, Geodesy, Cartography, Photogrammetry, Remote Sensing, Global Navigation Satellite System, Geographic Information System) – Evolution of geomatics – Advantages of geomatics

Surveying Measurements: Accuracy – Precision – Laws of accidental errors – Probability curve – Principle of least squares – Laws of weights – Probable error – Normal equation – Most probable value – Errors and their adjustments – Regression analysis – Correlation coefficient – Least square adjustment – Statistically significant value – Chi square test

Applications: Environmental monitoring and modelling – Disaster management – Meteorology – Agriculture and forestry – Urban planning and management – Logistics – Health and human services – Marketing and advertising – Transportation – Real estate – Insurance – Crime & Defense

References:

1. Srivastava, G. S., *Introduction to Geoinformatics*, McGraw Hill Education (India) Private Limited, 1st edition, 2014
2. Manoj K. Arora and R.C. Badjatia, *Geomatics Engineering*, Nem Chand publishers, 1st edition, 2011
3. Jay L. Devore, *Probability and statistics for Engineering and the Sciences*, 8th edition, Cengage Learning, 2014.
4. Satheesh Gopi, R.Sathikumar, N. Madhu, *Advanced Surveying: Total Station, GPS, GIS & Remote Sensing*, Pearson Education, 2nd edition, 2017.

CE3022E REMOTE SENSING AND GIS

L	T	P	O	C
2	0	2	5	3

Total lecture sessions: 26

Total practical sessions: 26

Course Outcomes:

CO1: Analyse the remote sensing images/ aerial photographs and extract data.

CO2: Apply GIS techniques for spatial data analysis by understanding the principles of GIS.

CO3: Plan and execute a GNSS survey by understanding the principles of GNSS.

Concepts and foundations of remote sensing- Energy sources and radiation principles- Energy interactions in the atmosphere – Energy interaction with earth surface features - Spectral reflectance of vegetation, soil and water - Atmospheric influence on spectral response patterns

Remote sensing platforms – Sun synchronous systems- Geosynchronous systems-Across track and along track scanning systems – Types of sensor resolutions (Spatial, Spectral, Radiometric and Temporal resolution) – Multispectral and thermal scanners – Visual Image Interpretation – Standard False Colour Composites – Elements of visual image interpretation – Introduction to Digital Image Processing

Aerial Photogrammetry – Basic concepts –Geometry of vertical photographs – Scale and Flying height – Relief displacement

Principles of GNSS – Components of GNSS – GNSS (GPS, GLONASS) – SBAS (GAGAN) – Planning a GPS Survey – Positioning methods (point positioning, relative positioning, Static, Fast static, RTK and Differential Positioning)

GIS basics - Maps – scale - coordinate system – GIS definition – Components of GIS – Spatial, Non- spatial and metadata - Types of spatial data - Raster and vector data formats

List of Exercises for Practical Sessions:

1. Downloading satellite images – Creating colour composites – Subsetting and Mosaicking satellite images
2. Georeferencing satellite images/aerial photographs/toposheets
3. Satellite image interpretation in GIS
4. GPS survey using QField
5. DGPS survey
6. Digitizing real world features in GIS
7. Map layout preparation in GIS

References:

1. Lo C. P and K.W. Yeung, *Concepts and Techniques of Geographic Information Systems*, Pearson Education, 2nd edition, 2016
2. Manoj K. Arora and R.C. Badjatia, *Geomatics Engineering*, Nem Chand publishers, 1st edition, 2011
3. Satheesh Gopi, R. Sathikumar, N. Madhu, *Advanced Surveying: Total Station, GPS, GIS & Remote Sensing*, Pearson Education, 2nd edition, 2017.
4. Thomas. M. Lillesand, Ralph. W. Kiefer and Jonathan W. Chipman, *Remote Sensing and Image Interpretation*, John Wiley and Sons, Inc., 6th edition, 2011.

CE3052E DIGITAL IMAGE ANALYSIS FOR REMOTE SENSING

L	T	P	O	C
3	0	0	6	3

Total lecture sessions: 39

Course Outcomes:

CO1: Understand basics of digital image and analyse the multi-band remote sensing image

CO2: Assess the radiometric and geometric errors and apply correction

CO3: Apply image enhancement, image transformation and classification techniques for feature extraction

Introduction: Characteristics of Digital Image Data, Image Histogram. Spectral Ranges Commonly Used in Remote Sensing, Multispectral Data, Image Scattergram, Variance-Covariance Matrix, Correlation Matrix.

Error Correction and Registration of Image Data: Remote Sensing Scanning Systems, Sources of Radiometric Distortion, Corrections for Radiometric Errors. Sources of Geometric Distortion, Correction for Geometric Errors: Image Registration and Resampling

Radiometric Enhancement Techniques: Contrast Modification, Histogram Equalization, Histogram Matching, Density Slicing.

Geometric Enhancement: Image Domain Techniques - Image Smoothing, Edge Detection and Enhancement, Line Detection, General Convolution Filtering.

Image Transformations: Principal Component Analysis (PCA), Colour Transforms (RGB-HIS, CYMK), Indices (EVI, NDVI, NDWI, SAVI)

Classification Techniques: Supervised Classification Algorithms, Unsupervised Classification Algorithms, Accuracy Assessment.

References:

1. John A. Richards and Xiuping Jia, *Remote Sensing Digital Image Analysis: An Introduction*, Springer (Sge), Fifth Edition, 2013.
2. John R. Jenson, *Remote Sensing of the Environment: An Earth Resource Perspective*, Pearson Education India, Second edition, 2013.
3. Rafael C. Gonza Lez and Richard E. Woods, *Digital Image Processing*, Pearson Education, Fourth Edition, 2018.
4. Robert A. Schowengerdt, *Remote Sensing: Models and Methods for Image processing*, Elsevier; Third edition, 2010.
5. Thomas. M. Lillesand, Ralph. W. Kiefer and Jonathan W. Chipman, *Remote Sensing and Image Interpretation*, John Wiley and Sons, Inc., Sixth Edition, 2011.

CE4030E GEOINFORMATICS

L	T	P	O	C
2	0	2	5	3

Total lecture sessions: 26

Total practical sessions: 26

Course Outcomes:

CO1: Select appropriate map projections and coordinate systems for intended application

CO2: Assess and manage the geospatial data quality

CO3: Carry out various geospatial analysis using geoprocessing utilities

Maps: Types, Characteristics, Coordinate systems, Map projections, Datums.

Introduction to GIS: Definition of GIS, Evolution, Components of GIS, DBMS, Geospatial data representation (Raster, Vector, Object-Oriented).

Geospatial Data Quality: Sources of geospatial data and attribute data, Geospatial data quality concepts, Components of geospatial data quality, Assessment of data quality, Managing spatial data errors, Geospatial data standards.

Raster Geoprocessing: Characteristics of raster geoprocessing, Acquiring and handling raster geospatial data, Raster geospatial data analysis, Output functions of raster geoprocessing

Vector Geoprocessing: Characteristics of vector geoprocessing, Vector data input functions, Non-topological GIS analysis functions, Topological functions (feature based, layer based), Vector geoprocessing output functions

Digital Terrain Modelling: Definitions and terminology, approaches to digital terrain data sampling, acquisition of digital terrain data, Data processing, analysis and visualization, Applications of Digital terrain models.

List of Exercises for Practical Sessions:

1. Georeferencing the raster map and coordinate conversion
2. Digitization and extracting various vector layers from map
3. Editing attribute tables, query processing and preparing map layouts
4. Preparation of point vector layer from tabular coordinate data
5. Spatial interpolation using the point vector layer
6. Proximity analysis and buffer analysis using vector layers
7. Vector to raster conversion and performing overlay analysis
8. Downloading satellite-based DSM and extracting area of Interest
9. Watershed delineation using DSM
10. Volume estimation using DSM

References:

1. Lo C. P and K.W. Yeung, *Concepts and Techniques of Geographic Information Systems*, Pearson Education, Second edition, 2016.
2. Michael N. Demers, *Fundamentals of Geographic Information Systems*, Wiley India Pvt. Ltd, Third Edition, 2008.
3. Peter. A. Burrough and Rachel A. Mcdonnell, *Principles of Geographical Information Systems*, Oxford University Press, USA, Second Edition, 1998.
4. Paul A. Longley, Michael Goodchild, David J. Maguire and David W. Rhind (Eds.), *Geographical Information Systems: Principles, Techniques, Management and Applications*, John Wiley and Sons, Second Edition, 2005.
5. Tor Bernhardsen, *Geographic Information Systems: An Introduction*, Wiley India Pvt. Ltd, Third Edition, 2007.

AP3031E INTRODUCTION TO GEOSTATISTICS

L	T	P	O	C
2	0	2	5	3

Total lecture sessions: 26

Total practical sessions: 26

Course Outcomes:

CO1: Define and explain key concepts in geostatistics, including spatial autocorrelation, variograms, and covariance functions

CO2: Conduct exploratory data analysis to gain insights into the spatial distribution of data.

CO3: Identify and analyze real-world civil engineering / urban planning problems where geostatistical methods can be applied.

Introduction: Overview of geostatistics and its applications, Basic principles of spatial data analysis, Introduction to spatial autocorrelation and variograms. Mapping techniques for spatial data
Exploratory data analysis in geostatistics,

Spatial Interpolation: Tobler's first law of Geography, Interpolation methods for geographical data: IDW, Kriging, Spline and Trend. Modelling urban density, Modifiable Areal Unit Problem, density surfaces and gradients. Neighbourhood analysis with raster data, Using grids for forecast, travel, and socio-economic data collection.

Spatial Statistics: Spatial auto correlation, measures of Spatial clustering and dispersion, Grouping techniques, Hotspot analysis. Measures of geographical distribution of facilities, utility systems, settlements etc. Shannon's entropy measure of sprawl. Regressions: Spatial OLS regression, exploratory regression techniques, geographically weighted regressions. Spatial econometrics

Project: Application of geostatistical methods to real-world problems, Individual or group projects, Presentation of project findings and discussion

List of Exercises for Practical Sessions:

1. Exploratory data analysis in geostatistics, mean distance, deviation ellipse
2. Interpolation exercise
3. Population interpolation
4. Spatial autocorrelation
5. Shannons entropy

References:

1. D. Manley, Scale, Aggregation, and the Modifiable Areal Unit Problem, in *Handbook of Regional Science*, Berlin, Heidelberg: Springer Berlin Heidelberg, 2014, pp. 1157-1171.
2. M. Fischer and A. Getis, *Handbook of Applied Spatial Analysis*, Berlin, Heidelberg: Springer Berlin Heidelberg, 2010.
3. Gaetan and X. Guyon, *Spatial Statistics and Modeling*, Vol. 147, no. 1975, New York, NY: Springer New York, 2010.
4. R. Webster and M. A. Oliver, *Geostatistics for Environmental Scientists*, Chichester: John Wiley & Sons, 2009.

AP3032E AUTOMATING GEOSPATIAL PROCESSES

L	T	P	O	C
2	0	2	5	3

Total lecture sessions: 26

Total practical sessions: 26

Course Outcomes:

CO1: Define and explain key concepts in geostatistics, including spatial autocorrelation, variograms, and covariance functions

CO2: Conduct exploratory data analysis to gain insights into the spatial distribution of data.

CO3: Identify and analyze real-world civil engineering / urban planning problems where geostatistical methods can be applied.

Introduction to Python for Geospatial Analysis: Overview of Python programming language, Introduction to Python libraries for geospatial analysis (e.g., arcpy, geopandas), Basic Python syntax and data types.

Working with Spatial Data in Python: Introduction to spatial data formats (shapefiles, geodatabases), Reading and writing spatial data using geopandas, Basic spatial data manipulations and transformations.

Automating Geoprocessing Tasks with arcpy: Introduction to arcpy module in ArcGIS, Creating and managing geodatabases using arcpy, Automating common geoprocessing tasks with Python scripts.

Spatial Analysis with Python: Performing spatial analysis operations using arcpy, Exploring spatial relationships and overlays. Integration of Python scripts with ArcGIS ModelBuilder.

Project: Application of geostatistical automation to real-world problems, Individual or group projects, Presentation of project findings and discussion

List of Exercises for Practical Sessions:

1. Basics syntax of python
2. Importing and exploring spatial data with geopandas
3. Basic spatial data manipulations and transformations
4. Automating common geoprocessing tasks with Python scripts
5. Exploring spatial relationships and overlays.

References:

1. Yang, *Introduction to GIS programming and fundamentals with Python and ArcGIS*, 1st ed., New York: CRC Press, 2017.
2. P. A. Zandbergen, *Python Scripting for Arcgis*, Redlands, CA: ESRI Press, 2015.
3. C. Garrard, *Geoprocessing with Python*, Shelter Island, NY: Manning, 2016.
4. P. Crickard, E. van Rees, and S. Toms, *Mastering Geospatial Analysis with Python Explore GIS Processing and Learn to Work with Geodjango, Cartoframes and MapboxGL -Jupyter*. Birmingham: Packt Publishing, 2018.

AP3033E REMOTE SENSING APPLICATIONS FOR SPATIAL ANALYSIS

L	T	P	O	C
2	0	2	5	3

Total lecture sessions: 26

Total practical sessions: 26

Course Outcomes:

CO1: Comprehend the principles of remote sensing

CO2: Identify urban features using spectral signatures

CO2: Assess Satellite Images for Spatial Analysis

CO3: Generate thematic maps using spatial analysis

Definition and Principles, Platforms and sensors, Visual image interpretation, interpretation keys, generation of thematic maps. Introduction to Google Earth Engine.

Remote Sensing for Land Cover Analysis, Remote Sensing and Land Use Policy.

Land Use and Land Cover Change - Definitions and Distinctions, Importance and Applications in Environmental Studies, Forest Cover and Deforestation Analysis, Change Detection in Land Cover and Land Use, Temporal Analysis, Techniques for Detection, Applications in Urban and Rural Setting, Urbanization Patterns and Trends.

Spatial Application of remote sensing: Classification and mapping- Urban Land Use Delineation- Study of Urban Sprawl and Growth Trends- Environmental Monitoring.

List of Exercises for Practical Sessions:

1. Image Acquisition
2. Image Correction and Rectification
3. Image Processing
4. Image Classification
5. Map generation

References:

1. James B.Campbell and Randolph H.Wynne, *Introduction to Remote Sensing*, Sixth Edition, The Guilford Press, New York, 2022.
2. Thomas. M. Lillesand, Ralph. W. Kiefer and Jonathan W. Chipman, *Remote Sensing and Image Interpretation*, John Wiley and Sons, Inc., 6th edition, 2015.
3. Jarocińska, Anna, van der Meer, Freek D., *Remote Sensing and Digital Image Processing*, Springer, 2016.
4. Reddy, Anji M., *Textbook of Remote Sensing and Geographical Information Systems*, IVth Edition B. S. Publications, 2012.
5. Sabins, F.F.Jr, *Remote Sensing Principles and Image interpretation*, W.H.Freeman & Co, Third Edition, 2007.
6. W.G.Rees, *Physical Principles of Remote Sensing*, Cambridge University Press, 3rd edition, 2012.

AP3034E SPECIALISED APPLICATIONS IN REMOTE SENSING

L	T	P	O	C
3	0	0	6	3

Total lecture sessions: 39

Course Outcomes:

CO1: Explain the use of advanced remote sensing applications

CO2: Choose appropriate techniques for advanced remote sensing

CO3: Identify and analyse the use of LiDAR, Microwave and hyperspectral data for real world applications.

Introduction to Advanced Remote Sensing: Overview of advanced remote sensing technologies, Integration of advanced sensors with traditional remote sensing platforms; Recent advancements in remote sensing research

LIDAR Applications: Principles of LIDAR (Light Detection and Ranging), LIDAR data acquisition and processing, Applications of LIDAR in topography, forestry, and urban planning

Microwave Remote Sensing: Principles of microwave remote sensing, Passive vs. active microwave sensors, Applications of microwave remote sensing in agriculture, soil moisture, and disaster monitoring

Hyperspectral Imaging: Fundamentals of hyperspectral imaging, Hyperspectral data acquisition and preprocessing, Applications in environmental monitoring, mineral exploration, and precision agriculture. Fusion of Remote Sensing Data: Integration of data from different remote sensing platforms, Techniques for data fusion and their applications, Case studies on the combined use of LIDAR, microwave, and hyperspectral data, Specialized Applications in Urban Planning and Infrastructure

Exercises:

1. Application of advanced remote sensing techniques to real-world scenarios
2. Individual or group projects
3. Presentation of project findings and discussion

References

1. I. H. Woodhouse, *Introduction to Microwave Remote Sensing*, CRC Press, 2017.
2. P. Dong and Q. Chen, *LiDAR Remote Sensing and Applications*, CRC Press, 2017.
3. R. Pu, *Hyperspectral Remote Sensing*, CRC Press, 2017.
4. Jarocińska, Anna, van der Meer, Freek D., *Remote Sensing and Digital Image Processing*, Springer, 2016.
5. Sabins, F.F.Jr, *Remote Sensing Principles and Image interpretation*, W.H.Freeman & Co, Third Edition, 2007.
6. W.G.Rees, *Physical Principles of Remote Sensing*, Cambridge University Press, 3rd edition, 2012.