DEPARTMENT OF CIVIL ENGINEERING

ANNA UNIVERSITY, CHENNAI.

OUR VISION:

Department of Civil Engineering, Anna University, shall strive hard to develop and impart technical knowledge and professional skills required for Civil Engineering and Geoinformatics Engineering practice through excellence in teaching, research and consultancy to address sustainable infrastructure development needs at local, national and International levels.

OUR MISSION:

Department of Civil Engineering, Anna University shall contribute to technological and development by

1. Providing a firm scientific and technological base in Civil Engineering and Geoinformatics Engineering to achieve self- reliance.
2. Providing quality education through innovation in teaching practices at par with global standards.
3. Nurturing leadership and entrepreneurship qualities with ethical values.
4. Developing and disseminating latest knowledge and technologies in emerging areas of Civil Engineering and Geoinformatics Engineering.
5. Sharing intellectual resources and infrastructure facilities through collaborative partnership.
6. Ensuring supporting conditions for enhancing the employability skills.

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS

REGULATIONS 2023

CHOICE BASED CREDIT SYSTEM

M.E REMOTE SENSING AND GEOMATICS (FULL-TIME)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

Graduates of the programme M.E Remote Sensing and Geomatics will

PEO1	Gain knowledge and skills in Remote Sensing and Geomatics which will enable them to have a career and professional accomplishment in the public or private sector Organizations
PEO2	Become consultants in Remote Sensing and Geomatics and solve complex real life issues related to data collection, analysis and synthesis for solving real world problems.
PEO3	Contribute to the enhancement of knowledge in Remote Sensing and Geomatics by performing quality research in institutions of international repute or in Research organizations or Academia.
PEO4	Practice their profession with good communication, leadership, ethics and social responsibility and formulate solutions that are technically sound, economically feasible,and socially acceptable.
PEO5	Graduates will function in multi-disciplinary teams and adapt to evolving technologies through life-long learning and innovation

PROGRAMME OUTCOMES (POs):

After going through the two years of study, our Remote Sensing and Geomatics Graduates will exhibit ability to:

PO#	Graduate Attribute	Programme Outcome
PO1	Research Aptitude	An ability to independently carry out research /investigation and development work to solve practical problems.
PO2	Technical Documentations	An ability to write and present a substantial technical report/document.
PO3	Technical Competence	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO4	Knowledge of Remote Sensing and Geomatics Engineering discipline	Demonstrate in-depth knowledge of Remote Sensing and Geomatics engineering discipline with an ability to evaluate, analyse and synthesise existing and new knowledge.
PO5	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation	Critically analyse complex Remote Sensing and Geomatics problems, apply independent judgment for synthesizing information, and make innovative advances in a theoretical, practical, and policy context.
PO6	Conceptualization and evaluation of Design Solutions	Conceptualize and solve Remote Sensing and Geomatics problems, evaluate potential solutions, and arrive at technically feasible, economically viable, and environmentally sound solutions with due consideration of health, safety, and sociocultural factors

Attested

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PEO / PO Mapping:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	3	3	3	3	3	3
PEO2	3	3	3	3	3	3
PEO3	3	3	3	3	3	3
PEO4	3	3	3	3	3	3
PEO5	3	3	3	3	3	3

1-Low, 2-Medium, 3-High

MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Probability and Statistical Methods	3	3	3	3	2	2
		Research methodology and IPR						
		Remote Sensing and Data Products	3	3	3	3	3	3
		Geographical Information System	2	3	2	3	2	1
		Programming for Spatial Data Processing	2	3	2	3	2	1
		Photogrammetry	3	3	3	3	3	3
	SEMESTER II	Microwave Remote Sensing and Techniques	3	3	3	3	3	3
		Satellite Image Processing	3	3	2	3	2	2
		Total station and GNSS Surveying	3	3	2	3	3	3
		Professional Elective I						
		Professional Elective II						
		Seminar	3	3	3	3	3	3
YEAR II	SEMESTER III	Professional Elective III						
		Professional Elective IV						
		Professional Elective V						
		Practical Training (4 weeks)	3	3	3	3	3	3
		Project Work I	3	3	3	3	3	3
	SEMESTER IV	Project Work II	3	3	3	3	3	3

1-Low, 2-Medium, 3-High

MAPPING FOR PROFESSIONAL ELECTIVE COURSES

S. NO.	COURSE TITLE	PO1	PO2	PO3	PO4	PO5	PO6
1.	Geodesy and Applications	3	3	3	3	3	3
2.	Soft Computing and Bio-Inspired Techniques	3	3	3	3	3	3
3.	GIS Applications	2	3	3	2	2	2
4.	Thermal and Hyper Spectral Remote Sensing	3	3	3	3	3	3
5.	Disaster Management and Geomatics Applications	2	3	2	3	3	3
6.	Geomatics for Hydrology and Water Resources Management	2	2	3	3	2	2
7.	Python and R Programming	3	2	3	2	3	3
8.	Geomatics for Urban Planning and Management	3	3	2	3	3	2
9.	Topographic and Bathymetric Laser Scanning	3	3	3	3	2	3
10.	Geomatics for Ocean and Coastal Zone Management	3	3	3	3	3	3
11.	Planetary Remote Sensing	3	3	3	3	3	3
12.	Spatial Data Modelling	2	3	2	3	2	2
13.	Web Technology Programming for GIS	3	2	2	2	3	2
14.	Meteorological Applications and Geomatics	3	3	3	3	3	3
15.	Geomatics for Environmental Monitoring and Modeling	3	3	3	3	3	3
16.	Geomatics for Agriculture and Forestry	3	3	3	3	3	3
17.	Geomatics for Transportation Planning and Management	3	3	3	3	3	3
18.	Spatial data adjustment and analysis	3	3	3	3	3	3
19.	Terrestrial and Close-Range Photogrammetry	3	3	3	3	3	2
20.	AI / DL for satellite image processing	3	2	2	2	2	2
21.	Land Information System	2	2	3	2	2	2
22.	Sustainable Development and Geomatics	2	2	2	3	3	3
23.	Geospatial Cloud Computing and Big Data Analytics	3	2	3	3	2	2
24.	Subsurface Survey Methods	3	2	3	3	3	3

1-Low, 2-Medium, 3-High

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ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E REMOTE SENSING AND GEOMATICS (FULL-TIME)
REGULATIONS 2023
CHOICE BASED CREDIT SYSTEM
CURRICULA AND SYLLABI FOR I TO IV SEMESTERS

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3160	Probability and Statistical Methods	FC	4	0	0	4	4
2.	RG3101	Remote Sensing and Data Products	PCC	3	0	4	7	5
3.	RG3102	Geographical Information System	PCC	3	0	4	7	5
4.	RG3103	Programming for Spatial Data Processing	PCC	2	0	2	4	3
5.	RG3104	Photogrammetry	PCC	3	0	2	5	4
6.	RM3151	Research methodology and IPR	RMC	2	1	0	3	3
			TOTAL	**17**	**1**	**12**	**30**	**24**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	RG3201	Microwave Remote Sensing and Techniques	PCC	2	1	0	3	3
2.	RG3202	Satellite Image Processing	PCC	3	0	4	7	5
3.	RG3203	Total Station and GNSS Surveying	PCC	3	0	4	7	5
4.		Professional Elective I	PEC	3	0	0	3	3
5.		Professional Elective II	PEC	3	0	0	3	3
PRACTICALS								
6.	RG3211	Seminar	EEC	0	0	2	2	1
			TOTAL	**14**	**1**	**10**	**25**	**20**

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SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective III	PEC	3	0	0	3	3
2.		Professional Elective IV	PEC	3	0	0	3	3
3.		Professional Elective V	PEC	3	0	0	3	3
PRACTICALS								
4.	RG3311	Practical Training (4 weeks)	EEC	0	0	0	0	2
5.	RG3312	Project Work I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**17**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	RG3411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR AWARD OF THE DEGREE: 73

FOUNDATION COURSE (FC)

S. No.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	MA3160	Probability and Statistical Methods	4	0	0	4	1

PROFESSIONAL CORE COURSES (PCC)

S. No.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	RG3101	Remote Sensing and Data Products	3	0	4	5	1
2.	RG3102	Geographical Information System	3	0	4	5	1
3.	RG3103	Programming for Spatial Data Processing	2	0	2	3	1
4.	RG3104	Photogrammetry	3	0	2	4	1
5.	RG3201	Microwave Remote Sensing and Techniques	2	1	0	3	2
6.	RG3202	Satellite Image Processing	3	0	4	5	2
7.	RG3203	Total Station and GNSS Surveying	3	0	4	5	2
		TOTAL	**20**	**1**	**20**	**30**	Attested

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. No.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	RM3151	Research methodology and IPR	2	1	0	3	1

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	RG3211	Seminar	0	0	2	1	2
2.	RG3311	Practical Training (4 weeks)	0	0	0	2	3
3.	RG3312	Project work I	0	0	12	6	3
4.	RG3411	Project work II	0	0	24	12	4
					TOTAL	21	

PROFESSIONAL ELECTIVE COURSES (PEC)

S. No.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	RG3001	Geodesy and Applications	3	0	0	3
2.	RG3002	Soft Computing and Bio-Inspired Techniques	3	0	0	3
3.	RG3003	GIS Applications	3	0	0	3
4.	RG3004	Thermal and Hyperspectral Remote Sensing	3	0	0	3
5.	RG3005	Disaster Management and Geomatics Applications	3	0	0	3
6.	RG3006	Geomatics for Hydrology and Water Resources Management	3	0	0	3
7.	RG3007	Python and R Programming	3	0	0	3
8.	RG3008	Geomatics for Urban Planning and Management	3	0	0	3
9.	RG3009	Topographic and Bathymetric Laser Scanning	3	0	0	3
10.	RG3010	Geomatics for Ocean and Coastal Zone Management	3	0	0	3
11.	RG3011	Planetary Remote Sensing	3	0	0	3
12.	RG3012	Spatial Data Modelling	3	0	0	3
13.	RG3013	Web Technology Programming for GIS	3	0	0	3
14.	RG3014	Meteorological Applications and Geomatics	3	0	0	3
15.	RG3015	Geomatics for Environmental Monitoring and Modeling	3	0	0	3
16.	RG3016	Geomatics for Agriculture and Forestry	3	0	0	3
17.	RG3017	Geomatics for Transportation Planning and Management	3	0	0	3

18.	RG3018	Spatial Data Adjustment and Analysis	3	0	0	3
19.	RG3019	Terrestrial and Close-Range Photogrammetry	3	0	0	3
20.	RG3020	AI / DL for Satellite Image Analysis	3	0	0	3
21.	RG3021	Land Information System	3	0	0	3
22.	RG3022	Sustainable Development and Geomatics	3	0	0	3
23.	RG3023	Geospatial Cloud Computing and Big Data Analytics	3	0	0	3
24.	RG3024	Subsurface Survey Methods	3	0	0	3

SUMMARY

S. NO.	NAME OF THE PROGRAMME: M.E REMOTE SENSING AND GEOMATICS					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	4	0	0	0	4
2.	PCC	17	13	0	0	30
3.	RMC	3	0	0	0	3
4.	PEC	0	6	9	0	15
5.	EEC	0	1	8	12	21
	TOTAL CREDIT	**24**	**20**	**17**	**12**	**73**

MA3160 PROBABILITY AND STATISTICAL METHODS L T P C
4 0 0 4

UNIT I ONE DIMENSIONAL RANDOM VARIABLES 12

Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a Random Variable.

UNIT II TWO DIMENSIONAL RANDOM VARIABLES 12

Joint distributions – Marginal and Conditional distributions – Functions of two dimensional random variables – Regression Curve – Correlation.

UNIT III ESTIMATION THEORY 12

Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation - Curve fitting by Principle of least squares – Regression Lines.

UNIT IV TESTING OF HYPOTHESES 12

Sampling distributions - Type I and Type II errors - Tests based on Normal, t, Chi-Square and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

UNIT V MULTIVARIATE ANALYSIS 12

Random Vectors and Matrices - Mean vectors and Covariance matrices - Multivariate Normal density and its properties - Principal components: Population principal components – Principal components from standardized variables.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1 Use the appropriate and relevant, fundamental and applied mathematical and statistics knowledge and methodologies in solving practical problem.

CO2 Bring together and flexibly apply knowledge to characterize, analyse and solve a wide range of problems.

CO3 Understand the balance between the complexity/accuracy of the mathematical/statistical models used and the timeliness of the delivery of the solution.

CO4 Steeped in research methods and rigor.

CO5 Develop critical thinking based on empirical evidence and the scientific approach to knowledge development.

REFERENCES:

1. Dallas E Johnson, “Applied multivariate methods for data analysis”, Thomson and Duxbury press, Singapore, 1998.
2. Gupta S.C. and Kapoor V.K. “Fundamentals of Mathematical Statistics”, Sultan and Sons, 11th Edition, Reprint, New Delhi, 2019.
3. Jay L. Devore, “Probability and statistics for Engineering and Sciences”, Thomson and Duxbury, 9th Edition, Singapore, Boston, 2016.
4. Krishnaiah K. and Shahabudeen P, “Applied Design of Experiments and Taguchi Methods”, PHI, New Delhi, 2012.
5. Richard A. Johnson and Dean W. Wichern, “Applied Multivariate Statistical Analysis”, Pearson Education, Fifth Edition, 6th Edition, New Delhi, 2013.
6. Richard Johnson. ”Miller & Freund"s Probability and Statistics for Engineer”, Prentice Hall of India Private Ltd., 8th Edition, New Delhi, 2011.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	3	3	3	2	2
CO3	3	3	3	3	2	2
CO4	3	3	3	3	2	2
CO5	3	3	3	3	2	2
Avg	**3**	**3**	**3**	**3**	**2**	**2**

1-Low, 2-Medium, 3-High

RG3101 **REMOTE SENSING AND DATA PRODUCTS** **L T P C**
3 0 4 5

UNIT I PHYSICS OF REMOTE SENSING **9**

Remote sensing - Definition - Components - Electromagnetic spectrum - Basic wave theory - Particle theory - Stefan Boltzman law - Wien's-Displacement law - Radiometric quantities - Effects of atmosphere - Scattering - Different types - Absorption - Atmospheric window - Energy interaction with surface features - Spectral reflectance of vegetation, soil and water - Atmospheric influence on spectral response patterns - Multi concept in Remote sensing.

UNIT II PLATFORMS **9**

Orbit elements - Types of orbits - Motions of planets and satellites - Launch of space vehicle - Orbit perturbations and maneuvers - Escape velocity - Types and characteristics of different remote sensing platforms - Sun synchronous and geosynchronous satellites.

UNIT III OPTICAL SENSORS **9**

Classification of remote sensors - Selectionof sensor parameters - Resolution concept - Spectral, radiometric and temporal resolution - Quality of images in optical systems - Imaging mode - Photographic camera - Opto-mechanical scanners - Pushbroom and whiskbroom cameras - Panchromatic, multi spectral , hyperspectral scanners - Geometric characteristics of scanner imagery - Earth resource satellites operating with optical sensors - Landsat, SPOT, IRS, WorldView.

UNIT IV DATA RECEPTION AND DATA PRODUCTS **9**

Ground segment organization - Data product generation - Sources of errors in received data - referencing scheme - Data product output medium - Digital products - Super structure, Fast, GeoTIFF, Hierarchical and HDF formats - Indian and International satellite data products - Ordering of data - Open sources for satellite imagery - USGS Earth Explorer - NASA Earth data Search - NOAA data access viewer - Bhuvan Indian Geo-Platform of ISRO - Google Earth Engine - Copernicus Open Access Hub - Upscaling and downscaling - Sample data download and appraisal.

UNIT V DATA ANALYSIS **9**

Data products and their characteristics - Elements of visual interpretation - Interpretation keys - Digital image processing - Preprocessing - Image rectification - Image enhancement techniques - Image classification - Supervised and unsupervised classification algorithms for multispectral and hyperspectral images - Accuracy assessment.

LABORATORY EXCERCISES **60**

1. Spectral reflectance observation of the following using handheld spectroradiometer.
   i) Vegetation. ii) Soil iii) Water iv) Built-up
2. Map reading Survey of India topo sheets.
3. Base Map preparation from SOI

4. Visual image interpretation keys for different land cover types on different satellite data
5. Land use/land cover map
6. Soil Map
7. Geology and geomorphology maps.
8. Watershed delineation

TOTAL:105 PERIODS (45 (THEORY) + 60 (PRACTICAL))

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand the concepts and laws related to remote sensing.
CO2: Acquire knowledge about various remote sensing platforms.
CO3: Understand the characteristics of different types of remote sensors.
CO4: Gain knowledge about reception, product generation, storage and ordering of satellite data.
CO5: Understand the concept of different image processing techniques and interpretation of Satellite data.

REFERENCES:

1. Lillesand T M, and Kiefer R W, "Remote Sensing and Image interpretation", John Wiley & Sons, 6th edition, 2015.
2. John R Jensen, "Introductory Digital Image Processing: A Remote Sensing Perspective", 4th Edition, 2017.
3. John A Richards, "Remote Sensing Digital Image Analysis", Springer – Verlag, 5th edition, 2013.
4. Paul Curran P J, "Principles of Remote Sensing", ELBS, 1985.
5. George Joseph, "Fundamentals of Remote Sensing", Universities Press (India) Pvt Ltd, Hyderabad, 3rd edition, 2018.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3102 **GEOGRAPHICAL INFORMATION SYSTEM** **L T P C**
3 0 4 5

UNIT I CARTOGRAPHY **9**

Definition of map - Mapping organization in India - Classification based on function, scale, characteristics - Ellipsoid and geoid - Coordinate systems - Rectangular and geographic coordinates - UTM and UPS - Projection - Function - Types of map projections - Transformations - Function - Affine transformation - Choice of map projection - Evolution of cartography - Geospatial, spatial and non spatial data - Definition of GIS - Evolution of GIS - Components of GIS.

UNIT II GIS DATA MODELS AND DATA INPUT **9**

Point, line polygon / area, elevation and surface - Tessellations - Attributes and levels of measurement - Data sources - Ground and remote sensing survey - Collateral data collection - Input: Map scanning and digitization, registration and georeferencing - Concepts of RDBMS - Raster data model - Grid - Data encoding - Data compression - Vector data model - Topological properties - Arc node data structure - Raster vs. vector comparison - File formats for raster and vector - Data conversion between raster and vector.

UNIT III RASTER AND VECTOR DATA ANALYSIS **9**

Raster data analysis: Local, neighborhood and regional operations - Map algebra - Vector data analysis: Topological analysis, point-in-polygon, line-in-polygon, polygon-in-polygon - Proximity analysis: Buffering, thiessen polygon - Non topological analysis: Attribute data analysis - Concepts of SQL - ODBC.

UNIT IV NETWORK ANALYSIS AND SURFACE ANALYSIS **9**

Network - Creating network data - Origin, destination, stops, barriers - Closest facility analysis, service area analysis, OD cost matrix analysis, shortest path analysis - Address geocoding - Surface analysis - DEM, DTM - Point data to surface interpolation - DEM representation - Applications.

UNIT V DATA OUTPUT AND WEB BASED GIS **9**

Map compilation - Cartographic functionalities for map design - Symbolization - Conventional signs and symbols - Spatial data quality - Lineage, positional accuracy, attribute accuracy, completeness, logical consistency - Metadata - Web based GIS: Definition, merits - Architecture - Map server - Spatial data infrastructure - Spatial data standards - Free and open source - Proprietary GIS software .

LABORATORY EXCERCISES **60**

1. Rectification and Spatial Referencing of Digital Map.
2. Onscreen Digitization and Database Creation.
3. Projection and Reprojection of spatial data.
4. Data Conversion – Vector to Raster, Raster to Vector.
5. Populating Attribute database and querying on attribute data.
6. Generation of DEM: from contours, spot heights, GRID and TIN, Isometric mapping.
   Mini Project: Optimal Siting and Routing using DEM and Viewshed Analysis.
7. Vector Analysis – Buffering, Overlay and Network analysis, flood mapping.
   Mini Project: Development of Flood Insurance Maps for a part of City.
8. Raster Analysis – Measurement - Arithmetic overlaying, Logical overlaying, Class interval selection, choropleth maps.
9. Map Output - Bar charts, Pie charts and symbols.
10. Map compilation.
11. Modelling spatial variability.
12. Weighted theissen polygon and proximity analysis.
    Mini Project: Visualisation of Temporal Variation of Climatic Parameters with Charts and Symbols.
13. Customisation and scripting.

TOTAL: 105 PERIODS (45 (THEORY) + 60 (PRACTICAL))

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand the Characteristics and Components of Maps and GIS.
CO2: Perform input of Spatial and Non-spatial data into GIS.
CO3: Analyze Spatial Relationship between Elements using GIS tools.
CO4: Evaluate Network and Surface Data for Decision Making.
CO5: Present the Spatial Information and Access the Quality against Standards.

REFERENCES:

1. Lo, C.P. and Yeung, Albert K.W., "Concepts and Techniques of Geographic Information Systems", Pearson, 2016.
2. Ian Heywood, Sarah Cornelius, Steve Carver, "An Introduction to Geographical Information Systems", Pearson Education, 4th Edition, 2012.
3. Borden D Dent, Jeff Torguson, Thomas W. Hodler, "Cartography: Thematic Map Design" 6th Edition, ISBN-13: 978-0072943825 McGraw-Hill Education – Europe, 2008
4. Kang-tsung Chang, "Introduction to Geographic Information Systems": 9th Edition, 9781259929649, McGraw-Hill Education, 2018
5. Michael N. DeMers, "Fundamentals of geographic information systems", Wiley, 2009.
6. Paul A. Longley, Michael F. Goodchild , David J. Maguire , David W. Rhind, "Geographic Information Science and Systems", John Wiley & Sons Inc, 2015, ISBN 978111867695.
7. Tor Bernhardsen, "Geographic Information Systems an Introduction", Willey, 3rd Edition, 2002.
8. Michael Frank Goodchild, Mike Worboys, Matt Duckham, "Foundations of Geographic Information Science", Taylor and Francis Group, 2020.
9. John R. Woodard, "Enterprise GIS: Concepts and Applications", CRC Press, 2020.
10. Mesev, Victor. "Integration of GIS and Remote Sensing". Chichester, England ;: Wiley, 2007.
11. Shellito, Bradley A. "Introduction to Geospatial Technologies". Fourth edition. New York: W. H. Freeman, 2017.
12. "Mapping : an Illustrated Guide to Graphic Navigational Systems". Mies, Switzerland ;: RotoVision, 2002.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	2	2	3	3	2	1
CO3	1	3	2	3	2	1
CO4	1	3	2	2	1	1
CO5	2	3	3	2	3	1
Avg	**2**	**3**	**2**	**3**	**2**	**1**

1-Low, 2-Medium, 3-High

RG3103 **PROGRAMMING FOR SPATIAL DATA PROCESSING** **L T P C**
2 0 2 3

UNIT I CONCEPTS OF OBJECT ORIENTED PROGRAMMING **6+6**

Principles - Abstract Data types - Inheritance - Polymorphism - Object Identity - Object Modeling - Object Oriented Programming Languages - Object Oriented Databases - Object Oriented user Interfaces - Object Oriented GIS - Object Oriented Analysis - Object Oriented Design - Examples.

UNIT II C++ PROGRAMMING FUNDAMENTALS **6+6**

Introduction to C++ - Keywords, identifiers - Data types - Variables - Operators`- Manipulators - Operator Overloading - Operator Precedence - Control Statements - Functions - Call by Reference - Arguments - Function Overloading - Exercises.

UNIT III CLASSES AND OBJECT **6+6**

Classes and Objects - Member Functions - Nesting of Member Functions Constructors Destructors - Type Conversions - Inheritance - Base class - Derived Class - Visibility modes - Single Inheritance - Multilevel Inheritance - Multiple Inheritance - Nesting - Polymorphism - File - Opening and Closing - Exercises.

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UNIT IV PROGRAMMING USING IDL **6+6**

Introduction - The IDL interface - Data types - Constants, arrays - Creating batch process - IDL Statements - Contour - Surface plot - Mapping.

UNIT V GIS CUSTOMISATION PROGRAMMING USING PYTHON **6+6**

Python interfaces - Variable - Lists - Control structures - Tuples - Dictionary - Functions - Modules - Exceptions - File handling - Read, write, appending - Geoprocessing - Modules, object geometry, raster and vector formats - Map production - Layer management, map layout elements, publishing, export, symbology - Customization.

TOTAL:60 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Acquainted with the concepts of OOPs technique.
CO2: Implement procedures involved in programming with fundamental C++.
CO3: Apply the tools and procedures involved in programming with C++ with Oops concept.
CO4: Apply scientific programming language and graphic visualization of complex numerical data for the purpose of interpretation
CO5: Implement the concepts of python scripting language for customization in GIS.

REFERENCE:

1. Balagurusamy E., "Object Oriented Programming with C++," Mc.Graw Hill Publications, 6th Edition, 2013.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	2	2	3	3	2	1
CO3	1	3	2	3	2	1
CO4	1	3	2	2	1	1
CO5	2	3	3	2	3	1
Avg	**2**	**3**	**2**	**3**	**2**	**1**

1-Low, 2-Medium, 3-High

RG3104 PHOTOGRAMMETRY **L T P C**
3 0 2 4

UNIT I PRINCIPLES OF PHOTOGRAMMETRY **9+6**

Definition and applications of Photogrammetry - Types of photographs, classification - Photographic overlaps - Camera: metric vs non-metric, aerial cameras - Vertical photographs - Geometry, scale, parallax equations, planimetric mapping - Tilted photograph - Geometry - Flight planning - Crab and drift– Computation of flight plan - Photogrammetry project Planning.

UNIT II PHOTOGRAMMETRY CONCEPTS **9+6**

Stereoscopes - Stereoscopic depth perception - Parallax concept - Parallax equation - Causes of Y Parallax - Viewing and measuring system - Principle of the floating mark - Coordinate systems for Photogrammetry - Collinearity and coplanarity condition - Space resection - Two-dimensional coordinate transformations: Congruence (euclidean), similarity (helmert), affine, projective, and polynomial - Three-dimensional coordinate transformation.

UNIT III STEREO PLOTTERS ORIENTATION AND MAPPING **9+6**

Stereo plotters - Classification – Analog, semi-analytical, analytical, and digital plotting concepts - Cross ratio - Concepts of analog and analytical orientation: Interior, relative, and absolute orientation - GPS/INS based orientation - Elements and principles of aerotriangulation - Independent models - Strip adjustment - Simultaneous bundle adjustment rectified photo, orthophoto, and true orthophoto - Ortho mosaic - Mono plotting - Stereo plotting - Feature collection.

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UNIT IV DIGITAL PHOTOGRAMMETRY **9+6**

Digital cameras - CCD camera - Full frame, frame transfer, interline CCD camera - Spectral sensitivity of CCD sensor - Geometry and radiometry problem of CCD image - Photogrammetric scanner - Image generation - Data compression - Formats - Georeferencing - Stereo viewing - Display modes - Image matching techniques - Image measurements - Automatic tie point generation - Automatic block triangulation, feature collection, and plotting - DSM and DEM generation - Accuracy of DEMs, orthorectification.

UNIT V OTHER PHOTOGRAMMETRIC TECHNIQUES AND APPLICATIONS **9+6**

Concepts and working principles of close-range photogrammetry, Terrestrial photogrammetry, non-topographic photogrammetry, and satellite photogrammetry - UAS technology - Large scale mapping and 3D modelling - Recent trends and applications of photogrammetry with the case study.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: To understand and highlight the importance of photography for topographic mapping, the functional and physical elements of photography.

CO2: To comprehend various photogrammetric techniques and applications, including aerial, terrestrial, and satellite photogrammetry.

CO3: To develop analytical skills and problem-solving abilities in the context of photogrammetry. photogrammetry, including machine learning and computer vision.

CO5: To provide hands-on experience and practical training in photogrammetry through laboratory exercises, fieldwork, and real-world projects.

REFERENCES:

1. Wolf Paul, DeWitt Bon, Wilkinson, Benjamin B, “Photogrammetry with Application in GIS”, 4th edition, 2014.
2. Linder, Wilfried D, “Digital Photogrammetry: A Practical Course”, 3rd edition, 2018.
3. Edward M Mikhail, James S Bethel, J Chris McGlone, “Introduction to Modern Photogrammetry”, 4th edition, 2015.
4. “Manual of Photogrammetry”, American Society for Photogrammetry and Remote Sensing (ASPRS), 6th edition, 2015.
5. Thomas Luhmann, Stuart Robson, Stephen Kyle, and Ian Harley, “Close Range Photogrammetry: Principles, Techniques and Applications”, 2nd edition, 2016.
6. Manfred Schroeder and Reinhard Koch, “Photogrammetry: Principles, Methods, and Applications”, 2nd edition, 2016.
7. Karl Kraus and Christian Heipke, “Photogrammetry: Geometry from Images and Laser Scans”, 2nd edition, 2016.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	2
CO2	3	3	3	3	3	3
CO3	3	3	3	2	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	2	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

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RM3151 RESEARCH METHODOLOGY AND IPR L T P C
2 1 0 3

UNIT I RESEARCH PROBLEM FORMULATION 9

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, the student can

CO1: Describe different types of research; identify, review and define the research problem

CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data

CO3: Explain the process of data analysis; interpret and present the result in suitable form

CO4: Explain about Intellectual property rights, types and procedures

CO5: Execute patent filing and licensing

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

RG3201	MICROWAVE REMOTE SENSING AND TECHNIQUES	L	T	P	C
		2	1	0	3

UNIT I PHYSICS OF MICROWAVES 9

Light theory , wave description of simple harmonic waves - Complex wave description, energy and power of waves - Brightness or intensity - Polarization property of microwaves - Wave equation for polarized waves, wave combination - Interference - Coherence, phase as a relative distance measure - Interference pattern - Fraunhofer criterion, microwave propagation - Maxwell equation - Signal loss through lossy media.

UNIT II ACTIVE MICROWAVE REMOTE SENSING 9

Radar basics - RADAR operation and measurements - Radar frequency bands - Antenna configuration, SLAR - Imaging geometry - Resolution concepts, SAR concepts - Doppler principle & processing system parameters and fading concepts - SAR focusing, geometric distortions, operational limitations, RADAR energy quantification, interaction with earth surface and vegetation, scattering models - Surface and volume scattering.

UNIT III PASSIVE MICROWAVE REMOTE SENSING 9

Introduction - History, plane waves, antenna systems - Radiometry - Emission laws - Brightness temperature - Antenna temperature - Power - Temperature correspondence, interaction with atmospheric constituents - Interaction with earth features, missions - Applications.

UNIT IV PLATFORMS, SENSORS AND DATA PROCESSING 9

Airborne, space borne and Indian missions, modes of acquisition, data products and selection procedure, SAR image processing software - Measurement and discrimination - Header extraction - Slant range to ground range - Multi-looking from SLC - Filtering technique - Geometric correction, factors affecting geometrical correction - Backscattering coefficient - Speckle processing - Image interpretation, SAR image fusion - Hybrid classification of optical microwave.

UNIT V IMAGING,NON-IMAGING TECHNIQUES AND APPLICATIONS 9

Polarimetry, interferometry, altimetry, scatterometry - Principles - Data & resource availability - Principle & applications in agriculture, forestry, ocean, geology, hydrology, cryospace studies, landuse mapping and ocean related studies.

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand the importance of Microwave Remote Sensing over other Remote Sensing techniques.

CO2: Gain knowledge on SAR data acquisition and processing.

CO3: Understand the physical fundamentals about wave theory related to Microwave Remote Sensing.

CO4: Impart the skills required to analyze and understand polarimetric and Interferometric concepts.

CO5: Knowledge about the oceanographic applications of scatterometry and altimetry and other active, passive microwave remote sensing applications over land and atmosphere.

REFERENCES:

1. Ulaby F T, Moore K R and Fung, “Microwave Remote Sensing vol-1, vol-2 and vol-3”, Addison - Wesley Publishing Company, London,1986.
2. Iain H Woodhouse, “Introduction to Microwave Remote Sensing”, Speckled Press, 1st edition, 2017, ISBN-13: 978-0415271233.

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3. Floyd M Handerson and Anthony J Lewis, “Principles and Applications of Imaging RADAR”, Manual of Remote sensing, 3rd edition, vol.2, ASPRS, Jhumurley and sons, Inc, 1998.
4. Philippe Lacomme, Jean clande Marchais, Jean-Philippe Hardarge and Eric Normant, “Air and spaceborne radar systems - An introduction”, Elsevier publications,1st edition, 2007.
5. Roger J Sullivan, Knovel, “Radar foundations for Imaging and Advanced Concepts”, SciTech Pub, 2004.
6. Ian Faulconbridge, “Radar Fundamentals”, Argos Press, 2nd Edition, 2019.
7. Eugene A.Sharkov, “Passive Microwave Remote Sensing of the Earth”, Physical Foundations, 2003.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	3	3	2
CO2	2	3	2	3	2	2
CO3	3	-	2	2	-	3
CO4	3	-	3	3	2	3
CO5	3	3	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3202 **SATELLITE IMAGE PROCESSING** **L T P C**
3 0 4 5

UNIT I FUNDAMENTALS **9**

Satellite systems and data - Acquisition - Storage - Orbits - Data formats - Data products - Image processing system - Factors to be considered - Image display systems - Image sampling and quantization - Basic relationship between pixels.

UNIT II SENSOR AND DATA MODEL **9**

Sensor model - Pixel characters - Image formation - Histogram - Types - Univariate & multivariate image statistics - Spatial statistics - Image registration and ortho rectification - Geometric and radiometric correction - Noise models.

UNIT III IMAGE ENHANCEMENTS **9**

Spectral signatures - Image characteristics, feature space scatterogram - Point, local and regional operation - Contrast, spatial feature and multi image manipulation techniques - Fourier transform - Principle component analysis - Optimal Rotation Transformation - Scale-space transform, wavelet transform, multi-image fusion.

UNIT IV THEMATIC CLASSIFICATION **9**

Training sites - Supervised, Unsupervised and Hybrid classifiers - Baye’s Theorem - Parametric classification - Decision tree - Other Non-parametric classifiers - Sub-pixel and super-pixel classification - Hyper-spectral image analysis - Accuracy assessment.

UNIT V FEATURE EXTRACTION **9**

Pattern recognition - Boundary detection and representation - Textural and contextual analysis - Decision concepts: Fuzzy sets - evidential reasoning - Expert system concepts - Artificial Neural Network - Object based methods - recent trends - Case studies.

LABORATORY EXCERCISES **60**

1. Reading and Displaying satellite data from BIL, BSQ and BIP Formats.
2. Generating False Colour Composite (FCC).
3. Extracting area of Interest (AOI).
4. Generating Histogram of various bands.
5. Georeferencing the base image.
6. Geometric correction of satellite image.
7. Enhancement using Band ratio and NDVI.
8. Enhancement using different Filtering techniques.
9. Enhancement using Image Fusion.
10. Principal Component Analysis (PCA).
11. Fourier analysis.
12. Unsupervised Classification.
13. Supervised Classification.
14. Classification using Neural Network and Fuzzy Logic.
15. Accuracy Assessment and Change detection study.

TOTAL: 105 PERIODS (45 (THEORY) + 60 (PRACTICAL))

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Gain knowledge about basic requirement of satellite image processing

CO2: Understand knowledge about the error in satellite image and also to restore it for further processing.

CO3: Perform various image Enhancement techniques to improve the visual Interpretability of the image

CO4: Gain knowledge about classification of the satellite image using various methods and also evaluate the accuracy of classification.

CO5: Implement the advanced image classification methods and conduct lifelong research in the field of image processing.

EFERENCES:

1. John R. Jensen., “Introductory Digital Image Processing: A Remote Sensing Perspective”, 4th Edition, 2017.
2. Robert Shcowebgerdt., “Remote sensing models & methods for image processing”, Academic Press, 2012.
3. John A.Richards., “Remote Sensing Digital Image Analysis”, 5th Edition, Springer – Verlag, 2013.
4. Rafael C. Gonzalez, Richard E. Woods., “Digital Image Processing”, 4th Edition, Prentice Hall, 2018.
5. W.G.Rees ., “Physical Principles of Remote Sensing”, Cambridge University Press, 2nd edition, 2001.
6. Annadurai., “Fundamentals of Digital Image Processing”, Pearson Education, 2016.
7. William K. Pratt., “Digital Image Processing: PIKS Scientific Inside”, 4th Edition, Wiley Interscience, 2007.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	3	3	2	3	2	2
CO3	3	3	2	3	2	2
CO4	3	2	3	2	2	2
CO5	3	3	3	3	3	3
Avg	**3**	**3**	**2**	**3**	**2**	**2**

1-Low, 2-Medium, 3-High

Attested

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RG3203 TOTAL STATION AND GNSS SURVEYING L T P C
3 0 4 5

UNIT I FUNDAMENTALS OF TOTAL STATION AND ELECTROMAGNETIC WAVES 9

Methods of Measuring Distance - Basic Principles of Total Station - Historical Development, Classifications, applications and comparison with conventional surveying. Classification - Applications of Electromagnetic waves, propagation properties, wave propagation at lower and higher frequencies.

UNIT II DISTANCE AND ATMOSPHERIC CORRECTION 9

Refractive index (RI) - Factors affecting RI - Computation of group RI for light and near infrared waves at standard and ambient conditions - Computation of RI for microwaves at ambient condition - Reference refractive index - Real time application of first velocity correction. Measurement of atmospheric parameters - Mean refractive index - Second velocity correction - Total atmospheric correction - Use of temperature and pressure transducers.

UNIT III ELECTRO OPTICAL AND MICROWAVE SYSTEM 9

Electro-optical system: Measuring principle, working principle, reflectors, sources of Error, Infrared and Laser Total Station instruments - Microwave system: Measuring principle, working principle, sources of Error, Microwave Total Station instruments. Comparison between Electro-optical and Microwave systems. Care and maintenance of Total Station instruments - Traversing and Trilateration - COGO functions, offsets and stake out - land survey applications.

UNIT IV GNSS SATELLITE SYSTEM 9

Basic concepts of GPS - Historical perspective and development - applications - Geoid and Ellipsoid - satellite orbital motion - Keplerian motion - Kepler‘s Law - Perturbing forces - Geodetic satellite - Doppler effect - Positioning concept - GNSS - Galileo, BeiDou, GLONASS, IRNSS and GAGAN, QZSS - Different segments - Space, control and user segments - satellite configuration - Signal structure - Orbit determination and representation - Anti Spoofing and Selective Availability - Task of control segment - Receivers.

UNIT V DATA PROCESSING 9

GPS observables - Code and carrier phase observation - Linear combination and derived observables - Concept of parameter estimation - Downloading the data RINEX format - Differential data processing - software modules - Solutions of cycle slips, ambiguities, Concepts of rapid, static methods with GPS - Semi Kinematic and pure Kinematic methods - Satellite geometry & accuracy measures - Applications - Long baseline processing - Use of different softwares..

LABORATORY EXERCISES 60

1. Study of Total station and measurement of Angle, Distance, and Coordinate measurement.
2. Establishment of Horizontal control point by Traversing and establishment of vertical control by Trigonometric levelling.
3. To determine the instrument station coordinate: Orientation by back site and Resection methods (Angles only and Distances only). To determine the height of the tower/column/power transmission line by REM method.
4. To determine the perimeter of a polygon by MLM / Inverse method and the area of a polygon (some points are inaccessible points, that are to be determined by different offset methods).
5. Topographic mapping and Preparation of Contour map using Total Station
7. Setting out of the structure and curve by Coordinates / Distance and angle.
8. Navigation and Feature collection using handheld GPS
9. GNSS Planning of points with and without obstructions.
10. Accuracy evaluation of baseline with different common observation times using GNSS.

11. Establishment of Ground Control Point using Static / Rapid Static differential GNSS survey by Lee Frog Method
12. Establishment of Ground Control Point using Static / Rapid Static differential GNSS survey by Trilateration method
13. Network Adjustment of GNSS observation
14. Preparation of Planimetric map using Post Processed Kinematic (PPK) method

TOTAL: 105 PERIODS (45 (THEORY) + 60 (PRACTICAL))

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Learn the fundamentals of Total station.
CO2: Provides knowledge about electromagnetic waves and its usage in Total Station and GPS.
CO3: Understand the measuring and working principle of electro optical and Microwave Total station.
CO4: Learn the basic concepts of GNSS.
CO5: Gains knowledge about GPS data downloading and processing.

REFERENCES:

1. Rueger, J.M., "Electronic Distance Measurement", Springer-Verlag, 4th edition, 1996.
2. Satheesh Gopi, Sathishkumar, N.madhu., "Advanced Surveying, Total Station GPS and Remote Sensing", Pearson education, 2nd Edition, 1996.
3. Laurila.S.H., "Electronic Surveying in Practice", John Wiley and Sons Inc, 1983.
4. Guocheng Xu., "GPS Theory, Algorithms and Applications", Springer - Verlag, 3rd Edition, 2016.
5. Alfred Leick., 'GPS satellite surveying", John Wiley & Sons Inc., 4th Edition, 2015.
6. Seeber G., "Satellite Geodesy", Walter De Gruyter, Revised Edition,2003.
7. Petr Vanicek and Edward J. Krakiwsky., "Geodesy: The concepts", North-Holland Publications Co., Amsterdam, 2nd edition, 2014.
8. George Vosselman and Hans-Gerd Maas., "Airborne and Terrestrial Laser Scanning", Whittles Publishing, 2014.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	3	3	3
CO2	3	3	2	3	3	3
CO3	3	3	2	3	3	3
CO4	3	2	2	3	3	3
CO5	3	3	3	3	3	3
Avg	**3**	**3**	**2**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3211 **SEMINAR** **L T P C**
0 0 2 1

SYLLABUS:

The students work on a specific technical topic in Geomatic Engineering. They will work for three hours per week, guided by a group of staff members. During this time, they will be asked to give a talk on a topic of their choice and engage in a dialogue with the audience. Additionally, they are required to submit a brief copy of their talk. Furthermore, the students will be expected to present a seminar lasting no more than fifteen minutes on the technical topic. The course delves into key theories, methodologies, and real-world examples, aiming to foster critical thinking and analysis. It also focuses on emerging trends, technologies, and advancements in the field of Geomatic Engineering. Moreover, the students are expected to answer queries related to the topic, and

interaction among the students and the audience is encouraged. The evaluation will be based on the overall quality of the presentation, both in terms of general and technical aspects, as well as the submitted report and the level of interaction displayed during the seminar.

TOTAL:30 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Effectively communicate complex ideas, and deliver presentations with clarity and confidence.

CO2: Evaluate scholarly articles, summarize key findings, and effectively incorporate relevant literature into their seminar presentations and reports.

CO3: Gather relevant information, critically evaluate sources, and synthesize findings to make a presentation and present before the technical evaluation committee of the seminar topic.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	2	2
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3311 **PRACTICAL TRAINING (4 WEEKS)** **L T P C**
0 0 0 2

SYLLABUS:

The students individually undertake training in reputed Industries during the summer vacation for a period of minimum four weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through Presentation and viva-voce examination by a team of internal staff.

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1 Understand industry requirement for Geospatial technology.
CO2 To have hands on training on technical aspects.
CO3 To comprehend the use of geospatial for industrial requirement.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	2
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3312 **PROJECT WORK I**

L	T	P	C
0	0	12	6

SYLLABUS:

The student individually works on a specific topic approved by a faculty member who is familiar with this area of interest. The student can select any topic which is relevant to his/her specialization in the program. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains a clear definition of the identified problem, a detailed literature review related to the area of work, and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 180 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1 Identify engineering challenges/problems, which require the use of the geomatics domain.

CO2 Do the review of the literature and identify the gaps/weaknesses in existing solutions to the identified challenge/problem.

CO3 Identify appropriate techniques to analyze complex engineering problems.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	2
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3411 **PROJECT WORK II**

L	T	P	C
0	0	24	12

SYLLABUS:

The student should continue the Project Work I on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report and the viva-voce examination by a panel of examiners including one external examiner.

TOTAL:360 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1 Establish research skills, including the ability to identify relevant sources of data, collect data, analyze information, and draw meaningful conclusions.

CO2 Apply the knowledge gained throughout their program and their expertise in their chosen area of research, including programming languages, data analysis tools, design software, or other specialized tools necessary to complete the project.

CO3 Write a comprehensive project thesis, present their work to a panel of examiners, and effectively communicate the research outcomes.

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CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

PROFESSIONAL ELECTIVE COURSES

RG3001 **GEODESY AND APPLICATIONS** **L T P C**
3 0 0 3

UNIT I INTRODUCTION **9**

Definition, history, and importance of geodesy - Geodesy in various disciplines and applications - Earth's shape and size - Geoid, ellipsoid, and Earth's figure - Geodetic datums and their relationship to the Earth's shape - Classification of geodesy - Distance measurement techniques - Angle measurements and orientation - Height determination methods.

UNIT II GEOMETRIC GEODESY **9**

Definition, history, and importance of geometric geodesy - Overview of coordinate systems and geodetic datums - Mathematical foundations of geodesy - Geometry of the Earth and celestial reference systems - Spherical trigonometry and its applications in geodesy - Geodetic coordinate systems, cartesian, geocentric, geodetic, and local coordinate systems - Transformation between different coordinate systems - Geodetic datums - Definition and characteristics of geodetic datums - Datum transformations and datum shifts - Geometric geodetic measurements - Horizontal angle and azimuth measurements.

UNIT III GEODETIC ASTRONOMY **9**

Definition, history, and importance of geodetic astronomy - Celestial sphere and celestial coordinate systems - Equatorial, ecliptic, and galactic coordinate systems -Transformation between celestial and terrestrial coordinate systems - Celestial observations: Measurement of astronomical angles and azimuths - Astrometry and the reduction of observational data - Time determination - Universal Time (UT) and Coordinated Universal Time (UTC) - Earth's rotation and its variations.

UNIT IV PHYSICAL GEODESY **9**

Definition, history, and importance of physical geodesy - Geopotential theory - Mathematical representation of the Earth's gravitational potential - Earth's gravity field - Gravity anomaly and its interpretation - Determination of gravity anomalies using terrestrial and satellite measurements - Geoid determination - Methods for geoid determination (e.g., satellite altimetry, terrestrial gravity data) - Geoid modeling and its applications in geodesy - Satellite missions: GRACE, Jason, Cryosat missions.

UNIT V APPLICATIONS OF GEODETIC MEASUREMENTS **9**

Geodetic control networks and their use in surveying and mapping - Geodesy in geophysics, geodynamics, and plate tectonics - Geodetic applications of astronomical observations - Applications of satellite data in geodetic studies - Monitoring and modeling of crustal deformation and plate motion - Geodesy in navigation and positioning systems - Geodetic applications in climate change monitoring and environmental studies - Geodetic software and tools - Emerging topics in Geodesy.

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand the fundamental concepts, history, and importance of geodesy and its applications in various disciplines.

CO2: Apply mathematical foundations and concepts of coordinate systems and geodetic datums to solve geodetic problems and perform coordinate transformations.

CO3: Apply celestial coordinate systems, perform transformations between celestial and terrestrial coordinate systems, and utilize astronomical observations for geodetic purposes.

CO4: Analyze and interpret gravitational potential, gravity anomalies, and geoid models using terrestrial and satellite measurements.

CO5: Utilize geodetic measurements for surveying, mapping, geophysics, and environmental studies.

REFERENCES:

1. Petr Vanicek and Edward J. Krakiwsky, “Geodesy: The Concepts", De Gruyter, 2nd edition, 2006, ISBN: 978-3110195884.
2. Thomas H. Meyer and Wolfgang Torge, "Physical Geodesy", De Gruyter, 2nd edition, 2018, ISBN: 978-3110468359.
3. David J. Getling, "Geodesy for Geomatics and GIS Professionals", CRC Press, 2018, ISBN: 978-1138393325.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	2
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	2	3	3	2	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3002 SOFT COMPUTING AND BIO-INSPIRED TECHNIQUES

L	T	P	C
3	0	0	3

UNIT I ARTIFICIAL NEURAL NETWORKS **9**

Introduction - Soft computing vs hard computing - Soft computing techniques - Applications - ANN: Definition - Structure and function of a single neuron: Biological neuron, artificial neuron, taxonomy of neural net, difference between ANN and human brain, characteristics and applications of ANN, single layer network, perceptron training algorithm, linear separability, widrow & hebbian learning rule/delta rule, ADALINE, MADALINE - Introduction of MLP – Deep learning concepts - Geomatic applications.

UNIT II FUZZY SYSTEMS **9**

Fuzzy logic: Fuzzy set theory, fuzzy set versus crisp set, crisp and fuzzy relations, fuzzy systems: crisp logic, fuzzy logic, introduction and features of membership functions, fuzzy rule base system: Fuzzy propositions, formation, decomposition & aggregation of fuzzy rules, fuzzy reasoning, fuzzy inference systems, fuzzy decision making and Geomatic applications.

UNIT III NEURO-FUZZY MODELLING **9**

Adaptive neuro-fuzzy Inference Systems - Architecture - Hybrid learning algorithm - Learning methods that cross-fertilize ANFIS and RBFN - Coactive neuro fuzzy modeling - Framework neuron functions for adaptive networks - Neuro fuzzy spectrum.

UNIT IV GENETIC ALGORITHM **9**

Genetic algorithm: Fundamentals, basic concepts, working principle, encoding, fitness function, reproduction - Genetic modeling: Inheritance operator, cross over, inversion & deletion, mutation operator, Bitwise operator - Generational cycle - Convergence of GA - Applications & advances in GA - Differences & similarities between GA & other traditional method.

UNIT V APPLICATIONS IN GEOMATICS **9**

AI search algorithm - Predicate calculus - Knowledge acquisition and representation - Rules of interface - Semantic networks-frames - Objects-Hybrid models - Geomatic applications.

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Acquaint with the necessity of soft computing techniques and fundamentals of Artificial Neural Networks.
CO2: Imparts the concepts of uncertainty and its impacts on artificial intelligence.
CO3: Implement hybrid computing techniques in geomatics.
CO4: Apply Genetic algorithm in geomatic applications.
CO5: Implement soft computing techniques in geomatic fields.

REFERENCES:

1. Freeman J A and Skapura B M, "Neural Networks, Algorithms Applications and Programming Techniques", Pearson, 2002.
2. Jacek M Zurada, “Introduction to Artificial Neural Systems” , Jaico Publishing House, 2006.
3. Jang J S R, Sun C T and Mizutami E, “Neuro Fuzzy and Soft computing”, Pearson, 2015.
4. Timothy J Ross, “Fuzzy Logic with Engineering Applications”, McGraw Hill, New York, 4th edition, 2016.
5. Laurene Fauseett, “Fundamentals of Neural Networks”, Prentice Hall India, New Delhi, Pearson, 2004.
6. George J Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic”, Prentice Hall Inc., New Jersey, 2008.
7. Nih J Ndssen, “Artificial Intelligence”, Harcourt Asia Ltd, Singapore, 1998.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	3	2	3	3	2	2
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3003 **GIS APPLICATIONS** **L T P C**
3 0 0 3

UNIT I NATURAL RESOURCE MANAGEMENT APPLICATIONS 9

Forestry: Resource inventory, forest fire growth modeling - Land: Land use planning, watershed management studies - Water - Identification of ground water recharge - Resource information system - Wetlands management, wildlife habitat analysis - Satellites data availability - Case Studies.

UNIT II DISASTER MANAGEMENT & FACILITY MANAGEMENT APPLICATIONS 9

Disaster management: Use of GIS in risk assessment, mitigation, preparedness, response and recovery phases of Disaster management - Utilities - Water utility applications - Electric utility application - Telecommunication: Tower spotting, route optimization for meter reading for utilities - Other utilities - Transportation network - Crowd sourcing methods and Algorithms.

UNIT III LOCATION BASED SERVICES APPLICATION 9

Vehicle tracking: Automatic vehicle location (AVL), Components of AVL: In vehicle equipment, various communication channels, web server, client - Vehicle tracking alarms used in vehicle tracking, fleet management - Vehicle navigation - Emergency call: Address geocoding, distress call application.

UNIT IV LAND INFORMATION SYSTEM & WEB GIS APPLICATIONS 9

Land information system (LIS) - Tax mapping - Mobile mapping - Other LIS applications - Web GIS: Architecture of web GIS, map server, web GIS applications - Bhuvan - NUIS – EPRIS

UNIT V DEMOGRAPHIC APPLICATIONS 9

Business applications: Sitting retail store, Customer loyalty studies, market penetration studies – Health application: Disaster surveillance, health information system - Crime mapping: Mapping crime data, hotspot analysis - 3D GIS

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Apply geomatics technology for management of natural resources.
CO2: Evaluate use of geomatics technology for disaster management and facility management.
CO3: Understand the use of geomatics in location based services.
CO4: Assess the applications of land information in tax and other domains.
CO5: Apply geomatics for solving social and business issues.

REFERENCES:

1. Ana Cláudia Teodoro, “GIS – An Overview of Applications”, Bentham Science publishers,2018.
2. Paul Longley, Michael F. Goodchild, David J.Maguire, David W.Rhind, “Geographic Information Systems and Science”, John Wiley and Sons, 2015.
3. Uzair M.Shamsi, “GIS Tools for Water, Wastewater, and Stormwater Systems”, ASCE Press, 2002.
4. Alan L, MD Melnick, “Introduction to Geographic Information Systems for Public Health”, Aspen Publishers, first edition, 2002.
5. Amin Hammad, Hassan Karimi, “Tele Geoinformatics: Location- based Computing and Services”, CRC Press, 2004.
6. Allan Brimicombe, “GIS Environmental Modeling and Engineering”, Taylor & Francis, 2010.
7. Van Dijk, M.G. Bos, “GIS and Remote Sensing Techniques in Land-And-Water- Management”, Kluwer Academic Publisher, 2001.
8. Ana Claudia Teodoro, “Frontiers in Information Systems GIS – An Overview of Applications”, Volume 1, Bentham Science Publishers, 2020.
9. Rifaat Abdalla, Marwa Esmail, “WebGIS for Disaster Management and Emergency Response”, Springer 2019.

10. Chander Kumar Singh, “Geospatial Applications for Natural Resources Management”, CRC Press 2018.
11. Miguel A. Labrador, Alfredo J. Perez, Pedro M. Wightman, “Location-Based Information Systems”, CRC Press 2019.
12. Hassan A. Karimi, “Advanced Location-Based Technologies and Services”, CRC Press 2016.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	3	2
CO2	1	3	3	3	2	2
CO3	1	2	2	2	2	2
CO4	2	1	2	2	2	2
CO5	2	3	3	2	2	2
Avg	**2**	**3**	**3**	**2**	**2**	**2**

1-Low, 2-Medium, 3-High

RG3004 THERMAL AND HYPERSPECTRAL REMOTE SENSING L T P C
3 0 0 3

UNIT I FUNDAMENTALS OF THERMAL REMOTE SENSING 9

Radiation science basics - Thermal radiation principles, thermal interaction behavior of terrain elements, thermal sensors and specifications - MUST (Medium Scale Surface Temperature Missions) infrared sensors and radiometers - Aerial thermal images - Image characters, spatial and radiometry - Sources of image degradation - Radiometric and geometric errors and correction - Interpretation of thermal image

UNIT II THERMAL IMAGE AND INTERPRETATION 9

Extraction of environmental variables - LST retrieval methods - Mapping of surface energy balance components - Surface flux studies - Thermal and optical RS for plant biophysics, hydrology, forestry and agriculture applications - Case studies.

UNIT III FIELD AND IMAGE SPECTROMETRY 9

Spectral radiometry - Imaging spectrometry: Considerations - Experimental design and instrumentation - Factors affecting the field spectrum - Hyper spectral sensor systems - Imaging spectrometry - Scattering principles - BDRF and hemispherical reflectance - Models; MODTRAN Sensors and platforms - Data characteristics.

UNIT IV HYPERSPECTRAL IMAGE ANALYSIS 9

Virtual dimensionality - Representation systems - Hypercube - Red edge - Indices - Hughes phenomenon - Multivariate analysis for data reduction - Data calibration, normalization - Spectral library - Response functions - MNF transformation - Kalman filters - Library matching, spectral angle mapper, BBMLC - Spectral mixture analysis - Endmember extraction - Spectral unmixing MIA analysis concepts - PCF, PCA, WPCA spectral transformation - Band detection, reduction and selection principles - Data compression.

UNIT V HYPERSPECTRAL IMAGE APPLICATIONS 9

Application to lithology, mineral exploration - Agricultural crop systems - Stress detection, plant production, vegetal biophysics and biochemistry, soil moisture , soil characteristics, degradation status - Forestry canopy characters, ecosystem, forest health, biodiversity, gap dynamics, environmental and resource management.

TOTAL: 45 PERIODS

Attested

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COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand the principles of thermal radiation and thermal image processing.
CO2: Understand the satellite thermal image for environmental parameter estimation.
CO3: Understand the spectrometry principles of satellite images.
CO4: Understanding the hyper spectral image analysis to derive various parameters of vegetation, soil and water.
CO5: The hyper spectral image to resource management in various fields.

REFERENCES:

1. Dale A Quattarochi and Jeffrey C Luvall, “Thermal Remote Sensing in Land surface Processes”, e-book, 2005 Taylor & Fancis, ISBN 0 203 50217 5
2. John A. Richards and Xiuping Jia, “Remote sensing digital Image Analysis - An introduction” fifth edition, Springer Verlag., 2012 ISBN 978 3 642 30061 5.
3. Chein I Chang, “Hyperspectral Imaging: Techniques for Spectral Detection and Classification”, Kluwer Academic/Plenum Publishers, New York, N.Y., 2003.(ISBN: 0-30647483-2)
4. Marcus Borengasser and William C.Hungate and Russel Watkins, “Hyper spectral Remote Sensing: Principles and application” CRC,1stEdition,2008.
5. Claudia Kuenzer, Stefan Dech Editors, “Thermal Infrared Remote Sensing Sensors, Methods, Applications”, Springer,2013.
6. Qihao Weng, Series Editor, “Hyperspectral Remote Sensing Fundamentals & Practices”, Taylor & Francis, CRC Press.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	3	3	3	3	3	3
CO3	2	2	3	2	2	2
CO4	3	3	2	3	3	3
CO5	3	3	3	3	3	3
Avg	3	3	3	3	3	3

1-Low, 2-Medium, 3-High

RG3005 DISASTER MANAGEMENT AND GEOMATICS APPLICATIONS **L T P C**
3 0 0 3

UNIT I DISASTER PRINCIPLES **9**

Disaster - Concepts and principles - Classification - Causes, characteristics and effects of various types of natural and manmade disasters - Global scenario - vulnerability profile in India - Institutional framework for disaster management - Role of government administration and NGOs - International disaster assistance - Sharing technology and technical expertise.

UNIT II LONG TERM MITIGATION MEASURES **9**

Needs and approach towards prevention - components of disaster mitigation - Disaster legislation and policy - Insurance - Cost effective analysis - Utilisation of resources - Training - Education - Public awareness -Role of media.

UNIT III PREPAREDNESS, RESPONSE AND RECOVERY **9**

Forecasting of disasters - Institutional arrangement for forecasting - Role of university and research organizations - Support by satellite remote sensing agencies - Preparedness - Trigger mechanism - Crisis management plan - Recovery - Reconstruction after disasters: Issues of practices.

UNIT IV SAFETY RATING OF STRUCTURES 9

Structural safety of hill slopes, dams, bridges, hospital, industrial structures - Planning seawalls and groynes - Cyclone shelter projects and their implications - Disaster resistant construction practices - Low cost housing for disaster prone areas

UNIT V REMOTE SENSING AND GIS FOR DISASTER MANAGEMENT 9

Remote sensing applications: Hazard evaluation - Zonation - Risk assessment and vulnerability- Damage assessment - Land use planning and regulation for sustainable development - Post disaster review GIS Applications: Spatial and non-spatial data bank creation - Operational emergency management - Vulnerability analysis of infrastructures and settlements - Pre-disaster and post disaster planning for relief operations - Disaster mapping

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand various types of disasters and infrastructural facilities available for managing Disasters.
CO2: Understand long term disaster mitigation principles.
CO3: Understand the requirements for disaster preparedness, response and recovery.
CO4: Gain knowledge about safety evaluation of essential social infrastructures.
CO5: Understand the applications of remote sensing and GIS in disaster management.

REFERENCES:

1. J.P.Singhal., "Disaster Management", Laxmi Publications, 2019, ISBN-10:9380386427, ISBN-13:978-9380386423.
2. Tushar Bhattacharya., "Disaster Science and Management", McGraw Hill India Education Pvt Ltd, 2012, ISBN-10: 1259007367, ISBN-13:978-1259007361.
3. Bell, F.G., "Geological Hazards: Their assessment, avoidance and mitigation", E & F.N SPON Routledge, 1999.
4. George G. Penelis and Andreas J. Kappos., " Earthquake Resistant Concrete Structures". E & F.N SPON, 2014.
5. "Mitigating Natural Disasters, Phenomena, Effects and Options, A Manual for Policy makers and planners", United Nations. New York, 1991.
6. Gupta Anil K, Sreeja S, Nair., "Environmental Knowledge for Disaster Risk Management", NIDM, 2012.
7. Kapur Anu., "Vulnerable India: A Geographical study of Disasters", IIAS and sage Publishers, 2010.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	3	3	3
CO2	3	3	3	3	3	3
CO3	2	3	2	3	3	3
CO4	2	2	2	2	2	2
CO5	3	3	3	3	3	3
Avg	**2**	**3**	**2**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3006	GEOMATICS FOR HYDROLOGY AND WATER RESOURCES MANAGEMENT	L	T	P	C
		3	0	0	3

UNIT I HYDROLOGIC COMPONENTS 9

Hydrologic cycle - Estimation of various components - Clouds: Types of clouds - rainfall: Types of rainfall - Runoff - Climate parameters - Data collection technologies - Spectral properties of water - Useful satellite surrogate parameters and data products for water management

UNIT II SURFACE WATER MODELLING 9

Drainage basin - Delineation and codification of watershed - Morphometric analysis - Hydrological modelling - Rainfall - Runoff modelling - Remote sensing - Based surface water analysis - Urban Hydrology - Models - Impact of climate change on hydrological modeling - Water quality mapping and monitoring with satellite data - Correlation model for pollution detection.

UNIT III RISK AND DAMAGE ASSESSMENT 9

Mapping of snow - Covered area - Snowmelt runoff - Glacier runoff modelling - Flood risk zoning - Flood damage assessment - Flood Modelling - Early warning system for flood mitigation - Drought - Types - Assessment of droughts and mitigation - Drought management with modern technology water harvesting structures.

UNIT IV GROUNDWATER MODELLING 9

Origin - Classification and properties of aquifer - Ground water potential identification - Surface indicators - Aquifer parameters - Hydrologic budgeting - Different types of groundwater models - Mathematical modelling of groundwater system - Sea water intrusion - Interfacing GIS with ground water model - Artificial recharge of ground water.

UNIT V IRRIGATION AND WATERSHED MANAGEMENT 9

Crop water requirements - Visible and Near Infrared - Crop Stress: Thermal Infra-Red and biophysical indices - Reservoir Sedimentation Studies - Capacity curve generation - Modelling of reservoir siltation - Erosion estimation using remote sensing - Prioritization of watersheds - watershed modelling for sustainable development.

TOTAL: 45 PERIODS

REFERENCES :

1. Gert A. Schultz, Edwin T. Engman., “Remote Sensing in Hydrology and Water Management,” Springer Berlin Heidelberg -2011
2. S. K. Gupta., “Modern Hydrology and Sustainable Water Development,” John Wiley & Sons – 2010.
3. K. Ramamohan Reddy., B. Venkateswara Rao., C. Sarala., “HYDROLOGY AND WATERSHED MANAGEMENT,” Allied Publishers – 2014.
4. Schultz, G. A. and Engman, E. T. (2000). “Remote Sensing in Hydrology and Water Management,” Springer-Verlag, Berlin, Germany.
5. David Keith Todd (2005)., “Groundwater Hydrology,” John Wiley & Sons, New York, Second Edition.
6. H. M. Raghunath (2000)., “Hydrology- principles, Analysis, Design,” New Age International, New Delhi.
7. Andrew Skidmore., “Environmental Modelling with GIS and Remote Sensing,” CRC Press– 2017
8. Dorota Swiatek, Stefan Ignar, “Modelling of Hydrological Processes in the Narew Catchment,” Springer Berlin Heidelberg - 2013
9. Tim Davie, “FUNDAMENTALS OF HYDROLOGY” Second edition, Taylor & Francis -2018
10. L. Asawa, “Irrigation and Water Resources Engineering,” New Age International–2008.

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CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	-	-
CO2	3	3	3	3	3	2
CO3	2	2	3	3	3	2
CO4	2	2	3	3	3	3
CO5	1	1	3	3	2	3
Avg	**2**	**2**	**3**	**3**	**2**	**2**

1-Low, 2-Medium, 3-High

RG3007 PYTHON AND R PROGRAMMING

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION **9**

Overview - Installation of Python and relevant libraries - Introduction to development environments - Data structures - Variables, data types - Basic operations - Control structures - Lists, tuples, dictionaries, and sets - Geospatial libraries in Python.

UNIT II GEOSPATIAL LIBRARIES OF PYTHON **9**

Importing, reading, and writing geospatial data - Geospatial data manipulation and attribute handling - Plotting and visualizing geospatial data - Customizing plots and creating maps - Geospatial analysis and processing - Spatial operations - Geometric calculations and measurements - Automating geospatial tasks.

UNIT III WEB MAPPING AND GEOSPATIAL SERVICES **9**

Introduction to web mapping libraries (Folium, Leaflet) - Interacting with web maps and geospatial services - Creating interactive geospatial visualizations. - Geomatics software development.

UNIT IV INTRODUCTION TO R PROGRAMMING **9**

Overview - Installation of R and relevant packages - Introduction to RStudio and the R development environment - R Basics and data structures - Variables, data types, and basic operations in R - Control structures (conditionals, loops) - Vectors, matrices, data frames, and lists in R.

UNIT V GEOSPATIAL DATA MANIPULATION IN R **9**

Introduction to geospatial packages (e.g., sf, sp) - Importing, reading, and writing geospatial data - Geospatial data manipulation and attribute handling - Data visualization packages (e.g., ggplot2) in R - Plotting and visualizing geospatial data - Customizing plots and creating maps - Geospatial data analysis - Spatial operations (e.g., buffering, overlay) - Descriptive statistics and spatial analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand the fundamentals of Python programming language and its syntax.
CO2: Apply Python programming techniques to process, analyze, and visualize geospatial data.
CO3: Build geospatial applications and tools using Python for specific geomatics domains, such as remote sensing, GIS, or spatial analysis.
CO4: Understand the fundamentals of the R programming language and its libraries.
CO5: Apply R programming techniques to process, analyze, and visualize geospatial data.

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REFERENCES:

1. Erik Westra, "Python Geospatial Development", Packt Publishing, 3rd Edition, 2016, ISBN: 978-1785288936.
2. Paul A. Zandbergen, "Python Scripting for ArcGIS", Esri Press, 2nd edition, 2013, ISBN: 978-1589482821.
3. Chris Garrard, "Geoprocessing with Python", CRC Press, 2016, ISBN: 978-1498775261.
4. Chris Garrard, "Automating GIS Processes with Python", CRC Press, 2nd edition, 2019, ISBN: 978-1138505581
5. Joel Lawhead and Erik Westra, "Learning Geospatial Analysis with Python", Packt Publishing, 2020, ISBN: 978-1839213309.
6. Roger S. Bivand, Edzer J. Pebesma, and Virgilio Gómez-Rubio, "Applied Spatial Data Analysis with R", Springer, 2nd edition, 2013, ISBN: 978-1461476177.
7. Robin Lovelace, Jakub Nowosad, and Jannes Muenchow, "Geocomputation with R", CRC Press, 2nd edition, 2020, ISBN: 978-1138304512.
8. Yongwan Chun and Daniel A. Griffith, "Spatial Statistics and Geostatistics: Theory and Applications for Geographic Information Science and Technology", Sage Publications, 2013, ISBN: 978-1412991644.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	-	-	-	-
CO2	3	2	3	2	2	2
CO3	3	3	3	2	3	3
CO4	1	1	-	-	-	-
CO5	3	3	3	2	3	3
Avg	**3**	**2**	**3**	**2**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3008 GEOMATICS FOR URBAN PLANNING AND MANAGEMENT L T P C

3 0 0 3

UNIT I INTRODUCTION 9

Scope and limitations of geomatics in urban planning and management - Overview of geospatial technologies and their relevance in urban contexts - Introduction to spatial data infrastructure and geospatial data standards - Data sources for urban planning - Overview of satellite sensors, data types, and spatial resolutions – Optical, Microwave, Thermal sensors and their applications - UAV, Laser scanners and Nightlight Images.

UNIT II SPATIO TEMPROAL MAPPING OF URBAN AREAS 9

Urban area - Definition and characterization - Principles of image interpretation for urban features - Urban landuse classification - Digital techniques for landuse mapping - Multi-source data fusion and data integration - Feature extraction techniques - Mapping of urban form and structure - Change detection - Sprawl detection and characterization - Urban heat island analysis and mapping urban green and blue infrastructure mapping.

UNIT III URBAN PLAN FORMULATION 9

Plan for urban area - Types - Master and Detailed Development Plans - Objectives and contents of plans – Role of Geomatics in plan formulation and review - Urban Information System - Population estimation - Urban solid waste management planning - Urban renewal planning - Urban growth modeling: Cellular automata and other modeling approaches - Scenario analysis and future growth projections.

UNIT IV SPATIOTEMPORAL ANALYSIS OF URBAN INFRASTRUCTURE 9

Geodemographic analysis and applications - GDP forecasting through remote sensing - Property tax assessment and management - Land value analysis - Asset inventory and spatial analysis - Case studies and applications - Optimization of facility locations - Site suitability analysis for infrastructure - Network analysis for route optimization - Accessibility assessment to urban infrastructure - Traffic modeling.

UNIT V TRENDS AND ADVANCEMENTS 9

Spatial statistics and modeling for urban applications - Web-based mapping for urban applications - 3D city modelling - Integration of BIM and GIS - Digital 3D reconstruction of urban heritage conservation - Digital twins concepts and applications - Geomatics for smart cities - Recent advancements - Case studies.

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand the fundamental concepts and principles of urban geomatics, including the integration of geospatial data and urban planning.

CO2: Develop skills in acquiring, processing, and analyzing geospatial data specific to urban environments.

CO3: Apply geomatics techniques to urban planning and management scenarios.

CO4: Utilize geospatial data visualization and cartographic techniques to communicate urban spatial patterns and trends effectively.

CO5: Understand the trends and developments in application of advanced geomatics tools for efficient planning and management of urban areas.

REFERENCES:

1. Folke Snickars and Robert E. Ståhlberg, "Geographic Information Systems for Urban and Regional Planning", Routledge, 1st edition, 2013, ISBN: 9780415141562.
2. Richard K. Brail, "GIS for Urban and Regional Planning", ESRI Press, 1st edition, 2015, ISBN: 9781589484645.
3. Richard Harris and Martin Charlton, "Spatial Planning and GIS", Routledge, 1st edition, 2015, ISBN: 9781138831630.
4. Stan Geertman and John Stillwell, "Planning Support Systems for Sustainable Urban Development", Springer, 1st edition, 2012, ISBN: 9789048193196.
5. Paul A. Longley and Michael Batty, "Geographic Information Systems in Urban Planning and Management", Taylor & Francis, 2nd edition, 2003, ISBN: 9780415167760.
6. Bin Jiang and Xiaobai Yao, "Geospatial Analysis and Modelling of Urban Structure and Dynamics", Springer, 1st edition, 2014, ISBN: 9783642365833.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	2	-
CO2	3	3	3	3	3	-
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	2	1	2	2	2
Avg	**3**	**3**	**2**	**3**	**3**	**2**

1-Low, 2-Medium, 3-High

Attested

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RG3009 TOPOGRAPHIC AND BATHYMETRIC LASER SCANNING L T P C
3 0 0 3

UNIT I LASER AND SPACE BORNE LASER PROFILERS 9

LASER, components of laser: active material, energy Source, reflection mirror - Laser production - laser classification: eye safety, Class I to Class IV lasers - Comparison of airborne laser scanning with ground survey, photogrammetry, GPS survey and satellite stereogrammetry - Laser ranging - Types of LiDAR: rangefinder LiDAR, doppler LiDAR, DIAL - Ellipsoid and geoid - Principles of laser ranging: pulse laser, Continuous wave laser - Space borne laser missions - Geoscience Laser Altimeter System (GLAS), LiDAR In-Space Technology Experiment (LITE), chandrayaan, CALIOP – Aerosol monitoring and measurement.

UNIT II AIRBORNE LASER SCANNERS 9

Components of airborne laser scanning system - GPS, IMU, LASER scanner, Position and Orientation System(PoS) - Types of scanning mechanism and ground measuring pattern - UAV based topographic laser scanner - Synchronization of laser scanner and PoS - LASER scanners specification and salient features - Concept of multi return - 3D cloud points - Reflectivity of ground features - Range correction factor.

UNIT III LIDAR DATA PROCESSING 9

Pre Processing: direct georeferencing, combining inertial and navigation data - Determination of optimal flight trajectory - Data processing - Coordinate transformations - Geolocating Laser foot prints - Strip adjustment - Digital Surface Model(DSM) to Digital Elevation Model(DEM): filtering, ground point filtering - Flight planning - Quality control parameters - Preparation of flight plan.

UNIT IV LIDAR DATA MANAGEMENT AND APPLICATIONS 9

Airborne laser scanner error sources - LiDAR data format: ASCII vs Binary, LAS format - Software used for LiDAR data processing and management - Merits of airborne laser terrain mapping - Overview of LiDAR applications - 3D city models - Road and building extraction - Forestry applications - Power line mapping.

UNIT V TERRESTRIAL AND BATHYMETRIC LASER SCANNER 9

Terrestrial Lidar: static and mobile (Vehicle Mounted) LiDAR - Terrestrial laser Scanner Specification - 3D Point Clouds and Processing Software - Applications of Terrestrial laser scanning - Airborne bathymetric laser Scanner - UAV based Bathycopter - Specification - Depth of penetration: secchi depth - Applications of bathymetric laser scanner

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand types of LASER and its classification, types of LiDAR and Satellite Laser Scanning Missions.
CO2: Understand components of ALS, various scanning mechanisms and concept of multi returns.
CO3: Analyze and process the Navigation and Inertial data for optimal flight path selection and coordinate transformation techniques for geolocating laser foot prints.
CO4: Apply derived products of ALS in various application domains with reference to case studies
CO5: Understand the concepts of TLS and ABS and its application.

REFERENCES:

1. Jie Shan and Charles K. Toth, Topographic Laser Ranging and Scanning – Principles and Processing,Second Edition, CRC Press, Taylor & Francis Group, 2018
2. Pinliang Dong, Qi Chen, LiDAR Remote Sensing and Applications, 1st Edition, CRC Press 2018

3. George Vosselman and Hans-Gerd Maas, Airborne and Terrestrial Laser Scanning, Whittles Publishing, 2010.
4. Matti Maltamo, Erik Næsset, Jari Vauhkonen, Forestry Applications of Airborne Laser Scanning-Concepts and Case Studies, Springer, Dordrecht 2014, reprint edition, ISBN 978- 94-017-8662-1
5. Michael Renslow, Manual of Airborne Topographic LiDAR, The American Society for Photogrammetry and Remote Sensing , 2013.
6. Zhilin Li, Qing Zhu, Chris Gold, Digital terrain modeling: principles and methodology, CRC Press, 2005.
7. Roger Read and Ron Graham, Manual of Aerial Survey: Primary Data Acquisition, Whittles Publishing, 2002.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	3	-	3	1	-
CO2	2	-	3	3	3	2
CO3	3	2	3	3	3	3
CO4	3	3	3	2	2	3
CO5	3	3	3	2	3	3
Avg	**3**	**3**	**3**	**3**	**2**	**3**

1-Low, 2-Medium, 3-High

RG3010 GEOMATICS FOR OCEAN AND COASTAL ZONE MANAGEMENT

L	T	P	C
3	0	0	3

UNIT I OCEAN ENGINEERING **9**

Coastal processes - Oceanic circulation - Upwelling and sinking - Waves - Reflection, diffraction and refraction - Wave generated currents - Catastrophic waves - Tides - Tidal forces - Bathymetry - Sediment drift - Navigation.

UNIT II OCEAN GENERAL STUDIES **9**

Physical properties of seawater - Chemistry of seawater - Biological parameters - Oceanographic instruments - Collection of water samples - Current measuring devices - Deep sea coring devices.

UNIT III COASTAL ENGINEERING **9**

Coastal hydrodynamic - Coastal erosion - Various protection structures - Estuaries and impact of coastal processes - Hydrodynamics of pollution dispersion - Modelling of suspended sediment.

UNIT IV REMOTE SENSING APPLICATION FOR OCEAN **9**

Various satellite and sensors for ocean and coastal applications - Application of CZCS - Chlorophyll and suspended sediment estimation - Retrieval of physical oceanographic parameters - Sea surface temperature - Significant wave height - Wind speed and wind direction - Coastal bathymetry - Sea level rise.

UNIT V COASTAL ZONE MANAGEMENT **9**

Introduction - Major issues/problems - Thematic maps on coastal resources - Wetland classification - Mapping of shoreline changes - Creation of CZIS - Coastal aquifer modelling - Integrated coastal zone management - Resolving conflict on resources utilization - CRZ Mapping.

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand the mechanism of various coastal processes and ocean circulations.
CO2: Gain knowledge about the sea water characteristics and sampling instruments.
CO3: Understand the concepts of coastal hydrodynamics and design of protective structures.
CO4: Gain knowledge on missions and sensors for ocean observation and retrieval of biophysical parameters through Remote observation.
CO5: Impart the skills required to identify and analyze the major coastal issues relevant to coastal resources and the applicability of Remote Sensing for its sustainable management.

REFERENCES:

1. Vasilis D Valavanis, "GIS in oceanography & Fisheries", Taylor & Francis, London & NewYork, 2002.
2. Alasdair J Edward, "Remote Sensing Handbook for Tropical Coastal Management", UNESCO publishing, 2000.
3. Grant Gross M, "Oceanography", Merrill Publishing company, Columbus, U.S.A.,1996.
4. Karsten Manager, "Shoreline Management Guidelines", DHI Water & Environment, Denmark, 2004.
5. Dean R G and Dalrymple R A, "Coastal Process with Engineering Application", Cambridge university press, Cambridge, 2004.
6. Paul D Komar, "Beach process and sedimentation", Prentice Hall Inc., NewJersey, 2nd edition, 1987.
7. Robin Davidson-Arnott, "Introduction to Coastal Processes and Geomorphology", Cambridge University Press, 2019.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	-	3
CO2	3	3	3	-	-	3
CO3	3	3	3	-	-	3
CO4	-	3	3	3	3	3
CO5	-	3	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3011 **PLANETARY REMOTE SENSING** **L T P C**
3 0 0 3

UNIT I UNIVERSE AND SOLAR SYSTEM **9**

Origin of Universe - Big Bang and Steady state theories, Solar System - Planets, satellites asteroids, meteorites and comets and internal differentiation of the planets - Planetary exploration mission and sensors.

UNIT II TERRESTRIAL PLANETS **9**

Geology and geophysics of terrestrial planets: Earth, Mars, Venus and Mercury; Physical properties, Composition, Mineralogy and Petrology of the planets and the Moon.

UNIT III PLANETARY ATMOSPHERE **9**

Exo and Endogenic processes associated with origin and internal evolution of planets - Planetary volcanism, Craters, Elemental Composition; Mineralogy and Petrology; Thermal, Seismic and Magnetic properties.

UNIT IV REMOTE SENSING FOR PLANETARY GEOLOGY **9**

Approaches to Remote Sensing analysis of the planetary surfaces; applications derived from interaction of electromagnetic radiation (X-ray, gamma-ray, visible, near-IR, mid-IR, radar).

UNIT V PLANETARY EXPLORATION MISSIONS **9**

Laser Altimetry and its application in Planetary science - Past, present and future missions **-** Analyses and Interpretation of data gathered through various missions; Identification of morphological features.

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Identify the components of Solar System and understand the payloads of related exploratory Missions.
CO2: Understand the mineralogy and petrology of terrestrial planets.
CO3: Describe the exo –endogenic process of Planetary Atmosphere.
CO4: Apply Remote Sensing Techniques for Planetary Surface Analysis.
CO5: Describe the various past and present planetary missions.

REFERENCES:

1. Shuanggen Jin, "Planetary Geodesy and Remote Sensing" 1st Edition, CRC PRESS, 2019.
2. Bo Wu, Kaichang Di, Jürgen Oberst, Irina Karachevtseva, "Planetary Remote Sensing and Mapping" 1st Edition, CRC Press,2018.
3. Raymond T.Pierrehumbert, "Principles of Planetary Climate", University of Chicago, Publication date: December 2010.
4. Deepak Kumar, "Remote Sensing Applications for Planetary Surfaces", Lambert Academic Publishing,2014.
5. Evans, L.G., R.C. Reedy, and J.I. Trombka,"Introduction to Planetary Remote Sensing Gamma Ray Spectroscopy, in Remote Geochemical Analysis: Elemental and Mineralogical Composition", Ed. C.M. Pieters and P.A.J. Englert, Cambridge Univ. Press, pp. 167-198.,2010.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	3
CO2	3	-	-	-	2	3
CO3	3	-	-	-	2	3
CO4	3	3	3	3	3	3
CO5	3	3	2	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3012 **SPATIAL DATA MODELLING** **L T P C**
3 0 0 3

UNIT I MODELLING SPATIAL PROBLEMS **9**

Introduction - Need for Spatial models - Conceptual model for solving spatial problems - Steps involved - Types of spatial models - Descriptive and process models - Types of process models - Creating conceptual models - Site suitability model - Case Study.

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UNIT II MODEL BUILDER IN GIS ENVIRONMENT 9

Graphical modeller of QGIS - Development of models using graphical model builder: Input to model - Algorithm input - Running a model - Nesting a model - ArcGIS model builder: Building a model, input: Variables, arrays - Iterative models - Building and running a model - Converting a model to python script.

UNIT III GEOSTATISTICAL ANALYSIS AND MODELING–MAPPING 9

Stepwise regression - Ordinary least squares (OLS) - Variogram and kriging: Ordinary kriging, simple kriging, universal kriging - Developing variogram model and Kriging - Spatial autoregressive (SAR) - Binary classification tree (BCTs) - Cokriging - Geospatial models for presence and absence data - GARP model -Maxent model - Logistic regression - Classification and regression tree (CART) - Envelope model.

UNIT IV SPATIOTEMPORAL MODELING 9

Concept - Cellular model : Definition, type, application - Integration with fuzzy, ANN - Agent based modeling : Concept, agent, analysis, application - Big data: Definition, tools, analysis and application, NetLogo models integrated GIS : Case studies.

UNIT V MACHINE LEARNING TOOLS 9

Artificial intelligence: Definition, types - Expert system - Sources of knowledge - Knowledge acquisition methods - Representation schemes - Types of inference: Forward and backward chaining - Artificial neural network - BPN - Fuzzy logic - Integration with GIS - Case studies.

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand the descriptive and process spatial models.
CO2: Understand model builder in GIS environment.
CO3: Apply geostatistical analysis and modeling.
CO4: Study various Spatio-Temporal models.
CO5: Understand the machine learning tools.

REFERENCES:

1. Manfred M. Fischer, Jinfeng Wang, “Spatial Data Analysis”, Springer-Verlag Berlin Heidelberg,2011,ISBN 978-3-642-21719-7
2. Christopher K. Wikle, Andrew Zammit-Mangion, Noel Cressie, “Spatio-Temporal Statistics with R”, 1st Edition, CRC Press, 2019.
3. Andrew Crooks, Nick Malleson, Ed Manley, Alison Heppenstall, “Agent-Based Modelling and Geographical Information Systems: A Practical Primer (Spatial Analytics and GIS)”, 2019, 1st Edition, SAGE Publications Ltd
4. Noel Cressie, Christopher K. Wikle, “Statistics for Spatio- Temporal Data" .1st Edition, 2011, Wiley Publishers
5. Maguire, D., M. Batty, and M. Goodchild. “GIS, spatial analysis, and modeling”. ESRI Press, 2005
6. Andrew Crooks, Nick Malleson, Ed Manley, Alison Heppenstall, “Agent-Based Modelling and Geographical Information Systems: A Practical Primer (Spatial Analytics and GIS)”, 1st Edition,
7. “Mastering Geospatial Development with QGIS 3.x: An in-depth guide to becoming proficient in spatial data analysis using QGIS 3.4 and 3.6 with Python”,Packt Publishing; 3rd edition, 28 March 2019.
8. TsungChang-Kang, “Introduction to Geographic Information Systems”, Tata McGraw Hill Publishing Company and Limited NewDelhi, 4th Edition, 2017.
9. Jay Gao, “Fundamentals of Spatial Analysis and Modelling”, CRC Press, 1st Edition, 2021
10. Giuseppe Patane and Michela Spagnuolo, “Heterogeneous Spatial Data: Fusion, Modelling, and Analysis for GIS Applications”. Springer 2022.
11. Hamid Reza Pourghasemi, Candan Gokceoglu, “Spatial Modeling in GIS and R for Earth and Environmental Sciences”, Elsevier Science 2019.

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12. Yuji Murayama, Rajesh Bahadur Thapa, “Spatial Analysis and Modeling in Geographical Transformation Process”, Springer Netherlands 2011.
13. José António Tenedório, Jorge Rocha, “Spatial Analysis, Modelling and Planning”, IntechOpen 2018.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	3	2	3
CO2	3	3	3	3	2	2
CO3	2	3	2	2	2	3
CO4	2	2	2	2	2	2
CO5	2	2	2	2	2	2
Avg	**2**	**3**	**2**	**3**	**2**	**2**

1-Low, 2-Medium, 3-High

RG3013 **WEB TECHNOLOGY PROGRAMMING FOR GIS** **L T P C**
3 0 0 3

UNIT I SPATIAL DATA STRUCTURES AND DATABASE MANAGEMENT 9

Spatial Data structures and Formats, Basic file formats (vector, raster) – JSON, GeoJSON, Geodatabase, Projections and EPSG Co-ordinate Systems, Attribute Tables – Spatial and Attribute Table linkage – Spatial Data modeling – design standards – Centralized / Distributed data model – Spatial Database administration – Data management and optimization - PostgreSQL- QGIS with Postgres- OGC Web Map services - WMS, WFS, WCS, WPS – Styling, tiling & caching.

UNIT II WEB GIS ARCHITECTURE 9

Internet and GIS, Web GIS Architecture and Components – Web Server – GIS Server / Application Server – Database Server, Open Server Standards - Protocols: HTTP, FTP, SMTP- Frontend & Backend programming: HTML, CSS, XML, MHTML, Service Oriented Architecture - REST/ SOAP service Protocols, Middleware - Web Services - GIS data sharing – WebMap services, COTS and Open Source / Free Software.

UNIT III HTML AND CSS PROGRAMMMING 9

HTML: 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.

UNIT IV WEB PROGRAMMING: PHP AND JAVASCRIPT 9

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 - Form handling and validations- PHP: Program Structures and Syntax, Variables and constants, Strings and Arrays, Operators, Control and looping structures, Functions - Embedding PHP within HTML – Establishing connectivity with database.

UNIT V MAPSERVER AND GEOSERVER 9

Anatomy of a MapServer Application- Mapfile- Query- Advanced User Interfaces- PHP Mapscript- MapCache- Migration- Environment Variables- Geo Server– 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 Map and Geo server.

TOTAL: 45 PERIODS

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COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: To introduce the Web GIS Architectures, Services for the GIS Spatial data.
CO2: To understand the markup languages, Cascaded Style Sheets concepts for the GIS Spatial Data.
CO3: To study the concepts of Java Scripts in programming the GIS Spatial Data.
CO4: To introduce the use of PHP programming for the GIS Spatial Data presentation.
CO5: To implement the complete GIS solution using the GeoServer concepts using case studies

REFERENCES:

1. Harvey M. Deitel, Deitel & Associates, Inc., Abbey Deitel, Deitel & Associates, Inc., "Internet and World Wide Web: How to Program", 5th Edition, Pearson Publication, July 2021. ISBN: 9780137618279.
2. Michael Dorman, "Introduction to Web Mapping", 1st Edition, January 2020. ISBN: 978-0367861186.
3. Stefano Iacovella, Brian Youngblood, "GeoServer Beginner's Guide", Second Revised Edition 2017. ISBN-13: 978-1849516686
4. Eric Pimpler, Mark Lewin, "Building Web and Mobile ArcGIS Server Applications with JavaScript", Second Edition. 2017. ISBN 9781787280526.
5. Chad Cooper, "Mastering ArcGIS Enterprise Administration", 2017. ISBN: 9781788297493, 1788297490.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	1	-	1
CO2	3	1	2	1	-	2
CO3	3	2	3	2	3	2
CO4	3	1	2	-	-	1
CO5	3	3	3	3	3	3
Avg	**3**	**2**	**2**	**2**	**3**	**2**

1-Low, 2-Medium, 3-High

RG3014 **METEOROLOGICAL APPLICATIONS AND GEOMATICS** **L T P C**
3 0 0 3

UNIT I GENERAL CONCEPTS IN METEOROLOGY **9**

Weather and climate - Composition of atmosphere - Weather elements and characteristics - Global temperature, pressure and wind belts - Scales of atmospheric processes, land/ocean coupling, vegetation types and climate, climatic classification by Koppen and thornth waithe, energy in the atmosphere - Indian monsoons - Weather systems and seasons, Indian climatology - Radiation transfer - Radiation spectrum - Absorption and emission of radiation by molecules - Radiation laws - Scattering principles - Atmospheric particles and radiations - Mechanism of cloud formation - Types of clouds - Precipitation processes - Weather stations, data, maps and symbols.

UNIT II RADIO METEOROLOGY **9**

Principles and classifications of radar - Meteorological applications of radar - Atmospheric sounding Radio Sonde - Pilot balloons - Wind estimation through radar - RawinSonde - Doppler techniques for precipitation estimation - Precipitation Radar (PR) - Global Precipitation Measurement (GPM), ozone soundings - Principle and satellite measurements of ozone - Aerosol soundings tracking of weather thunderstorms, tropical cyclones, tornadoes through radar - Hydro meteorological applications of radar - Applications to aviation meteorology - TIROS Operational and vertical sounder - Retrieval methods and algorithms.

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UNIT III METEOROLOGICAL MISSIONS 9

Orbital dynamics of satellite - Critical velocities - Polar and geostationary weather satellites - Active and passive sensors (radar/lidar/radiometry,scatterometer and altimeter) - Absorption bands of atmospheric gases - Design and characteristic of different types of sounders and imagers used in meteorological satellites - Viewing geometry - INSAT meteorology data processing system (IMDPS), IRS series - APT - AVHRR - Need for Remote Sensing techniques in weather forecasting and Numerical Weather Prediction (NWP) - Imaging and non imaging techniques in meteorology.

UNIT IV METEOROLOGICAL APPLICATIONS 9

Precipitation - Soil moisture estimation and their applications - Normalised Difference Vegetation Index (NDVI) - Ocean colour monitoring - Coastal zone mapping - Satellite communication systems in operational meteorological applications (cyclone warning dissemination system / automatic weather stations / meteorological data dissemination) - Estimation of snow and ice cover - Water body boundary mapping - Aerosols - Dust storms and volcanic ash clouds and fires - Maritime, dwelt, floods and agriculture.

UNIT V GLOBAL METEOROLOGICAL APPLICATIONS 9

Global and sub global events - Tracking of large weather system - Cloud motion vector - Dvorak's techniques of cylone intensity estimation - T-phi and other climatic charts - T number and current intensity no. - Applications to storm surge estimation - Satellite soundings - Global warming - Sea level changes and consequences.

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1 : Impacts the knowledge about the basis of Meteorology.
CO2 : Acquire knowledge about radar techniques in Meteorology.
CO3 : Understand the knowledge about platforms and sensors used in Meteorology.
CO4 : Develops knowledge about the remote sensing for Meteorology.
CO5 : Gives solutions to manage critical meteorological events.

REFERENCES:

1. Kidder and VonderHarr, "Satellite Meteorology: An introduction," Academic Press, San Diego, CA, 2008.
2. Arthur P. Cracknell, "The Advanced Very High Resolution Radiometer (AVHRR)," 1997, CRC Press, ISBN: 9780748402090.
3. Asnani, G.C "Tropical Meteorology", Vol. I and II, 3rd Edition, 2016.
4. Richard J. Doviak, Dusan S. Zrnic, "Doppler Radar and Weather Observations," Dover Publications;2014, ISBN: 978-0486450605.
5. Ellingson, "Satellite Data Applications: Weather and Climate," Proc.of AO I Symp., COSPAR, Birmingham, UK, Elsevier, MD, USA. Pergamon Pr; 1st Edition 1997.
6. Sauvageot, 1992, "Radar Meteorology," Artech House Publishers, Norwood, MA. 1992.
7. Hartwig Dobesch, Pierre Dumolard, Izabela Dyras, "Spatial Interpolation for Climate Data: The Use of GIS in Climatology and Meteorology," Wiley Publication, (2007 – Print), (2010 – Online).
8. RaghavanS. , "Radar Meteorology," Springer, 2003, ISBN: 9781402016042.
9. Kelkar R.R. "Satellite Meteorology," B S Publications, Hyderabad,2007.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	2	3
CO2	3	3	3	2	3	3
CO3	-	-	-	3	3	3
CO4	-	3	3	3	3	3
CO5	3	3	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3015 GEOMATICS FOR ENVIRONMENTAL MONITORING AND MODELING

L	T	P	C
3	0	0	3

UNIT I SATELLITE FOR ENVIRONMENTAL MANAGEMENT **9**

Introduction - Environmental satellite Mission: GEOS, NOAA, AVHRR, CZCS, Oceansat, Kalpana and others - Spectral characteristics - Data Products - Analysis Tools - Monitoring land, water, atmosphere and ocean using Remote Sensing Data

UNIT II WATER QUALITY MANAGEMENT **9**

Classification of water quality - Sampling procedure - Quality analysis and GIS modeling, Pipe Network Design using GIS - Water distribution design - EPANET 2.0, LOOP version 4.0, BRANCHSpectral responses of clear and contaminated water - Aquifer Vulnerability: Intrinsic and specific vulnerability - DRASTIC, SINTACS - Exposure to surface water and groundwater quality modelling software's - MIKE 21, WASP, QUAL2E and MODFLOW - Sea water Intrusion Modelling - Pollution diffusion model in river - Case studies

UNIT III AIR QUALITY **9**

Structure and composition of atmosphere - Sources and classification of air pollutants, Air Quality Standards – Chemical and Physical Components - Sampling - Mapping of atmospheric pollution - Air pollution due to industrial activity - Plume behaviors - Dispersion model: Gaussian Plume model - Introduction to commonly used software based models such as ADMS, AERMOD, CALINE, CALPUFF, DEGADIS, HYROAD, INDUSTRIAL SOURCE COMPLEX, SCREEN, HYSPLIT, INDEX etc. - Remote Sensing to monitor atmosphere constituents - Case Studies

UNIT IV SOLID WASTE MANAGEMENT **9**

Definition - Sources - Elements of integrated waste management and roles of stakeholders - Seven elements and seven step approach to integrated solid waste management planning, identification of storage and collection location - Analysis of collection route - Site selection: Transfer station, Disposal site - Waste allocation - leachate model - Case studies

UNIT V GLOBAL PROSPECTIVE AND CLIMATE CHANGE **9**

Prevention and Control measures - Carbon footprints and sinks, carbon trading, carbon credits and marketing, Indian and international status - Case studies - Definitions - Climate, Climate system, climate change - Drivers of Climate change - Characteristics of climate system components - Greenhouse effect – Carbon cycle - Climate model - types of model - General Circulation Models (GCM) - Issues with GCMs - Introduction to RCMs and LAMs - RCMs modellers - Advantages and disadvantages of GCMs and RCMs - case studies

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Gives knowledge about the platforms and sensors used for monitoring.
CO2: Acquire knowledge about sampling, testing of water and vulnerability models.
CO3: Understand about the air pollution and dispersion.
CO4: Gives knowledge about SW collection and management.
CO5: Impart knowledge about the effects of climate change and its control.

REFERENCES:

1. Allan Brimicombe., "GIS Environmental Modeling and Engineering", CRC Press, 2nd edition, 2009.
2. Andrew Skidmore., "Environmental Modelling with GIS and Remote Sensing", CRC Press, 2017.
3. Ian L.Pepper, Charles P.Gerbaand Mark L.Brusseau., "Environmental and Pollution science", Academic Press, 2nd Edition, 2011, ISBN : 978-0125515030.
4. David N.Miclsen., "Environmental Site Characterization and Ground water Monitoring",CRC Press, 2nd edition, 2005, ISBN: 978-1566705899.
5. Roger D.Griffin., Principles of Air Quality Management, CRC Press, 2nd edition, 2016.
6. Donald L.Wise., "Remediation for Hazardous waste contaminated soils", CRC Press, 1st Edition, 1994.
7. Michele Campagna., "GIS for sustainable development", CRC Press, 1st Edition, 2005.
8. Tchobanoglous George, Hilary Theisen, Samuel Vigi., "Integrated Solid Waste Management", McGraw – Hill Inc, 2014.
9. Dr Owen Harrop., "Air Quality Assessment & Management", CRC Press, 1st edition, 2001.
10. Robert Scally, "GIS for Environmental Management", ESRI Press, 2006.
11. ShuklaP R , Subobh K Sarma, NH Ravindranath, Amit Garg and Sumana Bhattacharya., "Climate Change and India: Vulnerability assessment and adaptation", University Press (India) Pvt Ltd, 2003.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	3	3
CO2	3	2	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3016 GEOMATICS FOR AGRICULTURE AND FORESTRY L T P C
3 0 0 3

UNIT I CROPS ACREAGE AND YIELD ESTIMATION 9

Spectral properties of crops in optical & TIR region, microwave backscattering behavior of crop canopy - Crops identification and crop inventory - Crop acreage estimation - Vegetation indices and biophysical model - Yield modelling - Crop condition assessment - Command area monitoring and management - Microwave RS for crop inventory - Case studies.

UNIT II SOIL MAPPING 9

Soil classifications - Soil survey, types and methods - Hydrological soil grouping - Factors influencing soil reflectance properties - Characteristics of saline & alkaline soils - Principle component analysis and orthogonal rotation transformation - Soil mapping - Watershed management - Problem soil identification - Land evaluation - Case studies.

UNIT III DAMAGE ASSESSMENT 9

Detection of pest and diseases - Flood mapping and assessments of crop loss - Drought assessment - Land degradation - Soil erosion and sedimentation - Soil loss assessment - Soil conservation - Agriculture damage prediction modelling.

UNIT IV FORESTRY 9

Forest taxonomy - Inventory of forest land - Forest types and density mapping - Forest stock mapping - Factors influencing degradation of forest - Delineation of degraded forest - Forest change detection and monitoring - Forest fire mapping & damage assessment - Biomass estimation - Carbon storage - ALTM for forest studies - Urban forestry issues.

UNIT V CLIMATIC IMPACT O F AGRICULTURE AND FORESTRY 9

Concepts of integrated surveys - Global effects and climatic changes: Land degradation and desertification, extreme events - Effect on forest produces health, forest hazards, sustainable forest management and practice - Biodiversity issues - Invasive biotics - Mitigation and adaptation - RS & GIS for drawing out action plans - Watershed approach - Landuse planning for sustainable development - Precision farming - Case studies.

TOTAL:45 PERIODS

COURSE OUTCOMES:

On completion of the course the student is expected to be able to

CO1: Understand the spectral properties of agricultural crops and their applications.
CO2: Understand the spectral properties of soil and applications.
CO3: Understanding the RS and GIS application to damage assessment due to disaster.
CO4: Understand the spectral properties of forest species and application to forest management.
CO5: Understand the climate impacts on agriculture and forestry management.

REFERENCES:

1. John G. Lyon, Jack MCcarthy, “Wetland & Environmental application of GIS”, 1st Edition, 1995.
2. Margareb Kalacska, G. Arturosanchez, “Hyper spectral RS of tropical and subtropical forest”,1st Edition, 2008.
3. Shunlin Liang, "Advances in land RS: System, modeling inversion and applications”,1st Edition, 2008.
4. Joe Boris dexon, “Soil mineralogy with environmental application”, Library of congress catalog, 2004.
5. James B, “Introduction to Remote sensing”, 3rd Edition ,Campbell, 4th edition Guilford Press, 2008.
6. David H. White, S. Mark Howden, “Climate Change: Significance for Agriculture and Forestry”, Springer, 1994.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	3	3	3	3	3	3
CO3	2	2	3	2	2	2
CO4	3	3	2	3	3	3
CO5	3	3	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3017 GEOMATICS FOR TRANSPORTATION PLANNING AND MANAGEMENT

L	T	P	C
3	0	0	3

UNIT I ENGINEERING SURVEYS AND GEOMETRIC DESIGN 9

Roadways and railways - Necessity for planning - Classification of roads and railways - Alignment surveys and investigations using conventional and remote sensing techniques (preliminary, reconnaissance and final location surveys) - Types of highway pavements - Design principles of highway geometric elements.

UNIT II URBAN TRANSPORTATION SYSTEMS AND PLANNING 9

Urban transportation: Policy alternatives - Transportation and the environment - Urban transport planning processes - Socio-demographic data and travel surveys - Transportation modelling - Traffic congestion - Plan evaluation and implementation - Planning and financing - Critiques of transportation modelling and forecasting.

UNIT III REMOTE SENSING IN TRANSPORTATION 9

Study of geographic pattern of urban development using remote sensing data products - Urban sprawl - Parking studies using aerial photos - Traffic analysis - Accident analysis - Site suitability analysis for transport infrastructure - Population distribution studies - Improvisation of rural road network - Regional road network connectivity - Vehicle tracking - Incident identification and management.

UNIT IV GIS AND TRANSPORTATION ANALYSIS 9

Transportation analysis in GIS: Introduction - Network flows - Shortest path algorithms- transportation databases: Creation and maintenance - Facility location - Vehicle routing - Highway and railway alignment - Highway maintenance.

UNIT V INTELLIGENT TRANSPORTATION SYSTEMS 9

Land use transport interaction models - Transport environment interaction models - Intelligent Transportation Systems (ITS) - Development - Architecture - Mobile Mapping - Integration with GIS - Applications - Case studies.

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand various highway geometric elements and surveys carried out for highway alignment.
CO2: Understand the factors involved in urban transportation planning.
CO3: Apply remote sensing techniques for transportation problems**.**
CO4: Apply GIS for transportation analysis.
CO5: Gain knowledge on latest developments in transportation planning.

REFERENCES:

1. Harvey J. Miller, Shih-Lung Shah, “Geographic Information Systems for Transportation - Principles and Applications”, Oxford University Press, 2001.
2. John Stillwell, Graham Clarke, “Applied GIS and Spatial Analysis”, John Wiley & Sons Ltd, 2004.
3. Papacostas, C.S, Prevedouros, P.D., “Transportation Engineering and Planning”, Prentice- Hall India, 2015.
4. L.R.Kadiyali, “Transportation Engineering”, Khanna Book publishing Co (P) Ltd, New Delhi, 2021.
5. Jotin Khisty C and B.Kent Lall, “Transportation Engineering - An Introduction”, Prentice Hall of India Private Limited, New Delhi, 2009.
6. Igor Ivan, Itzhak Benenson, Bin Jiang, Jiri Horak and James Haworth, “Geoinformatics for Intelligent Transportation System”, Springer International Publishing AG, 2015.
7. Barry Boots, Atsuyuki Okabe and Richard Thomas, “Modelling Geographical Systems - Statistical and computational applications”, Kluwer Academic Publishers, 2014.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3018 **SPATIAL DATA ADJUSTMENT AND ANALYSIS** **L T P C**
3 0 0 3

UNIT I MEASUREMENT AND ERROR **9**

Definition and significance of spatial data adjustment - Concepts of measurement and error - Sources of errors in spatial data, types of errors, and their characteristics. - Elementary concepts in probability - Reliability of measurement - Significant figures - Error propagation - Linearization - Multivariate distribution - Error ellipse - Weights of an observation - Stochastic model and functional model.

UNIT II LEAST SQUARES ADJUSTMENT **9**

Introduction - Simple adjustment methods - Least squares method - Examples of least squares problems - Techniques of least squares - Concept of weight - Relation between weights and standard errors - Statistics of weighted observations - Least squares adjustment of indirect observations - Least square adjustment of observations only.

UNIT III VARIANCE-COVARIANCE PROPAGATION **9**

Random events and probability - Random variables - Continuous probability distributions - Normal distribution - Expectation - Measures of precision and accuracy - Covariance and correlation - Covariance, cofactor, and weight matrices - Introduction to sampling - Derivation of the propagation laws - Examples - Stepwise propagation - Estimate of mean and variance.

UNIT IV PRE-ANALYSIS OF SURVEY MEASUREMENTS **9**

Pre-analysis procedure - Horizontal angle measurement, distance measurement, and elevation difference - Survey tolerances- Mapping standards: SOI, ASPRS - GPS network pre-adjustment data analysis - Spatial data error modelling.

UNIT V GEODETIC COMPUTATIONS AND ADJUSTMENT **9**

Rectangular, polar, and spherical coordinates - First and second geodetic problem - Methods of point determinations: Intersection, resection, arc section, and with over determinations - Two dimensional and Three dimensional transformation adjustments - GPS errors and the need for adjustment - Application of least squares in processing GPS data - Least squares adjustment of GPS networks - Code development.

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand the concept and importance of spatial data adjustment.
CO2: Apply statistical concepts and techniques for spatial data adjustment.
CO3: Implement spatial data adjustment models and algorithms.
CO4: Evaluate and analyze the quality of spatial data.
CO5: Utilize software and tools for spatial data adjustment techniques for real world application.

Attested

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REFERENCES:

1. Mikhail, E.M. and Gracie G., "Analysis and adjustment of Survey measurements", Van Nostrand Reinhold, New York, 2005.
2. Paul.R.Wolf and Charles. D.Ghilani, "Adjustment Computations -Statistics and least squares in surveying and GIS", John Wiley and sons inc.,6th Edition,2017.
3. P.J.G.Teunissen, "Adjustment theory - An introduction", VSSD. 2006.
4. Oscar S. Adams, "GEODESY: Application of the Theory of Least Squares to The Adjustment of Triangulation", Japanese Edition, Nabu Press, 2012.
5. Brinker Russell C Minnick Roy, "The Surveying HandBook", Volume-II, Springer,2nd Edition,1995.
6. Edward L. Ingram, "Geodetic Surveying and the adjustment of observations (Method of Least Squares)",Forgotten Books,2018.
7. Dr. B.C. Punmia, Ashok K.Jain and Arun K.Jain, "Surveying Vol-III", Laxmi Publications Pvt Ltd.,17th Revised Edition,2005.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	3
CO2	3	3	2	3	3	3
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	2	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3019 TERRESTRIAL AND CLOSE-RANGE PHOTOGRAMMETRY

L	T	P	C
3	0	0	3

UNIT I FUNDAMENTALS **9**

Definition: Terrestrial and Close-range Photogrammetry - Terrestrial cameras – Metric and non-metric cameras - Photo theodolites - Stereometric cameras - Photogrammetric process, systems, products - Aspects - Image forming model - Coordinate systems - Transformations - Adjustment techniques - Geometric elements - Horizontal and vertical angles from terrestrial photographs - Camera azimuth.

UNIT II IMAGING SYSTEMS **9**

Imaging concepts - Geometric fundamentals - Imaging systems - Targeting and illumination - Image pre-processing - Geometric image transformation - Digital processing of single images - Image matching and 3D object reconstruction.

UNIT III ANALYTICAL METHODS **9**

Orientation methods - Bundle triangulation - Object reconstruction - Line photogrammetry - Multimedia photogrammetry - Panoramic photogrammetry - Analytical self-calibration - Statistics - Matrix equations for analytical self-calibration - Initial approximations for least square adjustments - Solution approach for self-calibration adjustment - Control for terrestrial photogrammetry - Analytical determination of the horizontal position of a point from photographic measurement - Graphical method

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UNIT IV PHOTOGRAMMETRIC MEASURING SYSTEM **9**

Comparators - Single camera systems - Stereoscopic processing systems - Multi-image measuring systems - Systems of surface measurement - Project planning - Camera calibration - Dynamic photogrammetry – Close-range aerial imagery.

UNIT V APPLICATION **9**

Close-Range photogrammetry applications: Architecture and construction - Industrial Application - Forensics and crime scene analysis - Cultural heritage preservation - Medicine - Virtual and augmented reality. Terrestrial photogrammetry applications: Topographic mapping and land surveying - Infrastructure inspection and monitoring - Urban planning and development - Environmental monitoring - Building Information Modelling (BIM).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1 Understand the fundamental principles and concepts of photogrammetry, including camera calibration, image acquisition, image orientation, and 3D reconstruction.
CO2 Familiar with the techniques used to acquire data in terrestrial and close-range photogrammetry
CO3 Gain knowledge to process and analyze terrestrial and close-range photogrammetric data
CO4 Generate accurate and detailed 3D models using terrestrial and close-range photogrammetry techniques
CO5 Achieve knowledge of the diverse applications of terrestrial and close-range photogrammetry

REFERENCES:

1. Thomas Luhmann, Stuart Robson, Stephen Kyle, and Jan Boehm, “Close-Range Photogrammetry: Principles, Techniques, and Applications,” Second Edition, 2014.
2. Fabio Remondino and Sabry El-Hakim., “Terrestrial Laser Scanning and Close-Range Photogrammetry for 3D Digital Documentation of Cultural Heritage” First Edition, 2017
3. “American Society for Photogrammetry and Remote Sensing (ASPRS),” Manual of Photogrammetry, Sixth Edition, 2015
4. Y. L. Park., “Close-Range Photogrammetry: An Introduction,” First Edition, 2018.
5. Thomas Luhmann, Stuart Robson, Stephen Kyle, and Ian Harley, “Close Range Photogrammetry: Principles, Techniques and Applications,” Second Edition, 2016
6. E.M.Mikhail, J.S.Bethel, J.C.McGlone, “Introduction to Modern Photogrammetry”, Wiley Publisher, 2012
7. Wolfgang Förstner and Bernhard P. Wrobel, “Photogrammetric Computer Vision: Statistics, Geometry, Orientation, and Reconstruction,” Second Edition, 2014.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	2
CO2	3	3	2	3	3	2
CO3	3	3	3	3	3	2
CO4	3	3	2	3	3	3
CO5	3	3	3	3	2	3
Avg	**3**	**3**	**3**	**3**	**3**	**2**

1-Low, 2-Medium, 3-High

RG3020 **AI / DL FOR SATELLITE IMAGE ANALYSIS** **L T P C**
3 0 0 3

UNIT I ARTIFICIAL INTELLIGENCE **9**

Artificial Intelligence - Introduction - Role in Remote sensing - History of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation - AI problems - Introduction to Machine and Deep learning - Methods - Difference.

UNIT II EXPLORATORY DATA ANALYSIS 9

Exploratory Data Analysis (EDA) - basics - Inferential statistics - Hypothesis testing - Spectral divergence - Spectral angle mapper - Spectral correlation analysis - Regression and classification-supervised learning - Support vector machines - Random forest classifier - Gradient boosting random forest - Gaussian processor - Unsupervised learning - Clusters - K-means - Fuzzy concepts - possibilistic C-Means - Training date sets - Measures of accuracy: RMS, Correlation coefficient, ROC - Automated feature Extraction.

UNIT III DEEP LEARNING CONCEPTS AND METHODS 9

Deep learning - introduction - Role in remote sensing - Cloud essentials -Git hub - Concepts-convolution - Pooling - Activation functions - Tensors - Normalisation - Sampling - Training - Loss function - Optimizer - Inference - Ensemble techniques - Models with multiple sources - patch based mode vs. fully convolutional mode - Introduction to CNNs - Back Propagation Algorithm, Vanishing and Exploding Gradients Overfitting Evolution of CNN Architectures: AlexNet, ZFNet, VGG Net, Inception Nets, Res Nets, Dense Nets.

UNIT IV LEARNING BASED CLASSIFIERS 9

Kernel concepts - Linear regression - logistics regression - ANN - Variants of ANN - Back propagation - Weight update - CNN - Supervised machine learning concepts - Recurrent neural network - Hybrid learning network - Prediction algorithms - Exercise: Image matching and co-registration, building foot print extraction, vegetation classification - Developing soil moisture prediction model.

UNIT V APPLICATIONS OF CNN 9

CNNs for Detection: Background of Object Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO. CNNs for Segmentation: Types of Segmentation: Instance vs semantic segmentation. FCN, Seg- Net, U-Net, Mask-R CNN. - Autoencoders - Exercise: Image fusion, Feature extraction.

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Familiarize with the concept of Artificial Intelligence.
CO2: Acquainted with the Knowledge about exploratory data analysis.
CO3: Acquainted with the basics of Deep learning.
CO4: Apply various methods of deep learning in Geomatics.
CO5: Familiarize with the applications of CNN in Geomatics.

REFERENCES:

1. S. Russell and P. Norvig., “Artificial Intelligence: A Modern Approach”, Prentice Hall, 3rd Edition, 2010.
2. Ian J. Goodfellow, Yoshua Bengio, Aaron Courville., “Deep Learning”, MIT Press, 2017.
3. Francois Chollet., “Deep Learning with Python”, Manning Publications, 2nd edition, 2021.
4. Maria Pia Del Rosso, Alessandro Sebastianelli and Silvia Liberata Ullo., “Artificial Intelligence Applied to Satellite-based Remote Sensing Data for Earth Observation”, The Institution of Engineering and Technology,1st, edition, 202.
5. Gustau Camps-Valls, Devis Tuia, Xiao Xiang Zhu and Markus Reichstein., “Deep Learning for the Earth Sciences”, John Wiley & Sons Ltd, 1st edition, 2021.
6. Bratko., "Prolog: Programming for Artificial Intelligence”, Addison Wesley Educational Publishers Inc., 4th edition, 2011.
7. M. Tim Jones,, "Artificial Intelligence: A Systems Approach (Computer Science)”, Jones and Bartlett Publishers, Inc, 1st Edition, 2008.
8. Phil Kim, “Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence”, Apress, 2017.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	1	2
CO2	2	2	2	1	2	1
CO3	3	2	2	2	2	2
CO4	3	3	3	3	2	3
CO5	3	3	3	3	3	3
Avg	**3**	**2**	**2**	**2**	**2**	**2**

1-Low, 2-Medium, 3-High

RG3021 LAND INFORMATION SYSTEM

L	T	P	C
3	0	0	3

UNIT I CADASTRE - INTRODUCTION **9**

History of cadastral survey - Types of survey - Tax - Real property - Legal cadastre - Graphical and numerical cadastre, legal characteristics of records - Torrens system - Field methods.

UNIT II METHODS OF SURVEYING **9**

Cadastral survey methods - Survey of villages - Instruments used for cadastral survey - Orthogonal, polar survey methods - Boundary survey; stone accounts, correlation statements, jamabhandhi accounts; Natham survey, Rectangulation - Town survey - Calculation of area - PIR in town survey, government land, encroachment survey, GPS and Total Station in Cadastral survey - CORS network - Virtual control points - DGNSS.

UNIT III MAINTENANCE AND MEASUREMENT **9**

Cadastral survey maintenance - FMS: manual and digital - Resurveys - Measurement of sub-division - Measurement of obstructed lines - Survey of urban areas - Control requirement for Urban survey use of satellite imagery in boundary fixing - Maintenance of accounts - Handling dispute area survey.

UNIT IV LAND MODERNISATION **9**

Land records in India - Digital conversions of records - Obsolete ownership - Record of rights - Digital solutions for land records - NLRMP - DILRMP - Smart cities; C40 cities - International and national efforts - Examples - Indian initiatives - Swaach bharath ; Tamil nilam.

UNIT V MODERN TECHNOLOGY **9**

Current developments - Tools and techniques - GIS, LIS, digital Twin concepts - Documentation - Data maintenance - Data standards - Map standards - Dynamicity of land databases - Land related solutions - Block chain technology - Web technology

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand the importance of land as resources and related principles of land records and taxation.

CO2: Apply various methods used for surveying, mapping and maintenance of cadastral records.

CO3: Understand the process in land record keeping, updation and of documentation of land records and the current national developments in this regard.

CO4: Update with modern surveying technology and geospatial solutions for creation, maintenance and documentation of land records.

CO5: Frame a more efficient methodology to create and maintain digital cadastre, LIS, etc. using the trending geospatial concepts.

Attested

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REFERENCES:

1. Peter F.Dale, John D,McLaughlin, “Land Information Management: An Introduction with Special Reference to Cadastral Problems in Third World Countries”, Clarendon Press, 1988.
2. George M.Cole &Donald A Wilson, “Land Tenure, Boundary Surveys, and Cadastral Systems”, CRC Press, 2016.
3. “Multipurpose Land Information Systems the Guidebook”, The Federal Geodetic Control Committee, US,1989.
4. The Tamil Nadu survey and boundaries act, 1923, Tamil Nadu Act No.VIII.
5. “Cadastral Survey Methodologies and Techniques in Developing Countries,” Pertti ONKALO, 2006.
6. NLRMP - Guidelines, Technical Manuals and MIS, 2009.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	-	-
CO2	3	3	3	3	3	2
CO3	2	2	3	3	3	2
CO4	2	2	3	3	3	3
CO5	1	1	3	3	2	3
Avg	**2**	**2**	**3**	**2**	**2**	**2**

1-Low, 2-Medium, 3-High

RG3022 SUSTAINABLE DEVELOPMENT AND GEOMATICS

L	T	P	C
3	0	0	3

UNIT I ECOSYSTEM AND SUSTAINABILITY 9

Eco system – carbon, nitrogen , Sulphur and phosphorus cycles- carrying capacity of earth- ecological sensitivity- biodiversity- global ecological overshoot- pollution- pollutants: land, water, atmosphere- waste generation and management - plastic waste – energy and environment

UNIT II SUSTAINABLE PRACTICES 9

Climate change - greenhouse effect- ozone depletion- Sustainable land management (SLM) – FAO’s mandate- integrated approach and food security- food-energy-water nexus- water in cities and industries- rain water harvesting – green buildings- green labels- concept of 5R- eco tourism environmental policies in India

UNIT III SDG EVOLUTION AND WORLD EXPERIENCE 9

UNDP - Rio Earth summit 1992 - Agenda 21 - Millennium summit- MDGs – World summit on sustainable development - R + 20, Rio - Open working group - Post-2015 development agenda - 2030 agenda - 2015 agreements and international policy shaping - SDG formulation-Targets and indicators global sustainable development report 2019 and 2023- Cooperative federalism, sub groups and task force - Key initiatives - Verticals - Reports - Model agreements- Global initiative - Covid - 19 experience- UN – GGIM - Genesis - Objectives - IAEG-SDGS - Regional committees - Working groups - Build the bridge phases - Collaboration , corroboration and collation.

UNIT IV GEOMATIC TOOLS FOR GIS 9

Geospatial technology - Earth observation - Historical and current sensors and technology - Open and cost data products - Geo portals - Application areas - SDG focus indicators - National datasets - Data portals - GIS - Data assimilation - Modeling capabilities - Statistical disaggregation.

Attested

UNIT V SDG - GEOSPATIAL ROAD MAP 9

Data availability - Focus indicators - Geospatial Indian story maps - Geo-viable SDG indicators - Water availability - Primary productivity - Building index - Land capability maps - Health indices - Land temperature maps - Watershed characteristics - Climate products from satellites - Assessment of SDG matrix.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Appreciate the importance of sustainable development and the understand history of the world's unified effort to achieve through SDG s and the participation of the partner countries including India to achieve the same.

CO2: Understand the relevance of SDG s , the role of the geospatial technology as central idea to realize the SDG s and the status of this technology worldwide

CO3: Acquire the knowledge about the standard geospatial focus indicators to achieve SDGs and evaluate the methodology to formulate them.

CO4: Acquire knowledge on the current development, issues, methods and solutions in application of geospatial technology in comprehending the SDGs for a better world future.

CO5: Analyze critically and evaluate methods by applying the knowledge gained and to be a part of innovation efforts and capacity building of geospatial technology to achieve SDGs.

REFERENCES:

1. Jonathan M Harris " Basic Principles of Sustainable development" Tufts University- open book , 2000, http://ase.tufts.edu/gdae
2. The Sustainable Development Goals, United Nations: Department of Public Information, 2018, ISBN - 978-9211013696.
3. Dilip Kumar, R.B. Singh, Ranjeet Kaur., "Spatial Information Technology for sustainable Development Goals", Sustainable Development Goals series, Springer, 1st Edition, 2019,ISBN-13, 978-3319580388.
4. Rajabifard, Abbas., "Sustainable Development Goals Connectivity Dilemma" Taylor & Francis, 2022 , http:// library.oapen.org/ handle/20.500.12657/24929,ISBN9780429290626.
5. SDG's Geospatial roadmap - UNGGIM, https://ggim.un.org/meetings/GGIMcommittee/11th Session/documents/The_Geospatial_SDGs_Roadmap_WGGI_IAEG_SDGs_20210804.pd

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	3	3	3
CO2	3	1	1	3	3	3
CO3	3	3	3	3	3	3
CO4	3	2	3	3	3	3
CO5	1	3	3	3	3	3
Avg	**2**	**2**	**2**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High

RG3023 GEOSPATIAL CLOUD COMPUTING AND BIG DATA ANALYTICS

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION TO CLOUD COMPUTING 9

Introduction to cloud computing - Characteristics - Computing infrastructure - Service oriented architecture and infrastructure design - Cloud enterprise - Cloud service and deployment models - Cloud standards – open source and commercial clouds – challenges- Big data - Data stream analytics frameworks- Virtual machines on the big clouds - Spatial cloud computing- Cloud transformations - Emergence of a geospatial cloud.

UNIT II CLOUD-BASED DISTRIBUTED DATA MANAGEMENT PLATFORMS 9

Challenge and opportunities of distributed Data - Transferring and sharing data - Managing identity and credentials - Open source framework to build a cloud - Eucalyptus, openStack, VMWare - Private, public and hybrid clouds - Geo-spatial technology through cloud-based platforms - Cloud Vendors-Globus and SaaS capability- Security in the cloud - Role-Based.

UNIT III CLOUD SERVICES FOR GEOSPATIAL DATA 9

Introduction to geospatial big data paradigm - storage and processing solutions - Visualization Methods and Tools - GIS Cloud - Application and Technology Model - Advantages- ETL processes - Geospatial Big data Mining - Hadoop and MapReduce frameworks - Spark and Stream Data Processing - Cloud-based databases and web editing- opportunities and challenges - Cloud Computing for Geospatial Big Data Analytics - Geospatial cloud partners.

UNIT IV CLOUD STREAMING FOR GEOSPATAIL DATA ANALYTICS 9

Taxonomy of machine and deep learning methods - Supervised and unsupervised regression and classification methods - Model development and selection - Cloud-based machine and deep learning frameworks - Automated training database generation- mapping and feature extraction - Cognitive computing and Neuromorphic processors - tensorFlow for neural network computing and deep learning - Google's deepmind reinforcement deep learning algorithm.

UNIT V GEOSPATIAL CLOUD COMPUTING STRENGTH AND APPLICATIONS 9

GIS data - Sharing and mapping, asset management and environmental streamlining, Cloud-based GIS applications such as UPlan, IPLAN, and WATS' Mi Community Remarks, multi-agency collaboration and partnerships - Case studies - Remote Sensing data integration - Climate, Environment, Ocean, Cryosphere, Transportation, Healthcare, Agriculture, Forestry, Disaster mitigation and management.

TOTAL:45 PERIODS

COURSE OUTCOMES:

- On completion of the course the student is expected to be able to

CO1: Understand the basic concepts of cloud computing
CO2: Learn about the cloud-based distributed data management platforms.
CO3: Explore the potential of data-driven approaches in cloud streaming and big data analytics.
CO4: Learn about the state-of-the-art of commercial and open-source cloud services available for geospatial data
CO5: Explore the strength and various application areas of geospatial cloud computing.

REFERENCES:

1. Khan, S., Ali, S.A., Hasan, N., Shakil, K.A., Alam, M., "Big Data Scientific Workflows in the Cloud: Challenges and Future Prospects;" In: Das, H., Barik, R., Dubey, H., Roy, D. (eds) Cloud Computing for Geospatial Big Data Analytics. Studies in Big Data, vol. 49. Springer, Cham. https://doi.org/10.1007/978-3-030-03359-0_1.
2. Ming-Hsiang Tsou 2014., "Big data: techniques and technologies in geoinformatics, Annals of GIS," vol. 20, no. 4, pp. 295-296. https://doi.org/10.1080/19475683.2014.944934.
3. Barik, R.K. et al. 2018., "Fog Assisted Cloud Computing in Era of Big Data and Internet-of-Things: Systems, Architectures, and Applications," In: Mishra, B., Das, H., Dehuri, S., Jagadev, A. (eds) Cloud Computing for Optimization: Foundations, Applications, and Challenges. Studies in Big Data, vol 39. Springer, Cham. https://doi.org/10.1007/978-3-319-73676-1_14.
4. J. Sun et al., "An Efficient and Scalable Framework for Processing Remotely Sensed Big Data in Cloud Computing Environments," in IEEE Transactions on Geoscience and Remote Sensing, vol. 57, no. 7, pp. 4294-4308, July 2019, doi: 10.1109/TGRS.2018.2890513.
5. Li, Z. (2020)., "Geospatial Big Data Handling with High Performance Computing: Current Approaches and Future Directions;" In: Tang, W., Wang, S. (eds) High Performance Computing for Geospatial Applications. Geotechnologies and the Environment, vol. 23. Springer, Cham. https://doi.org/10.1007/978-3-030-47998-5_4.

Attested

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CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	1	2
CO2	3	1	2	-	-	1
CO3	3	2	3	-	-	2
CO4	3	1	2	3	3	3
CO5	3	3	3	3	3	3
Avg	**3**	**2**	**3**	**3**	**2**	**2**

1-Low, 2-Medium, 3-High

RG3024 SUBSURFACE SURVEY METHODS L T P C
3 0 0 3

UNIT I UNDERGROUND SURVEYING 9

Introduction: Purpose, methods, advantages - Underground traversing and its constraints, Correlation of underground and surface surveys by different methods: traversing through shafts, assumed bearing, Weiss quadrilateral, Weiss triangle methods - Estimation of errors.

UNIT II ALIGNMENT AND STOPE SURVEYING 9

Alignment / Gradient control of vertical and inclined shafts, sinking and raising shafts - Gradient control in development openings - Holing surveys - Fixing center lines for shafts - Measuring subsidence - Determining the true and apparent dip and strike from bore hole data - Determining the deviation in the borehole drilling- Stope surveying - Purpose and advantages - Classification of stope surveying - Methods and instruments used - Documentation of underground structures, mining maps.

UNIT III GROUND PENETRATING RADAR SURVEY 9

Electromagnetic principles of GPR - Electrical and magnetic properties of rocks - Soil and fluids - Types of GPR - Measurement configuration - Bands and polarizations - Manual and vehicle mounted GPR - Salient technical features of commercially available GPR - Ground penetrating radar surveys: Reflection survey - Multi source - Multi receiver - Data processing: Dewow - Time - Gain - Deconvolution - Migration - Topographic correction - Signal optimization, modulation, processing and filtration - Modeling and analysis - Processing software (commercially available & RGPR)- Other geophysical surveys for subsurface investigation.

UNIT IV GEOPHYSICAL SURVEY 9

Scope of geophysical exploration - Physical properties of the earth - Electrical methods -SP, IP, resistivity methods: Wenner and Schlumberger methods - Gravity methods: Gravimeters, determination of shape and depth of ore bodies – Magnetic methods: Preparation of anomaly maps- Seismic methods: Principles, Field operation, Refraction and reflection survey – Radioactivity methods: Fundamentals, Principle and field instruments.

UNIT V APPLICATIONS 9

Applications in ground water resources: Depth to water from the land surface - Archaeological science: Identification and mapping buried structures - Mapping of underground utilities like power cables - Pipelines and other buried utilities - Containment mapping. - Imaging shallow stratigraphy: Delineation of soil profiles to shallow depth - Geological mapping: Depth to bedrock, karst features, groundwater contact.

TOTAL:45 PERIODS

Attested

COURSE OUTCOMES:

- completion of the course the student is expected to be able to

CO1: Plan the subsurface survey for a given project also capable of extending consultancy service for real time Hydrographic and Mining operations.

CO2: Apply the knowledge of different methods of survey to investigate real subsurface condition

CO3: Apply the knowledge of survey to measure stope and traverse underground

CO4: Plan the subsurface investigation program for a given project and also capable of extending consultancy service for real time underground mapping and Foundation Engineering problems

CO5: Apply the knowledge of different methods of exploration to select appropriate methods of boring for investigating real field conditions.

REFERENCES:

1. George Wood Logan, “Elements of Hydrographic Surveying”, Legare Street Press, 2022, ISBN -13: 978-1015494541
2. Ghatak, S., “Mine Surveying and Levelling – Vol I, II & III“, Coal Field Publishers, Asansol, 2005.
3. Harry M. Jol, “GROUND PENETRATING RADAR: Theory and Applications”, 1st edition, Elsevier Science, 2008, ISBN: 9780444533487.
4. Raffaele Persico, “Introduction to ground penetrating radar: Inverse Scattering and Data Processing”, Y John Wiley & Sons, Inc., Hoboken, New Jersey, 2014.
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CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	2
CO2	3	3	3	3	3	3
CO3	3	2	3	2	2	3
CO4	3	3	2	2	3	2
CO5	3	2	3	3	3	3
Avg	**3**	**2**	**3**	**3**	**3**	**3**

1-Low, 2-Medium, 3-High