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 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 social development by

1. Providing a firm scientific and technological base in Civil 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.
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 - 2019
CHOICE BASED CREDIT SYSTEM
M.E. REMOTE SENSING AND GEOMATICS

1. 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

2. PROGRAMME OUTCOMES (POs):

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

PO#	Graduate Attribute	Programme Outcome
PO1	Engineering knowledge	Apply the knowledge of mathematics, science and engineering fundamentals to the formulation and conceptualization of Remote Sensing and Geomatics theory and model.
PO2	Problem analysis	Identify, formulate and solve engineering problems.
PO3	Design/development of solutions	Design and evaluate solutions for efficient management of natural, socio-economic resources through intervention of Remote Sensing and Geomatics tools.
PO4	Conduct investigations of complex problems	Conduct investigations of Remote Sensing and Geomatics engineering problems including literature survey, appropriate methodology, analysis, interpretation of data and synthesis of information to provide valid conclusion
PO5	Modern tool usage	Create, select and apply appropriate techniques and modern engineering tools including analysis, modeling and design software, with due understanding of the limitations.
PO6	The Engineer and society	Conduct themselves to uphold the professional and social obligations.
PO7	Environment and sustainability	Understand the Socio economic impact of Remote Sensing and Geomatics Engineering solutions for sustainable development

PO8	Ethics	Understand and commit to professional ethics and responsibilities of Remote Sensing and Geomatics Engineer and to contribute to the society for sustainable development.
PO9	Individual and team work	Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings and demonstrating a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis.
PO10	Communication	Communicate effectively with the engineering community and with society at large, and write reports and make effective presentations.
PO11	Project management and finance	Demonstrate Knowledge of management and business practices, such as risk and change management and understand their limitations
PO12	Life-long learning	Develop ability to engage in independent and life-long learning to improve competence by critical examination of the outcomes of one's actions and learning from corrective and preventive measures.

3. **PROGRAMME SPECIFIC OUTCOMES (PSOs):**

By the completion of Remote Sensing and Geomatics program the student will have following Program specific outcomes

PSO1	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.
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation	Critically analyze complex Remote Sensing and Geomatics problems, apply independent judgment for synthesizing information and make innovative advances in a theoretical, practical and policy context.
PSO3	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 socio cultural factors

MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
YEAR I	SEMESTER I	Statistical Methods for Engineers															
		Remote Sensing	M	H	H	H	H	H	H	M	M	M	M	M	M	M	M
		Geographical Information System	M	H	M	M	H	L	M		M		M		H	M	L
		Programming for Spatial data processing	M	H	H	H	H	M	M	M	M	M	H	H	H	H	
		Program Elective 1															
		Research Methodology and IPR	M	H	H	H	H	M	H	H	H	M	M	H	M	H	H
		Audit Course I*															
		Geographical Information System Laboratory	M	M	M	H	H	L	M		L		M		H	M	H
		Remote Sensing Laboratory	H	L	M	H	L	H						H	M	L	L
	SEMESTER II	Photogrammetry	H	H	H	H	H	H	M	M	H	M	M	H	H	H	H
		Satellite Image Processing	H	H	H	H	M		M		M			M	H	H	H
		Program Elective II															
		Program Elective III															
		Total Station and GPS Surveying	H	H	H	L	H		H	H				H	H	H	H
		Audit Course II*															
		Satellite Image Processing Laboratory	M	H	M	M	H	M	M		H	H	M	H	H	M	M
		Photogrammetry Laboratory	L	L	M	M	H	M	L	L	L	L	M	M	M	M	L
		Practical Training	H	M	L	H	H	H	H	H			H		M	L	L
YEAR II	SEMESTER III	Program Elective IV															
		Program Elective V															
		Open Elective															
		Matlab Programming	H	H	H	H	H	H				M	H	H	H	H	H
		Project Phase I	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	SEMESTER IV	Project Phase II	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

PROGRAM ELECTIVE COURSES

COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Laser Scanning for Terrain Mapping	H	M	M	L	M		M						M	H	H
Geodesy	M	H		M	M	L		L	M	L		H	M	M	H
GIS Applications	M	H	H	M	H			H		M	M		M	M	M
Planetary Remote Sensing	H	M	M	M	M								M	M	
Geoinformatics for meteorology	H	H	H	M	H	M	M	H	M	H	H	H	M	H	H
Soft Computing Techniques	H	H		H	H	M	M	H	M	M	M	M		H	H
Spatial Data Modelling	M	H	M	L	M								M	M	M
Thermal and Hyper Spectral Remote Sensing	H	H	H	M	H	L	L	M		H		H	H	M	M
Microwave Remote Sensing	H	H	M	H	M	H	H	M	M	M	H	H	M	H	H
Web Technology Programming for GIS	L	M	M	M	L						M	L	L	M	L
Python and R Programming	L	H	M	M	H		M				L	M	L	M	L
Internet of Things	M	L	M	M	M										
Geomatics for Agriculture and Forestry	M	L	H	M	H	H		H				H	H	H	L
Geomatics for Urban Planning and	M	H	M	H	H	M	L	M		L	M		H	M	H
Geomatics for Ocean and Coastal zone Management	H	H	H	M	M	H	H	M	H	H	H	M	H	H	M
Disaster Management and Geomatics Applications	M	M	H	H	H	H	H	H	H	H	M	H	H	H	M
Geomatics for Transportation Planning and Management	M	H	H	M	H	M	H	M	L	M	M	H	M	H	M
Geomatics for Hydrology and Water Resources Management	H	H	H	H	H	M	M	H	H	H	M	H	H	H	H
Geomatics for Environmental Monitoring and Modeling	M	H	H	M	M	M	H	H	H	H	H	H	M	H	H

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.E. REMOTE SENSING AND GEOMATICS

REGULATIONS – 2019

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.	MA5157	Statistical Methods for Engineers	FC	3	1	0	4	4
2.	RG5101	Remote Sensing	PCC	3	0	0	3	3
3.	RG5102	Geographical Information System	PCC	3	0	0	3	3
4.	RG5103	Programming for Spatial Data Processing	PCC	2	0	2	4	3
5.		Program Elective I	PEC	3	0	0	3	3
6.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
7.		Audit Course I*	AC	2	0	0	2	0
PRACTICALS								
8.	RG5111	Geographical Information System Laboratory	PCC	0	0	4	4	2
9.	RG5112	Remote Sensing Laboratory	PCC	0	0	4	4	2
			TOTAL	**18**	**1**	**10**	**29**	**22**

* Audit Course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	RG5201	Photogrammetry	PCC	3	0	0	3	3
2.	RG5202	Satellite Image Processing	PCC	3	0	0	3	3
3.		Program Elective II	PEC	3	0	0	3	3
4.		Program Elective III	PEC	3	0	0	3	3
5.	RG5203	Total Station and GPS Surveying	PCC	3	0	2	5	4
6.		Audit Course II*	AC	2	0	0	2	0
PRACTICALS								
7.	RG5211	Satellite Image Processing Laboratory	PCC	0	0	4	4	2
8.	RG5212	Photogrammetry Laboratory	PCC	0	0	4	4	2
			TOTAL	**17**	**0**	**10**	**27**	**20**

* Audit Course is optional

SEMESTER III

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective IV	PEC	3	0	0	3	3
2.		Program Elective V	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
4.	RG5301	Matlab Programming	PCC	2	0	2	4	3
PRACTICALS								
5.	RG5311	Project Phase I	EEC	0	0	12	12	6
6.	RG5312	Practical Training	EEC	0	0	0	0	2
			TOTAL	**11**	**0**	**14**	**25**	**20**

SEMESTER IV

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	RG5411	Project Phase II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS: 74

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA5157	Statistical Methods for Engineers	3	1	0	4	1

PROGRAM CORE COURSES (PCC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RG5101	Remote Sensing	3	0	0	3	1
2.	RG5102	Geographical Information System	3	0	0	3	1
3.	RG5103	Programming for spatial data processing	2	0	2	3	1
4.	RG5111	Geographical Information System Laboratory	0	0	4	2	1
5.	RG5112	Remote Sensing Laboratory	0	0	4	2	1
6.	RG5201	Photogrammetry	3	0	0	3	2
7.	RG5202	Satellite Image Processing	3	0	0	3	2
8.	RG5203	Total Station and GPS Surveying	3	0	2	4	2
9.	RG5211	Satellite Image Processing Laboratory	0	0	4	2	2
10.	RG5212	Photogrammetry Laboratory	0	0	4	2	2
11.	RG5301	Matlab Programming	2	0	2	3	2
					TOTAL	**30**	

PROGRAM ELECTIVE COURSES [PEC]

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	RG5001	Laser Scanning for Terrain Mapping	3	0	0	3
2.	RG5002	Geodesy	3	0	0	3
3.	RG5003	GIS Applications	3	0	0	3
4.	RG5004	Planetary Remote Sensing	3	0	0	3
5.	RG5005	Geoinformatics for Meteorology	3	0	0	3
6.	RG5006	Soft Computing Techniques	3	0	0	3
7.	RG5007	Spatial Data Modelling	3	0	0	3
8.	RG5008	Thermal and Hyper Spectral Remote Sensing	3	0	0	3
9.	RG5009	Microwave Remote Sensing	3	0	0	3
10.	RG5010	Web Technology Programming for GIS	3	0	0	3
11.	RG5011	Python and R Programming	3	0	0	3
12.	RG5012	Internet of Things	3	0	0	3
13.	RG5013	Geomatics for Environmental Monitoring and Modeling	3	0	0	3
14.	RG5014	Geomatics for Agriculture and Forestry	3	0	0	3
15.	RG5015	Geomatics for Urban Planning and Management	3	0	0	3
16.	RG5016	Geomatics for Ocean and Coastal Zone Management	3	0	0	3
17.	RG5017	Disaster Management and Geomatics Applications	3	0	0	3
18.	RG5018	Geomatics for Transportation Planning and Management	3	0	0	3
19.	RG5019	Geomatics for Hydrology and Water Resources Management	3	0	0	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM5151	Research Methodology and IPR	2	0	0	2	1
					TOTAL CREDITS	2	

OPEN ELECTIVE COURSES [OEC]

*(Out of 6 Courses one Course must be selected)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	OE5091	Business Data Analytics	3	0	0	3	3
2.	OE5092	Industrial Safety	3	0	0	3	3
3.	OE5093	Operations Research	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	3	0	0	3	3
5.	OE5095	Composite Materials	3	0	0	3	3
6.	OE5096	Waste to Energy	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AX5091	English for Research Paper Writing	2	0	0	0	1/2
2.	AX5092	Disaster Management	2	0	0	0	
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0	
4.	AX5094	Value Education	2	0	0	0	
5.	AX5095	Constitution of India	2	0	0	0	
6.	AX5096	Pedagogy Studies	2	0	0	0	
7.	AX5097	Stress Management by Yoga	2	0	0	0	
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0	
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0	
					TOTAL CREDITS	**0**	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RG5312	Practical Training	2	0	0	2	3
2.	RG5311	Project Phase I	0	0	12	6	3
3.	RG5411	Project Phase II	0	0	24	12	4
					TOTAL CREDITS	**20**	

SUMMARY

	Name of the Programme: M.E REMOTE SENSING AND GEOMATICS					
	SUBJECT AREA	**CREDITS PER SEMESTER**				**CREDITS TOTAL**
		I	**II**	**III**	**IV**	
1.	FC	04	00	00	00	04
2.	PCC	13	14	03	00	30
3.	PEC	03	06	06	00	15
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	00	08	12	20
7.	Non Credit/Audit Course	✓	✓	00	00	
8.	**TOTAL CREDIT**	**22**	**20**	**20**	**12**	**74**

MA5157 STATISTICAL METHODS FOR ENGINEERS L T P C
3 1 0 4

OBJECTIVES:

- To enable them to estimate the value of the parameters involved in the specific distribution from a possible continuum of alternatives.
- To give an idea of testing the statistical hypothesis claimed based on a set of data points using suitable test statistics which follows standard sampling distributions.
- To establish a relationship that make it possible to predict one or more variable in terms of others using correlation and regression analysis.
- To introduce the various experimental designs and their corresponding analysis of variance which play vital role in many real time scenarios.
- To impart knowledge of handling random vectors which represent random variables in multi-dimensional space.

UNIT I ESTIMATION THEORY 12

Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency–Maximum Likelihood Estimation – Method of moments.

UNIT II TESTING OF HYPOTHESIS 12

Tests based on Normal, *t*, χ^2 and *F* distributions for testing of means, variance and proportions – Analysis of *r x c* tables – Goodness of fit.

UNIT III CORRELATION AND REGRESSION 12

Multiple and Partial Correlation - Method of Least Squares- Plane of Regression - Properties of Residuals - Coefficient of Multiple Correlation - Coefficient of Partial Correlation - Multiple Correlation with total and partial correlations - Regression and Partial correlations in terms of lower order coefficients.

UNIT IV DESIGN OF EXPERIMENTS 12

Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design.

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

OUTCOMES:

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

- Obtain the value of the point estimators using the method of moments and method of maximum likelihood.
- Use various test statistics in hypothesis testing for mean and variances of large and small samples.
- Determine the regression line using the method of least square and also to calculate the partial and multiple correlation coefficient for the given set of data points.
- Test the hypothesis for several means using one way, two way or three way classifications.
- Get exposure to the principal component analysis of random vectors and matrices.

REFERENCES:

1. Devore, J.L., “Probability and Statistics for Engineering and the Sciences”, Thomson and Duxbury, Singapore, 6th Edition, Boston, 2004.
2. Gupta, S.C., and Kapoor, V.K., “Fundamentals of Mathematical Statistics”, Sultan Chand and Sons, Eleventh Edition, Reprint, New Delhi, 2019.
3. Johnson, R. A. and Gupta, C. B., “Miller & Freund’s Probability and Statistics for Engineers”, Pearson Education, Asia, Eighth Edition, New Delhi, 2015.
4. Johnson, R.A., and Wichern, D.W., “Applied Multivariate Statistical Analysis”, Pearson Education, Sixth Edition, New Delhi, 2013.
5. Spiegel, M.R. and Stephens, L.J.,” Schaum’s outlines on Statistics”, Tata McGraw-Hill, 6th Edition, New York, 2018.

RG5101 **REMOTE SENSING** **L T P C**
3 0 0 3

OBJECTIVES:

- To familiarize about the basic principles of remote sensing
- To acquire knowledge about the motion of remote sensing satellites in the space
- To expose the various types of sensors used for remote sensing
- To gain knowledge about the generation of satellite data products

UNIT I PHYSICS OF REMOTE SENSING 9

Remote Sensing - Defintion - Components - Electro Magnetic Spectrum – Basic wave theory – Particle theory – Stefan Boltzman law - Wiens-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 geo synchronous satellites.

UNIT III OPTICAL SENSORS 9

Classification of remote sensors – selection of 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 scannerimagery - 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

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.

TOTAL: 45 PERIODS

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, VI edition of John Wiley & Sons-2015.
2. John R. Jensen, Introductory Digital Image Processing: A Remote Sensing Perspective, 4th Edition, 2015.

3. John A.Richards, Springer – Verlag, Remate Sensing Digital Image Analysis 5th edition, 2013.
4. Paul Curran P.J. Principles of Remote Sensing, ELBS; 1985.
5. Charles Elachi and Jakob J. van Zyl , Introduction To The Physics and Techniques of Remote Sensing , Wiley Series in Remote Sensing and Image Processing, 2nd edition, 2006.
6. George Joseph, Fundamentals of Remote Sensing, Third Edition, Universities Press (India) Pvt Ltd, Hyderabad, 2018
7. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 2011

CO – PO Mapping – REMOTE SENSING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	M	M	M	M		M
PO2	Problem analysis					H	H
PO3	Design / development of solutions					H	H
PO4	Conduct Investigations of complex problems					H	H
PO5	Modern Tool Usage	M	H	H	H		H
PO6	The Engineer and society				M		M
PO7	Environment and Sustainability				M		M
PO8	Ethics					M	M
PO9	Individual and Team work		M		H		H
PO10	Communication	M			H		H
PO11	Project Management and Finance		M			M	M
PO12	Life Long Learning				M		M
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	H	H	H	H	H	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation	H	L	L	M	H	M
PSO3	Conceptualization and evaluation of Design solutions	M	M	M	M	H	M

RG5102 GEOGRAPHICAL INFORMATION SYSTEM L T P C
3 0 0 3

OBJECTIVES:

- Expose the students with concepts of cartography as major components of input and output related to cartography.
- To provide exposure to data models and data structures in GIS and to introduce various Raster and Vector Analysis capabilities.
- To expose the concept of quality and design of cartographic outputs in open GIS environment.

UNIT I CARTOGRAPHY 9

Definition of Map - Mapping Organsiation in India- Classification based on Function, Scale, Characteristics – Ellipsoid and Geoid – Co-ordinate 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- Geo-Spatial, Spatial and Non-spatial data – Definition of GIS – Evolution 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 Representaiton – 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 - Meta Data – Web based GIS: Definition, Merits - Architecture – Map Server – Spatial Data Infrastructure – Spatial Data Standards – Free and Open Source – Proprietary - GIS Software .

TOTAL: 45 PERIODS

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	Analyse 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.

CO – PO Mapping – GEOGRAPHICAL INFORMATION SYSTEM

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	H		L	L		M
PO2	Problem Analysis			H			H

PO3	Design / development of Solutions		H				M
PO4	Conduct investigations of complex problems	M		M	M		M
PO5	Modern Tool Usage			H	H	M	H
PO6	The Engineer and society						
PO7	Environment and Sustainability						
PO8	Ethics		M			H	M
PO9	Individual and Team work		L				L
PO10	Communication					M	M
PO11	Project Management and Finance		M	M	M	M	M
PO12	Life Long Learning						
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	H		H		M	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation		M			H	M
PSO3	Conceptualization and evaluation of Design solutions	M	L			L	L

RG5103 PROGRAMMING FOR SPATIAL DATA PROCESSING L T P C
2 0 2 3

OBJECTIVE:

- The objective of the course is to make the students to understand the concepts of OOPS, C++ Programming, IDL and Python

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++ PROGRAMMINGFUNDAMENTALS 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 OBJECTS 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

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 – Geoproessing – Modules, Object geometry, raster and vector formats – map production – layer management, map layout elements, publishing, export, symbology - customization.

TOTAL :60 PERIODS

OUTCOMES:

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

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

REFERENCES:

1. Balagurusamy.E., Object Oriented Programming with C++, Mc.Graw Hill Publications, 6th edition. 2013.
2. GarradChris ,Geoprocessing with Python, Pearson Publications, 2016.
3. Stanley B.Lippman, A C++ Primer, 2nd Edition, Addison Wesley Publications, 5th Edition,2012.
4. Timothy Budd, An Introduction to Object Oriented Programming, Third Edition, Pearson Education, 2008
5. Kenneth P. Bowman, An Introduction to Programming with IDL: Interactive Data Language, Academic Press**,** First edition,
6. Liam E.Gumley, Practical IDL Programming, Morgan Kaufmann Publishers, First Edition, 2002
7. Joel Lawhead, QGIS Python Programming Cookbook - Second Edition, Kindle Edition, 2017.

CO – PO Mapping – PROGRAMMING FOR SPATIAL DATA PROCESSING

PO/PSO		**Course Outcome**					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	M	M	M	M	M	M
PO2	Problem Analysis				H	H	H
PO3	Design / development of Solutions					H	H
PO4	Conduct Investigations of Complex problems	L		L	H	H	H
PO5	Modern tool usage			M	H	H	H
PO6	The Engineer and society						
PO7	Environment and Sustainability					M	M
PO8	Ethics					M	M
PO9	Individual and Team work			M	M	M	M
PO10	Communication		M	H	H	H	M
PO11	Project Management and Finance			H	H	H	H
PO12	Life Long Learning			H	H	H	H
PSO1	Knowledge of Remote Sensing and Geomatics discipline				H	H	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering problems and innovation				H	H	H
PSO3	Conceptualization and evaluation of design solutions						

RM5151 RESEARCH METHODOLOGY AND IPR LT P C
2 0 0 2

OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TOTAL : 30 PERIODS

OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓											
CO3	✓							✓				
CO4	✓				✓							
CO5	✓					✓						✓

REFERENCES:

1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010

RG5111 GEOGRAPHICAL INFORMATION SYSTEM LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To give practical exposure to the students to data input, data storage, data analyses and data output capabilities of a standard GIS software(proprietary and open softwares)
- It also adds skills in mapping techniques and map outputs.

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 data base 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: 60 PERIODS

OUTCOMES:

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

CO1	Create GIS database through Digitization and Georeferencing
CO2	Generate DEM from various elevation sources
CO3	Perform Spatial Analysis of Vector Data using GIS tools
CO4	Present Geospatial Information in form of Maps, Charts and Symbols
CO5	Customize tools and interfaces through scripting

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.

CO – PO Mapping - GEOGRAPHICAL INFORMATION SYSTEM LABORATORY

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	M	M		L		M
PO2	Problem Analysis		M	H		M	M

PO3	Design / development of Solutions	L		M	L	M	M
PO4	Conduct investigations of complex problems		H	M			H
PO5	Modern Tool Usage	H	H	H	M	M	H
PO6	The Engineer and society						
PO7	Environment and Sustainability						
PO8	Ethics	L			L		L
PO9	Individual and Team work	H		L			L
PO10	Communication		L		H	L	M
PO11	Project Management and Finance	L			M	M	M
PO12	Life Long Learning						
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline			H	H	M	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation	M			M	L	M
PSO3	Conceptualization and evaluation of Design solutions		M	H	M		H

RG5112 **REMOTE SENSING LABORATORY** **L T P C**
0 0 4 2

OBJECTIVE:

- This course will facilitate the students to have hands on experience on different steps of Visual digital satellite image.

REMOTE SENSING EXERCISES

1. Spectral reflectance observation of the following using handheld spectro radiometer.
   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. Slope maps and Watershed delineation.

TOTAL : 60 PERIODS

OUTCOMES:

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

CO1	Understand spectral reflectance of vegetation, soil, water and built-up using spectro radiometer.
CO2	Understand the satellite image formats and base map preparation.
CO3	Ready to prepare the base map from Survey of India Toposheets.
CO4	Understanding the image elements for landuse/ Landcover maps.
CO5	Understand the geology and geomorphology maps through RS data and practical ability to delineate feature boundaries.

REFERENCES:

1. Lillesand T.M., and Kiefer,R.W. Remote Sensing and Image interpretation, VI edition of John Wiley & Sons-2015.

2. John R. Jensen, Introductory Digital Image Processing: A Remote Sensing Perspective, 4th Edition, 2015.
3. John A.Richards, Springer – Verlag, Remate Sensing Digital Image Analysis 5th edition, 2013.
4. Paul Curran P.J. Principles of Remote Sensing, ELBS; 1985.
5. Charles Elachi and Jakob J. van Zyl, Introduction To The Physics and Techniques of Remote Sensing , Wiley Series in Remote Sensing and Image Processing, 2nd edition, 2006.
6. George Joseph, Fundamentals of Remote Sensing, Third Edition, Universities Press (India) Pvt Ltd, Hyderabad, 2018
7. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 2011

CO – PO Mapping - REMOTE SENSING LABORATORY

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	H	M		H		H
PO2	Problem Analysis	M	L	L	L	L	L
PO3	Design / development of Solutions	H			M		M
PO4	Conduct investigations of complex problems				H	H	H
PO5	Modern Tool Usage	L		L			L
PO6	The Engineer and society						
PO7	Environment and Sustainability						
PO8	Ethics						
PO9	Individual and Team work	H				L	H
PO10	Communication						
PO11	Project Management and Finance						
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	M	M	L	M	M	M
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation	L	L	L	M	L	L
PSO3	Conceptualization and evaluation of Design solutions	L	L	L	M	M	L

RG5201 PHOTOGRAMMETRY L T P C
3 0 0 3

OBJECTIVE:

- To introduce basics and concepts of aerial photography, acquisition and mapping from aerial photographs using different types of stereo plotters

UNIT I INTRODUCTION TO PHOTOGRAMMETRY 9

Principles - Stereoscopic depth perception – aerial photo-aerial camera -Scale – overlaps – stereoscopy – concepts – viewing and measuring system – principle of floating mark – methods of parallax measurement – vertical photographs – geometry, scale, parallax equations, planimetric mapping – Tilted photograph – Geometry, Coordinate system, Scale, Planimetric mapping

UNIT II TRANSFORMATIONS 9

Coordinate systems for Photogrammetry - Map projections, Datums and conversions- 2D Coordinate transformations-Collinearity and Space resection-Analytical stereomodel and relative orientation- Three dimensional Coordinate transformations

UNIT III PHOTOGRAMMETRY AND MAPPING 9

Concepts of interior, relative, absolute orientation – direct georeferencing – object, image relation - collinearity and coplanarity conditions – effect of orientation elements - Elements and principles of Aerotriangulation – Independent Models-Simultaneous bundle adjustment - ortho mosaic

UNIT IV DIGITAL IMAGE HANDLING 9

Digital cameras- CCD camera- full frame, frame transfer, interline CCD camera - Time delay integration- spectral sensitivity of CCD sensor – geometry and radiometry problem of CCD image - Image Generation - Data Compression - formats – Georeferencing - Stereo viewing - Display modes - image matching techniques - Image measurements.

UNIT V DP PROCEDURES AND APPLICATIONS 9

Review of space resection & intersection - Automatic tie point generation - Automatic Block triangulation, feature collection and plotting–DEM Generation - accuracy of DEMs, Orthorectification - regular & irregular data collection methods - contour generation - watershed delineation - Satellite Photogrammetry principles – missions - stereo image products. (satellite stereo grammetry) – Aerial, terrestrial, tilted photogrammetry

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1	Understand and appreciate the importance of photography as means of mapping, functional and physical elements of photography.
CO2	Understand and reflect on the history and need of the photogrammetric mapping and the relevants of the accuracy standards and means to achieve them for precise large scale maps with scientific methods.
CO3	Evaluate the standards of map based on the state of the art tool and techniques and assers the production standards for photogrammetric map making.
CO4	Acquire knowledge on the current development, issues methods and solutions in map making and evaluate methods of production.
CO5	Analyze critically and evaluate methods by applying the knowledge so gained and to be a part of innovation and integration of mapping technology.

REFERENCES:

1. Paul R.Wolf, Elements of Photogrammetry, McGraw-Hill Science, 2013, ISBN 0070713464, 9780070713468
2. Karl Kraus, Photogrammetry, Fundamentals and standard processes, Dümmler, 2000, ISBN 978 3 110190076
3. Mikhail Kasser and Yves Egels, “Digital Photogrammetry”, Taylor and Francis, 2003, ISBN 0 748 40944 0
4. Francis h. Moffitt, Edward M. Mikhail, Photogrammetry, TBS The Book Service Ltd, 1980, ISBN 13: 9780700221370
5. Edward M. Mikhail, James S.Bethel, J.Chris McGlone, Introduction on “Modern Photogrammetry”, John Wiley & Sons, Inc., 2012, ISBN 0-471-30924-9
6. Wilfried Linder, “Digital Photogrammetry”-Theory and Applications, Springer-Verlag Berlin Heidelberg New York, 3rd Edition, 2014, ISBN 3-540-00810-1
7. Digital Photogrammetry – A practical course by Wilfried Linder, 3rd edition, Springer, 2009

CO – PO Mapping – PHOTOGRAMMETRY

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	H	H	M	H	M	H
PO2	Problem analysis	M	M	H	H	H	H
PO3	Design / development of solutions	M	M	M	H	H	H
PO4	Conduct Investigations of complex problems	M	M	H	H	H	H
PO5	Modern Tool Usage	M	M	M	H	H	H
PO6	The Engineer and society	M	M	M	H	H	M
PO7	Environment and Sustainability	L	L	L	H	H	M
PO8	Ethics	M	M	H	H	H	H
PO9	Individual and Team work	H	H	M	H	H	H
PO10	Communication	M	M	M	M	H	M
PO11	Project Management and Finance	L	L	L	M	H	M
PO12	Life Long Learning	H	H	M	M	H	H
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	H	H	H	H	H	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation	L	L	M	H	H	H
PSO3	Conceptualization and evaluation of Design solutions	L	L	L	M	H	H

RG5202 SATELLITE IMAGE PROCESSING L T P C
3 0 0 3

OBJECTIVE:

- The objective of the course is to describe about the procedure of satellite data acquisition and analysis.

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- Uni-variate & multi-variate 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'sTheorem – 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 - Case studies

TOTAL: 45 PERIODS

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 Degradation 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 method and also evaluate the accuracy of classification.
CO5	Implement the advanced image classification methods and conduct life long research in the field of image processing.

REFERENCES:

1. John R. Jensen, Introductory Digital Image Processing: A Remote Sensing Perspective, 4th Edition, 2015.
2. Robert Shcowebgerdt, Remote sensing models & methods for image processing,Academic Press , 2012.
3. John A.Richards, Springer – Verlag, Remate Sensing Digital Image Analysis 5th Edition, 2012..
4. Digital Image Processing (4th Edition) Rafael C. Gonzalez, Richard E. Woods Prentice Hall, 2018.
5. W.G.Rees - Physical Principles of Remote Sensing, Cambridge University Press, 2nd edition, 2001.
8. Fundamentals of Digital Image Processing by Annadurai Pearson Education (2006)
9. Digital Image Processing: PIKS Scientific Inside by William K. Pratt 4th Edition,Wiley Interscience,2007.

CO – PO Mapping – SATELLITE IMAGE PROCESSING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	L	H	H	H	H	H
PO2	Problem analysis		L	M	H	H	H
PO3	Design/development of solutions		L	M	H	H	H
PO4	Conduct investigations of complex problems		H	H	H	H	H
PO5	Modern tool usage	M	M	H	M	H	M
PO6	The Engineer and society						
PO7	Environment and sustainability				M	M	M
PO8	Ethics						
PO9	Individual and team work				M		M
PO10	Communication						
PO11	Project management and finance						
PO12	Life-long learning	M	M	L	M	H	M

PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	L	M	M	H	H	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation	L	M	M	H	H	H
PSO3	Conceptualization and evaluation of Design solutions	L	M	H	H	H	H

RG5203 TOTAL STATION AND GPS SURVEYING L T P C
3 0 2 4

OBJECTIVES:

- To understand the working of Total Station and GPS equipment and solve the surveying problems.

UNIT I FUNDAMENTALS OF TOTAL STATION AND GPS 9+6

Methods of Measuring Distance, Basic Principles of Total Station, Historical Development, Classifications, applications and comparison with conventional surveying. Global Navigation System, Regional Navigation System and SBAS - Basic concepts of GNSS, Glonass,IRNSS - Historical perspective and development - applications - Geoid and Ellipsoid- satellite orbital motion - Keplerian motion – Kepler‟s Law - Perturbing forces - Geodetic satellite - Doppler effect- Different Coordinate and Time System.

UNIT II ELECTROMAGNETIC WAVES 9+6

Classification - applications of Electromagnetic waves, Propagation properties, wave propagation at lower and higher frequencies- Refractive index (RI) - factors affecting RI-Computation of group 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 - pressure transducers.

UNIT III ELECTRO OPTICAL AND MICRO WAVE SYSTE 9+6

Electro-optical system: Measuring principle, Working principle, 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 system. Care and maintenance of Total Station instruments– Applications of COGO functions -Traversing and Trilateration – Downloading and mapping - Recent trends

UNIT IV GPS SATELLITE SYSTEM AND DATA PROCESSING 9+6

GPS - Different segments - space, control and user segments - satellite configuration - GPS signal structure - Orbit determination and representation - Anti Spoofing and Selective Availability - Task of control segment - GPS receivers- GPS observables - code and carrier phase observation - linear combination and derived observables - concept of parameter estimation – downloading the data -data processing – software modules -solutions of cycle slips, ambiguities, RINEX format. Concepts of rapid, static methods with GPS - semi Kinematic, pure Kinematic and Real time kinematic methods -basic constellation of satellite geometry & accuracy measures - applications- use of different softwares.

UNIT V INTRODUCTION TO GEODESY 9+6

Definitions- Classifications, Applications, Problem and purpose of Geodesy - Historical development and Organization of Geodesy. Reference Surfaces and their relationship. Engineering, Lunar, Planetary and interferometric Synthetic aperture radar Geodesy – Local and

International Spheroid. Definitions- Classifications, Applications, Problem and purpose of Geodesy - Historical development and Organization of Geodesy. Reference Surfaces and their relationship. Engineering, Lunar, Planetary and interferometric Synthetic aperture radar Geodesy – Local and International Spheroid.

TOTAL : 75 PERIODS

OUTCOMES:

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

CO1	Gives basic idea about Total station and GPS
CO2	Acquire knowledge about electromagnetic waves and its usage in Total station.
CO3	Getting idea about working principle of electro optical and Microwave Total station
CO4	Understand the working of GPS
CO5	Understand the Geometry of the earth, Gravity and its relationship with nature

REFERENCES :

1. Rueger, J.M. Electronic Distance Measurement, Springer-Verlag, Berlin, 1996.
2. Satheesh Gopi, rasathishkumar, N.madhu, — Advanced Surveying , Total Station GPS and Remote Sensing — Pearson education , 2014,isbn: 978-81317 00679
3. Wolfgang Torge, Geodesy, Walter De Gruyter Inc., Berlin, 4th Edition,2014.
4. R.Subramanian, Surveying and Levelling, Oxford University Press, Second Edition, 2012.
5. Laurila, S.H. Electronic Surveying in Practice, John Wiley and Sons Inc, 1983.
6. Guocheng Xu, GPS Theory, Algorithms and Applications, Springer - Verlag, Berlin, 3rd Edition,2016.
7. Alfred Leick, GPS satellite surveying, John Wiley & Sons Inc., 4th Edition,2015.
8. Seeber G, Satellite Geodesy, Walter De Gruyter, Berlin, 2003, Revised Edition.
9. Petr Vanicek and Edward J. Krakiwsky, Geodesy: The concepts, North-Holland Publications Co., Amsterdam,2015.

CO – PO Mapping – TOTAL STATION AND GPS SURVEYING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	H	H	M	M		H
PO2	Problem analysis		H	H			H
PO3	Design / development of solutions		H	H		H	H
PO4	Conduct Investigations of complex problems	L	L	L	L	L	L
PO5	Modern Tool Usage			H		H	H
PO6	The Engineer and society			H		H	H
PO7	Environment and Sustainability						
PO8	Ethics						
PO9	Individual and Team work						
PO10	Communication			H		H	H
PO11	Project Management and Finance						
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline			H	H	H	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation			H	H	H	H
PSO3	Conceptualization and evaluation of Design solutions			H	H	H	H

RG5211 SATELLITE IMAGE PROCESSING LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- This course will facilitate the students to have hands on experience on different steps of satellite image processing using various softwares.

EXERCISES:

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: 60 PERIODS

OUTCOMES:

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

CO1	Understand the satellite image file formats and characteristics
CO2	Realize the necessity of geometric correction
CO3	Apply the various available techniques to enhance the interpretability of satellite images
CO4	Get the hands on experience on fundamental classification techniques
CO5	Understand the impact of advanced classification techniques and accuracy assessment

REFERENCES:

1. Richards, Remote sensing digital Image Analysis - An Introduction, 5th Edition 2012 Springer -Verlag .
2. Robert, G. Reeves,- Manual of Remote Sensing Vol. I & II - American Society of Photogrammetry, Falls, Church, USA, 1983.
3. Richards, Remote sensing digital Image Analysis - An Introduction 5th Edition, 2012, Springer -Verlag 1993.
4. Digital Image Processing by Rafael C. Gonzalez, Richard Eugene Woods- Pearson/ Prentice Hall,2008
5. Fundamentals of Digital Image Processing by Annadurai Pearson Education (2006)

CO – PO Mapping – SATELLITE IMAGE PROCESSING LABORATORY

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	M					M
PO2	Problem Analysis				H	H	H
PO3	Design / development of Solutions		M		H	H	M
PO4	Conduct Investigations of Complex problems		M		M	M	M

PO5	Modern tool usage				H	H	H
PO6	The Engineer and society				M	M	M
PO7	Environment and Sustainability				M	M	M
PO8	Ethics						
PO9	Individual and Team work		M	M	H	H	H
PO10	Communication		M	M	H	H	H
PO11	Project Management and Finance				M	M	M
PO12	Life Long Learning				H	H	H
PSO1	Knowledge of Remote Sensing and Geomatics discipline		H	H	H	H	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering problems and innovation					M	M
PSO3	Conceptualization and evaluation of design solutions				M	M	M

RG5212 PHOTOGRAMMETRY LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- To acquire practical knowledge in the field of Remote Sensing and Photogrammetry.

REMOTE SENSING EXERCISES

1. Preparation of Base Map from Survey of India Topo sheets 4
2. Introduction to various satellite data products and image interpretation keys 4
3. Preparation of Land use/land cover map using Satellite Data. 4
4. Preparation and analysis of spectral signatures using handheld spectro radiometer for
   (a) Vegetation 4
   (b) Soil 4
   (c) Water 4

PHOTOGRAMMETRY EXERCISES

1. Testing stereovision with test card 4
2. Mirror stereoscope- base lining and orientation of aerial photographs and photo interpretation. 4
3. Scale of vertical photographs. 4
4. To find the height of point using Parallax concept. 4
5. Aerial Triangulation using digital photogrammetry 4
6. Bundle Block adjustment 4
7. Generation and editing of DTM and Contour 4
8. Orthophoto generation and Mosaic 4
9. Preparation of Planimetric map 4

TOTAL :60 PERIODS

OUTCOMES:

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

CO1	Imparts the knowledge in preparation of base map and thematic maps.
CO2	Gain knowledge on preparation and analysis of spectral signatures of various features.
CO3	Understand the basic concepts of aerial photo and orientation procedure.
CO4	Provides hands on experience on the use of stereoscopic instruments and Digital photogrammetry software.
CO5	Prepare the orthophoto and mapping by digital photogrammetry.

REFERENCES:

1. Paul R.Wolf, Elements of Photogrammetry, McGraw-Hill Science, 2013, ISBN 0070713464, 9780070713468
2. Karl Kraus, Photogrammetry, Fundamentals and standard processes, Dümmler, 2000, ISBN 978 3 110190076
3. Mikhail Kasser and Yves Egels, “Digital Photogrammetry”, Taylor and Francis, 2003, ISBN 0 748 40944 0
4. Francis h. Moffitt, Edward M. Mikhail, Photogrammetry, TBS The Book Service Ltd, 1980, ISBN 13: 9780700221370
5. Edward M. Mikhail, James S.Bethel, J.Chris McGlone, Introduction on “Modern Photogrammetry”, John Wiley & Sons, Inc., 2012, ISBN 0-471-30924-9
6. Wilfried Linder, “Digital Photogrammetry”-Theory and Applications, Springer-Verlag Berlin Heidelberg New York, 3rd Edition, 2014, ISBN 3-540-00810-1
7. Digital Photogrammetry – A practical course by Wilfried Linder, 3rd edition, Springer, 2009

CO– PO Mapping –PHOTOGRAMMETRY LABORATORY

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	L	L	L	L	L	L
PO2	Problem Analysis	L	L	L	L	L	L
PO3	Design / development of Solutions	L	L	M	M	M	M
PO4	Conduct investigations of complex problems	L	L	L	H	H	M
PO5	Modern Tool Usage	M	M	M	H	H	H
PO6	The Engineer and society	L	L	L	L	L	L
PO7	Environment and Sustainability	L	L	L	L	L	L
PO8	Ethics	L	L	L	L	L	L
PO9	Individual and Team work	L	L	M	M	M	M
PO10	Communication	L	L	L	L	L	L
PO11	Project Management and Finance	L	L	M	M	M	M
PO12	Life Long Learning	M	M	M	L	L	M
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	M	M	M	M	M	M
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation	M	L	L	H	H	M
PSO3	Conceptualization and evaluation of Design solutions	L	L	M	L	L	L

RG5301 **MATLAB PROGRAMMING** **LT P C**
2 0 2 3

OBJECTIVES

- The main objective of this course is to make the student familiar with the basics of MATLAB and usage of various tools in field of geomatics.

UNIT I INTRODUCTION TO MATLAB PROGRAMMING, APPROXIMATIONS AND ERRORS 6+6

Basics of MATLAB programming - Array operations in MATLAB - Loops and execution control - vector operation: Creation, dot product, work with vectors: create, topology, union and intersection, reselection, buffering, generate suitability map - Working with files:Scripts and Functions - Plotting and program output - Defining errors and precision in numerical methods - Truncation and round-off errors-Error propagation, Global and local truncation errors

UNIT II DIFFERENTIATION AND INTEGRATION 6+6

Numerical Differentiation in single variable - Numerical differentiation: Higher derivatives-Differentiation in multiple variables - Newton-Cotes integration formulae - Multi-step application of Trapezoidal rule - MATLAB functions for integration - Introduction to ODEs; Implicit and explicit Euler's methods - Second-Order Runge-Kutta Methods - MATLAB ode45 algorithm in single variable - Higher order Runge-Kutta methods - Error analysis of Runge-Kutta method

UNIT III LINEAR AND NON LINEAR EQUATIONS 6+6

Linear algebra in MATLAB - Gauss Elimination - LU decomposition and partial pivoting - Iterative methods: Gauss Siedel - Special Matrices: Tri-diagonal matrix algorithm - Nonlinear equations in single variable - MATLAB function fzero in single variable - Fixed-point iteration in single variable - Newton-Raphson in single variable - MATLAB function fsolve in single and multiple variables - Newton-Raphson in multiple variables

UNIT IV ALGEBRA AND TRANFORMS 6+6

Solving quadratic equation, factorization, calculus: exploring limits, use of octaves, Differential: solving DE, maxima and minima, exponential, logarithmic and trigonometric derivatives, Integral: finding indefinite and definite integral, Transform: Laplace and inverse Laplace transform , Fourier and inverse Fourier transform, working with lessons: derive slopemap, create watershed, find landslide vulnerability

UNIT V DATA VISUALIZATION AND MODELLING 6+6

Graph elements; color, theme, type, title and lable, drawing multiple functions, generating sub plots, drawing bar chart, contour, 3D plots, move elements, trace movement, work with plotting: regression analysis and presentation, contour map from DEM

TOTAL : 60 PERIODS

OUTCOMES:

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

CO1	To enable the student to understand basic MatLab functions
CO2	To enable to solve mathematical problems related to differentiation and integration
CO3	To enable to solve problems related to Liner and Non Linear equations to correct the same to geospatial algorithms
CO4	To enable to solve transformations of geospatial problems
CO5	To make to develop skills in geospatial tool box and map making

REFERENCES:

1. Holly Moore, " MATLAB for Engineers" Third Edition – Pearson Publications
2. Stephen J. Chapman, "MATLAB Programming for Engineers" Fourth Edition –Thomson learning**.**
3. Fausett L.V.(2007) Applied NumericalAnalysis Using MATLAB, 2nd Ed.,Pearson Education.

4. MATLAB: An Introduction with Applications, by Amos Gilat, 2nd edition, Wiley, 2004
5. Hahn B., and D. Valentine, 2013. Essential Matlab for Engineers and Scientists: 5th Edition, Academic Press.
6. Getting Started with MATLAB 7: A Quick Introduction for Scientists and Engineers, by Rudra Pratap,OUP USA,2005.
7. Programming and Engineering Computing with MATLAB 2018 by Huei-Huang Lee , SDC Publications, 2018.

CO – PO Mapping – MATLAB PROGRAMMING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge		H	H			H
PO2	Problem analysis		H	H	M		H
PO3	Design / development of solutions		M			H	H
PO4	Conduct Investigation of complex problems	H					H
PO5	Modern Tool Usage			L		H	M
PO6	The Engineer and society						
PO7	Environment and Sustainability					M	M
PO8	Ethics						
PO9	Individual and Team work		M			H	H
PO10	Communication						
PO11	Project Management and Finance	H	M		H		M
PO12	Life Long Learning	M		L		H	H
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline		M		H	H	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation		M	L		H	M
PSO3	Conceptualization and evaluation of Design solutions		M	L		H	M

RG5311 PROJECT PHASE I L T P C
0 0 12 6

OBJECTIVE:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS:

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. 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 clear definition of the identified problem, 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

OUTCOME:

- At the end of the course the students will have a clear idea of his/her area of work and they are in a position to carry out the remaining phase II work in a systematic way.

CO – PO Mapping – PRACTICAL TRAINING

PO/PSO		Overall Correlation of COs to POs
PO1	Knowledge of Engineering Sciences	H
PO2	Problem analysis	H
PO3	Design / development of solutions	H
PO4	Investigation	H
PO5	Modern Tool Usage	H
PO6	Individual and Team work	H
PO7	Communication	H
PO8	Engineer and Society	H
PO9	Ethics	L
PO10	Environment and Sustainability	H
PO11	Project Management and Finance	M
PO12	Life Long Learning	H
PSO1	Knowledge of Remote Sensing and Geomatics discipline	M
PSO2	Critical analysis of Remote Sensing and Geomatics issues and innovation	H
PSO3	Conceptualization and evaluation of Design issues	H

RG5312 **PRACTICAL TRAINING** **L T P C**
0 0 0 2

OBJECTIVE:

- To train the students in the field work so as to have a firsthand knowledge of practical problems related to Remote Sensing and Geomatics in carrying out engineering tasks.
- To develop skills in facing and solving the field problems.

SYLLABUS:

The students individually undertake training in reputed Industries during the summer vacation for a period of minimum two 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.

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	Enable student to connect technology and field problem.
CO4	To comprehend the use of geospatial for industrial requirement
CO5	To make student to prepare for report, presentation for their activities.

CO – PO Mapping – PRACTICAL TRAINING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	L	H	H	H	L	H
PO2	Problem Analysis	L	M	H	M	L	M
PO3	Design / development of Solutions		L		H	L	L
PO4	Conduct investigations of complex problems	H		H	L	M	H
PO5	Modern Tool Usage		H	L	M	H	H
PO6	The Engineer and society		H	H			H
PO7	Environment and Sustainability						
PO8	Ethics						
PO9	Individual and Team work	H		H		M	H
PO10	Communication		H	M		H	H
PO11	Project Management and Finance	H		H			H
PO12	Life Long Learning						
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	M	M	M	M	M	M
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation	L	L	M	L	L	L
PSO3	Conceptualization and evaluation of Design solutions	L	L	L	L	H	L

RG5411 **PROJECT PHASE II** **L T P C**

0 0 24 12

OBJECTIVES:

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS:

The student should continue the phase I work 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 through based on the report and the viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 360 PERIODS

OUTCOME:

- On completion of the project work students will be in a position to take up any challenging practical problem and find better solutions.

PO/PSO		Overall Correlation of COs to POs
PO1	Knowledge of Engineering Sciences	H
PO2	Problem analysis	H
PO3	Design / development of solutions	H

PO4	Investigation	M
PO5	Modern Tool Usage	H
PO6	Individual and Team work	M
PO7	Communication	L
PO8	Engineer and Society	H
PO9	Ethics	L
PO10	Environment and Sustainability	H
PO11	Project Management and Finance	H
PO12	Life Long Learning	H
PSO1	Knowledge of Remote Sensing and Geomatics discipline	H
PSO2	Critical analysis of Remote Sensing and Geomatics issues and innovation	H
PSO3	Conceptualization and evaluation of Design issues	H

RG5001 LASER SCANNING FOR TERRAIN MAPPING L T P C
3 0 0 3

OBJECTIVE:

- To provide exposure to LiDAR mapping and its applications

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: Range Finder LiDAR,Doppler LiDAR, DIAL – Ellipsoid and Geoid - Principles of Laser Ranging: Pulse Laser, Continuous Wave Laser – Space Borne Laser Missions – Geo Science Laser Altimeter System (GLAS), LiDAR In-SpaceTechnology Experiment (LITE), Chandrayan, CALIOP – Aerosol Monitoring and Measurement

UNIT II AIR BORNE 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 - Synchronisation 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 – Co-ordinate Transformations – Geolocating Laser Foot Prints – Strip Adjustment – Digital Surface Model to Digital Elevation Model: 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

OUTCOMES:

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

CO1	To understand types of LASER and its classication, types of LiDAR and Satellite Laser Scanning Missions
CO2	To understand components of ALS, various scanning mechanism and concept of multi returns
CO3	To analyse and process the Navigation and Inertial data for optimal flight path selection and coordinate transformation techniques for geolocating laser foot prints
CO4	To apply derived products of ALS in various application domains with reference to case studies
CO5	To 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 2016, 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 – LASER SCANNING FOR TERRAIN MAPPING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	H	H	L	L	H	H
PO2	Problem analysis	L	L	H	H	M	M
PO3	Design / development of solutions			M	M	M	M
PO4	Conduct investigations of complex problems	L		L		L	L
PO5	Modern Tool Usage			M	M	M	M
PO6	The Engineer and society				M	M	M
PO7	Environment and Sustainability						
PO8	Ethics						
PO9	Individual and Team work						
PO10	Communication						
PO11	Project Management and Finance						
PO12	Life Long Learning						
PSO1	Knowledge of Remote Sensing and Geomatics Engineering Discipline	M	M	M	M	M	M
PSO2	Critical Analysis of Remote Sensing and Geomatics Engineering issues and innovation			H	H	H	H

PSO3	Conceptualization of and evaluation of Design solutions			H	H	H	H

RG5002 **GEODESY** **L T P C**
3 0 0 3

OBJECTIVE:

- To understand the concept of geodetic surveying and solve the geodetic problems.

UNIT I FUNDAMENTALS 9

Definitions, classifications, applications and problems of geodesy. Historical development and organization of geodesy. Reference surfaces and their relationship, Engineering, lunar and planetary geodesy, Geodetic control(Horizontal and vertical)-Standards, methods and computations.

UNIT II GEOMETRIC GEODESY 9

Basics-Geodetic,Geocentric, Reduced Spheroidal latitudes and their relationship. coordinates in terms of reduced, geodetic and geocentric latitude. Radius of curvature in the meridian &prime vertical and their relationship. Mean Radius of curvature at any azimuth. Length of the meridian arcs and arcs of parallel and area of trapezium on the spheroid. Curves on the spheroid, properties of geodesic and Everest spheroid. Natural or Astronomical coordinate system, Geodetic or Geographical coordinate system, Rectangular or Cartesian coordinate system and relationship between them. Curvilinear coordinate system. Deflection of vertical, spherical excess. Astro-geodetic method of determining the reference spheroid.

UNIT III PHYSICAL GEODESY 9

Gravity field of earth, Concept of equipotential, geopotential and spheropotential surface Normal gravity, The significance of gravity measurements, Measurement of absolute and Relative gravity, Reduction of gravity measurements, Isostasy. Gravity networks, Gravity anomaly and Gravity disturbance. Funtamental equation of physical Geodesy. Determination of Geoid and Deflection of vertical. Orthometric height, Normal height, Dynamic height and their corrections. spheroidal height and Geoidal height.

UNIT IV GEODETIC ASTRONOMY 9

Basics-Horizon, hour angle, Right Ascension, Ecliptic co-ordinate systems and relationship with Cartesian co-ordinate system, Transformation between them. Special star positions, Major constellation. Rising and setting of stars with respect to declination, hour angle and azimuth. Culmination, Prime vertical Crossing and Elongation. Variation in celestial co-ordinates. Sidereal time, Universal time, Zone time and Atomic time. Determination of Astronomical azimuth, latitude and longitude. Star catalogues, Ephemerides and Almanacs.

UNIT V GEODETIC COMPUTATION 9

Rectangular and Polar co-ordinates. First and Second geodetic problem. Similarity and Helmert's transformation. Point determination by Intersection, Resection and Arc Section.

TOTAL : 45 PERIODS

OUTCOMES:

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

CO1	Understand the fundamentals of Geometry of the earth, Gravity and its relationship with nature
CO2	Understand the procedure for establishing horizontal and vertical Geodetic control and its adjustment procedure.
CO3	Determination of Azimuth, Latitude, Longitude and Time by Geodetic astronomical observations.

CO4	Provide the various aspects of Geometric and Physical Geodesy.
CO5	Inculcate the different height systems used to solve the field problem.

REFERENCES:

1. George l. Hosmer, Geodesy, Kessinger publishing 2007.
2. Howard goreJ., Elements of Geodesy, Kessinger publishing 2007.
3. Wolf gang torge, Geodesy, Walter De Gruyter Inc. Berlin, 4th Edition,2014.
4. Geometrical Geodesy Maarten Hooijberg, Springer verlag 2005.
5. Physical Geodesy Berhard Hofmann-wellenhot & Helmut moritz, springer verlag, 2nd Corrected Edition, 2006.
6. Petr Vanicek and Edward J.Kakiwsky, Geodesy, the concepts north Holland publications co, Amsterdam, 1991.
7. Heribert Kahmen and wolf gang faig, surveying, watter De Gruyter, Berlin, Reprint, 2012.
8. Schwarze, V.S.Geodesy, The challenge of the 3rd millennium, spinger verlag, 1st Edition, 2002.

CO – PO Mapping – GEODESY

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	M	M	M	M	M	M
PO2	Problem Analysis	H	H	H	H	H	H
PO3	Design / development of Solutions						
PO4	Conduct Investigations of Complex Problems	M	M	M	M	M	M
PO5	Modern Tool Usage	M	M	M	M	M	M
PO6	The Engineer and society	L	L	L	L	L	L
PO7	Environment and Sustainability						
PO8	Ethics	L	L	L	L	L	L
PO9	Individual and Team work	M	M	M	M	M	M
PO10	Communication	L	L	L	L	L	L
PO11	Project Management and Finance						
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	M	M	M	M	M	M
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation	M	M	M	M	M	M
PSO3	Conceptualization and evaluation of Design solutions	H	H	H	H	H	H

RG5003 **GIS APPLICATIONS** **L T P C**
3 0 0 3

OBJECTIVE:

- To provide exposure to applications of GIS in various application domains through case studies.

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: Invehicle 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, Hot Spot Analysis – 3D GIS.

TOTAL: 45 PERIODS

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, Telegeoinformatics: 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.

CO – PO Mapping – GIS APPLICATIONS

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	M	L	L	M	M	M
PO2	Problem Analysis	H	H	M	L	H	H
PO3	Design / development of Solutions	H	H	M	M	H	H
PO4	Conduct investigations of complex problems	M	M	L	L	M	M
PO5	Modern Tool Usage	M	M	H	H	M	H
PO6	The Engineer and society		M	M	H	H	H
PO7	Environment and Sustainability	H				M	M
PO8	Ethics						
PO9	Individual and Team work						
PO10	Communication						
PO11	Project Management and Finance	M	H	M	M	H	M
PO12	Life Long Learning						
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	M	H	M	M	M	M
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation	H	M	M	M	M	M
PSO3	Conceptualization and evaluation of Design solutions	M	M	M	M	M	M

RG5004 PLANETARY REMOTE SENSING L T P C
3 0 0 3

OBJECTIVES:

- To provide an insight to the field of planetary science
- To enlighten the student on modern techniques available for remote sensing of planetary surfaces.

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

OUTCOMES:

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

CO1	To identify the components of Solar System and understand the payloads of related exploratory missions
CO2	To understand the mineralogy and petrology of terrestrial planets
CO3	To describe the exo –endogenic process of Planetary Atmosphere
CO4	To apply Remote Sensing Techniques for Planetary Surface Analysis
CO5	To describe the various past and present planetary missions

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1. Shuanggen Jin, Planetary Geodesy and Remote Sensing 1st Edition, CRC PRESS, 2014
2. Bo Wu, Kaichang Di, Jürgen Oberst, Irina Karachevtseva, Planetary Remote Sensing and Mapping 1st Edition, CRC Press,2018
3. Principles of Planetary Climate by Raymond T.Pierrehumbert, University of Chicago, Publication date: December 2011.
4. Remote Sensing Apllications for Planetary Surfaces by Deepak Kumar, Lambert Academic Publishing,2014
5. Introduction to planetary remote sensing gamma ray spectroscopy, in Remote Geochemical Analysis: Elemental and Mineralogic Composition, C.M. Pieters and P.A.J. Englert, eds., Cambridge Univ. Press, pp. 167-198. Evans, L.G., R.C. Reedy, and J.I. Trombka, 1993
6. Remote Sensing for the Earth Sciences: Manual of Remote Sensing, Third Edition, Volume 3, pp. 509-564, A.N. Rencz, Editor, John Wiley & Sons, 1999.
7. Radar Remote Sensing of Planetary Surfaces Cambridge University Press 2011 by Bruce A. Campbell

CO – PO Mapping – PLANETARY REMOTE SENSING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	H	H	M		M	H
PO2	Problem analysis				M		M
PO3	Design / development of solutions				M		M
PO4	Conduct investigations of complex problems		M	M		M	M
PO5	Modern Tool Usage		M	M	M	M	M
PO6	The Engineer and society						
PO7	Environment and Sustainability						
PO8	Ethics						
PO9	Individual and Team work						
PO10	Communication						
PO11	Project Management and Finance						
PO12	Life Long Learning						

PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	H	M	M	H	M	M
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation			M	M		M
PSO3	Conceptualization and evaluation of Design solutions						

RG5005 GEOINFORMATICS FOR METEOROLOGY L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge in Concepts in Meteorology, Radio and Satellite Meteorology and its Applications

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 Thornthwaithe, 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 – atmosounding Radio Sonde - pilot balloons - Wind estimation through Radar - Rawin Sonde - 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.

UNIT III SATELLITE METEOROLOGY 9

Orbital dynamics of satellite – Critical velocities – Polar and Geostationary weather satellites - Active and passive sensors (Radar/Lidar/Radiometery,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/Icachana 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 – 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 subglobal 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 – Sealevel changes and Consequences.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1	Impacts the knowledge about 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, 1995
2. Arthur P. Cracknell, "The Advanced Very High Resolution Radiometer (AVHRR)", 1997, CRC Press, ISBN: 9780748402090.
3. Smith and Schreiner, "Advances in Remote Sensing", Deppak Publications
4. Asnani, G.C "Tropical Meteorology", Vol. I and II, 3rd Edition, 2016.
5. Richard J. Doviak, Dusan S. Zrnic, "Doppler Radar and Weather observations", Dover Publications;2014, ISBN: 978-0486450605
6. Ellingson, "Satellite Data Applications: Weather and Climate", Proc.of AO I Symp., COSPAR, Birmingham, UK, Elsevier, MD, USA. Pergamon Pr; 1st Edition 1997
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10. Kelkar R.R. Satellite Meteorology, B S Publications, Hyderabad,2007

CO – PO Mapping – GEOINFORMATICS FOR METEOROLOGY

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	H	H	H			H
PO2	Problem analysis				H	H	H
PO3	Design / development of solutions				H	H	H
PO4	Conduct Investigation of complex problems				M	M	M
PO5	Modern Tool Usage				H	H	H
PO6	The Engineer and society	M	M	M	H	H	M
PO7	Environment and Sustainability	M	M	M			M
PO8	Ethics				H	H	H
PO9	Individual and Team work	M	M	M	H	H	M
PO10	Communication				H	H	H
PO11	Project Management and Finance				H	H	H
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline			H	M	M	M
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation				H	H	H
PSO3	Conceptualization and evaluation of Design solutions				H	H	H

RG5006 SOFT COMPUTING TECHNIQUES L T P C
3 0 0 3

OBJECTIVE :

- The objective of the course is to make the students to understand the concepts of Artificial Neural Network, Fuzzy logic and Genetic algorithms and also their application in Geomatic.

UNIT I SOFT COMPUTING AND ARTIFICIAL NEURAL NETWORKS 9

Soft Computing : 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 - 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.

UNITV APPLICATIONS OF SOFT COMPUTING 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

OUTCOMES:

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

CO1	Understanding 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	Helps to realize the merits of hybrid computing techniques
CO4	Introduces the concepts of heuristic search methods and optimization of solutions
CO5	Gain knowledge on utility of soft computing on multidisciplinary problems

REFERENCES:

1. Introduction to Artificial Neural Systems by Jacek.M Zurada, Jaico Publishing House, 2004.
2. Freeman J.A. and Skapura B.M., "Neural Networks, Algorithms Applications and Programming Techniques", Pearson ,2002.
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,NewYork, 4th Edition,2016.
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6. George J.Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall Inc., New Jersey,1995
7. Nih.J. Ndssen Artificial Intelligence, Harcourt Asia Ltd.,Singapore,1998

CO – PO Mapping – SOFT COMPUTING TECHNIQUES

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	H	H	H	M	L	H
PO2	Problem analysis	H	M	M		H	H
PO3	Design / development of solutions	M		M		H	
PO4	Conduct Investigations of Complex Problems		H	H		H	H
PO5	Modern Tool Usage	H	H	H	H	L	H
PO6	The Engineer and society	M	M	M	M	H	H
PO7	Environment and Sustainability					M	M
PO8	Ethics					M	M
PO9	Individual and Team work			M	M	H	M
PO10	Communication	M	M	M	M	H	M
PO11	Project Management and Finance	H	M	M		M	M
PO12	Life Long Learning	M	M	M	M		M
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	L	L	L	M	H	
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation			H		H	H
PSO3	Conceptualization and evaluation of Design solutions			H		H	H

RG5007 SPATIAL DATA MODELLING L T P C
3 0 0 3

OBJECTIVE :

- To provide complete understanding of the concepts of Spatial Data Modelling

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 Spatial Models- Descriptive and Process models - Types of Process models - Creating Conceptual models - Site Suitability model – Case Study.

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- Arc GIS 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 Automata 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 IntelligenceI:definition,types – Exper 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

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 anlysis and modeling
CO4	Study various Spatio-Temporal model
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
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8. TsungChang-Kang, Introduction to Geographic Information Systems, Tata McGraw Hill Publishing Company and Limited NewDelhi, 4th Edition, 2017.

CO – PO Mapping – SPATIAL DATA MODELLING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	H		M	M	M	M
PO2	Problem analysis		H	H	M	M	H
PO3	Design / development of solutions				M	M	M
PO4	Conduct investigations of complex problems	L	H		M	L	M
PO5	Modern Tool Usage		H	M	M	H	H
PO6	The Engineer and society						
PO7	Environment and Sustainability						
PO8	Ethics						
PO9	Individual and Team work						
PO10	Communication						
PO11	Project Management and Finance						
PO12	Life Long Learning						
PSO1	Knowledge of Remote Sensing and Geomatics Engineering Discipline	H	H	M	M	M	H
PSO2	Critical Analysis of Remote Sensing and Geomatics Engineering issues and innovation		M	M	M	M	M
PSO3	Conceptualization of and evaluation of Design solutions		M			M	M

RG5008 THERMAL AND HYPERSPECTRAL REMOTE SENSING L T P C
3 0 0 3

OBJECTIVE:

- To make the post graduate students understand principles, processes and applications of thermal and hyper spectral remote sensing for earth resources.

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 – hyperspectral 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 HYPERSPECTRALIMAGEAPPLICATIONS 9

Application to lithology, mineral exploration – agricultural crop systems – stress detection, plant production, vegetal bio physics and bio chemistry, soil moisture , soil characteristics, degradation status - forestry canopy characters, ecosystem, forest health, biodiversity, Gap dynamics, environmental and resource management.

TOTAL 45 PERIODS

OUTCOMES:

On completion of this course, the student shall 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 hyperspectral image analysis to derive various parameters of vegetation, soil and water.
CO5	The hyperspectral 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: 0-306-47483-2)
4. Marcus Borengasser and William C., Hungate and Russel Watkins, “Hyper spectral Remote sensing: principles and application” CRC, 1st Edition,2008.
5. Claudia Kuenzer, Stefan Dech Editors, Thermal Infrared Remote Sensing Senors, Methods, Applications, Springer,2013.
6. Qihao Weng, Series Editor, Hyperspectral Remote Sensing Fundamentals & Practices, Taylor & Francis, CRC Press.

CO – PO Mapping – THERMAL AND HYPERSPECTRAL REMOTE SENSING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	H	H	M	H	H	H
PO2	Problem Analysis	M	H	M	H	H	H
PO3	Design / development of Solutions		H	H	M	H	H
PO4	Conduct investigations of complex problems	L	M		H	L	M
PO5	Modern Tool Usage	L	H	M	H	H	H
PO6	The Engineer and society			L		M	M
PO7	Environment and Sustainability		H	L	M	H	H
PO8	Ethics						
PO9	Individual and Team work			L	L	L	L
PO10	Communication			L	L		L
PO11	Project Management and Finance						
PO12	Life Long Learning	H	H	M	M	H	H

PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	H	H	M	H	H	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation	L	M	M	M	M	M
PSO3	Conceptualization and evaluation of Design solutions		L	L	M	M	M

RG5009 MICROWAVE REMOTE SENSING L T P C
3 0 0 3

OBJECTIVE:

- To impart the knowledge of Microwave Remote sensing and its applications.

UNIT I 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 II ACTIVE MICROWAVE REMOTE SENSING 9

Radar basics - RADAR operation and measurements - Radarfrequency 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 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 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.

UNIT V SPECIAL TOPICS 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

OUTCOMES:

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

CO1	Understanding of 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, 2015, Speckled Press; 1st edition,ISBN-13: 978-0415271233
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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,1st Edition, Springer, 2003.

CO – PO Mapping – MICROWAVE REMOTE SENSING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	H	H	H			H
PO2	Problem Analysis		H		H		H
PO3	Design / development of Solutions		M		M	H	M
PO4	Conduct Investigation of Complex problems	L	M		H	H	H
PO5	Modern tool usage	M	H		M		M
PO6	The Engineer and society		H	M		H	H
PO7	Environment and Sustainability					H	H
PO8	Ethics		L		H	H	M
PO9	Individual and Team work	M	M		H	H	M
PO10	Communication			M	M	M	M
PO11	Project Management and Finance	M	M		H	H	H
PO12	Life Long Learning	H	H		H	M	H
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	H	M	M	H		M
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation				H	H	H
PSO3	Conceptualization and evaluation of Design solutions		M		H	H	H

RG5010 WEB TECHNOLOGY PROGRAMMING FOR GIS L T P C
3 0 0 3

OBJECTIVE:

- This course provides skills in learning a set of scripts and their applications for providing web based services using GIS technology.

UNIT I INTRODUCTION TO WEBGIS AND MARKUP LANGUAGE 9

Internet and GIS – Web GIS Architecture and Components – OGC Web Services- WMS, WFS, WCS, WPS – Open Server Standards - Protocols: HTTP, FTP, SMTP- Frontend & Backend programming –- Basic file formats (vector, raster) – JSON, GeoJSON- Real time applications.

UNIT II HTML5 AND CSS 9

HTML: Introduction –HTML, XML, MHTML - 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 III JAVA SCRIPT 9

Data types and Variables - Operators, Expressions, and Statements -Functions - Objects - Array, Date and Math related Objects - Document Object Model - Event Handling - Controlling Windows & Frames and Documents - Form handling and validations.

UNIT IV PHP 9

Introduction - Programming basics - Print/echo - Variables and constants – Strings and Arrays – Operators, Control structures and looping structures – Functions – Reading Data in Web Pages - Embedding PHP within HTML – Establishing connectivity with database.

UNIT V GEOSERVER 9

Introduction – Web Administration – Geo server data directory –loading and working with data – shape file – PostGIS file – other web format data - styling the layers – services: WMS, WFS, WCS – security – demos and case studies on Geo server.

TOTAL : 45 PERIODS

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:

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CO – PO Mapping – WEB TECHNOLOGY PROGRAMMING FOR GIS

PO / PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge		M	L	M	L	L
PO2	Problem Analysis	M	L	M	L	H	M
PO3	Design / Development of Solutions	M	M	L	L	M	M
PO4	Conduct Investigation of Complex Problems		M	L	M	L	M
PO5	Modern Tool Usage	L	L	M	L	M	L
PO6	The Engineer and society						
PO7	Environment and Sustainability						
PO8	Ethics						
PO9	Individual and Teamwork						
PO10	Communication						
PO11	Project Management and Finance	L	M	L	M	M	M
PO12	Life Long Learning	L	M	L	L	L	L
PSO1	Knowledge of Remote Sensing and Geometics Engineering Discipline	L	L	L	L	H	L
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and Innovation	M	L	L	M	M	M
PSO3	Conceptualizaton and Evaluation of Design solutions	L	L	L	L	H	L

RG5011 PYTHON AND R PROGRAMMING L T P C
3 0 0 3

OBJECTIVES:

- To expose students to various concepts and capabilities of python scripting language
- To familiarize students to write simple programs in python for spatial data storage and analysis
- To expose students to concepts and capabilities of R programming

UNIT I INTRODUCTION TO PYTHON 9

Scripting, Introduction to Python, Numbers and operators, Variables and Data types, Expressions, Decisions and Loops, Modules, File Access, loading Vector & Raster layers

UNIT II PROGRAMMING USING PYTHON 9

List, Dictionaries, Simple Functions, Simple Graphics, Image Processing, Design of Simple GUI, Instance Variables, functions for vector to raster conversion, georeferencing raster layer, creating a hillshade map

UNIT III OBJECT ORIENTATION IN PYTHON 9

Objects and Classes, Data-Modeling, Building a New Data structure, Inheritance and Polymorphism, Data Encryption, Threads and Processes, Search Algorithms, Basic Sort Algorithms

UNIT IV R PROGRAMMING BASICS 9

Introduction, Data types, Variables, Vectors, Scalars, Conclusion, Data Frames, Lists, Matrices, Arrays, Classes, Arithmetic and Boolean Operators and values, Structures, Control Statements, Loops, Recursion, Scoping Rules, Loop functions, Array and Matrices, Spatial programming

UNIT V DATA MANIPULATION AND DATA VISUALISATION 9

Functions, Math Functions, Linear Algebra Operation, Probability Distributions: Normal, Binomial, Poisson, Graphics, Creating Graphs, Customizing Graphs, Box plot, Histogram, Pie graph, Line chart, Scatterplot, Spatial Attribute Analysis

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1	Summarise the data types, variable, expressions and control statements used in python
CO2	Write simple programs in python for visualization and analysis of vector & image data
CO3	Analyse the object orientation capabilities of python and its applications in spatial analysis
CO4	Describe the data, variables, operators and functions available in R
CO5	Apply the R programming for analysis of spatial and non-spatial data and for visualisation

REFERENCES

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2. David I. Schneider, Introduction to Programming Using Python, 1st Edition, Pearson, ISBN: 9780134058221, 2016
3. Y. Daniel Liang, Introduction to Programming Using Python, 1st edition, Pearson, ISBN: 9780132747189, 2013
4. Lawhead Joel, QGIS Python Programming Cookbook,2nd Revised Edition, Packt Publishing, ISBN: 9781783984985, 2017.
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CO – PO Mapping – PYTHON AND R PROGRAMMING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	L			L		L
PO2	Problem Analysis			H		H	H
PO3	Design / development of solutions			M		M	M
PO4	Investigation		L	M		M	M
PO5	Modern Tool Usage		H	H		H	H
PO6	The Engineer and society						
PO7	Environment and Sustainability						

PO8	Ethics						
PO9	Individual and Team work						
PO10	Communication			M		M	M
PO11	Project Management and Finance			L		L	L
PO12	Life Long Learning	M			M		M
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	L			L		L
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation		M	M		M	M
PSO3	Conceptualization and evaluation of Design solutions			L		L	L

RG5012 INTERNET OF THINGS L T P C
3 0 0 3

OBJECTIVES:

- To understand Smart Objects and loT Architectures
- To learn about various !OT-related protocols
- To build simple loT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of loT
- To develop loT infrastructure for popular applications

UNIT I FUNDAMENTALS OF loT 9

Evolution of Internet of Things - Enabling Technologies - loT Architectures: oneM2M, loT World Forum (loTWF) and Alternative loT models - Simpiifiied loT Architecture and Core loT Functional Stack - Fog, Edge and Cloud in loT - Functioral blocks of an loT ecosystem - Sensors, Actuators, Smart Objects and Connecting Smart Objects

UNIT II loT PROTOCOLS 9

loT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11 ah and LoRaWAN - Network Layer: IP versions, Constrained Nodes and Constrained Networks - Optimizing IP for loT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks - Application Transport Methods: Supervisory Control and Data Acquisition - Application Layer Protocols: CoAP and MQTT

UNIT III DESIGN AND DEVELOPMENT 9

Design Methodology - Embedded computing logic - Microcontroller, System on Chips - loT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.

UNIT IV DATA ANALYTICS AND SUPPORTING SERVICES 9

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest - Role of Machine Learning - No SQL Databases - Hadoop Ecosystem - Apache Kafka, Apache Spark - Edge Streaming Analytics and Network Analytics - Xively Cloud for loT, Python Web Application Framework - Django -AWS for loT - System Management with NETGONF-YANG

UNIT V CASE STUDIES/INDUSTRIAL APPLICATIONS 9

Cisco loT system - IBM Watson loT platform - Manufacturing - Converged Plantwide Ethernet Model (CPwE) - Power Utility Industry - GridBlocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, the student should be able to:

- Explain the concept of loT.
- Analyze various protocols for loT.
- Design a Poe of an +o'T system using Rasperry Pi/Arduino
- Apply data analytics and use cloud offerings related to loT.
- Analyze applications of loT in real time scenario

CO1	To introduce the fundamentals, evolution, architecture and sensors of IOT.
CO2	To provide the protocols of IOT.
CO3	To provide the Design and Development of IOT system using the Embedded computing Logic.
CO4	To give the Data Analytics and supporting services for IOT system.
CO5	To present the case studies and Implementation of IOT system.

REFERENCES:

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2. Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach||, Universities Press, 2015
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4. Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
5. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things||, Springer, 2011.
6. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance your projects, 2nd Edition, O'Reilly_Media,_2011.
   https://www.arduino.cc/
   https://www.ibm.com/smarterplanet/us/en/?ca=v smarterplanet

CO-PO Mapping - INTERNET OF THINGS

PO / PSO		Course Outcome						Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	CO1	
PO1	Engineering Knowledge	M	L	M	M	M		M
PO2	Problem Analysis	L	L	M	L	M		L
PO3	Design / Development of Solutions	M	M	H	M	M		M
PO4	Conduct Investigation of Complex Problems	L	M	L	M	M		M
PO5	Modern Tool Usage	M	L	M	M	M		M
PO6	The Engineer and Society							
PO7	Environment and Sustainability							
PO8	Ethics							
PO9	Individual and Teamwork							
PO10	Communication							
PO11	Project Management and Finance							
PO12	Life Long Learning							
PSO1	Knowledge of Remote Sensing and Geometics Engineering Discipline							

PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and Innovation							
PSO3	Conceptualizaton and Evaluation of Design solutions							

RG5013 GEOMATICS FOR ENVIRONMENTAL MONITORING AND MODELLING L T P C
3 0 0 3

OBJECTIVE:

- To understand the various remote sensing and GIS technological applications in the field of Environmental Engineering.

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 - Spectral responses of clear and contaminated water –Aquifer Vulnerability: Intrinsic and specific vulnerability - DRASTIC, SINTACS – Ground Water Quality Modelling: MODFLOW, MT3D – Sea water Intrusion Modelling – pollution diffusion model in river - Case studies.

UNIT III AIR QUALITY 9

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 AERMOD, CALPUFF, ISCST3 and CALINE4 etc. - Remote Sensing to monitor atmosphere constituents - Case Studies.

UNIT IV SOLID WASTE MANAGEMENT 9

Definition – sources – identification of storage and collection location - Analysis of collection route - Site selection: Transfer station, Disposal site – Waste allocation – design of leachate and gas collection in sanitary landfills – 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 - Green house effect – Carbon cycle - case studies

TOTAL: 45 PERIODS

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 due to pollution

REFERENCES:

1. Allan Brimicombe, GIS, Environmental Modeling and Engineering, Second Edition, CRC Press, 2009.
2. Andrew Skidmore (Editor), 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
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7. Michele Campagna, GIS for sustainable development, CRC Press; 1st Edition, 2005.
8. Tchobanoglous George, Hilary Theisen, Samuel Vigi, Integrated Solid Waste Management, Mc Graw – Hill Inc, Singapore. 1993.
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, Hyderabad, 2003.

CO – PO Mapping – GEOMATICS FOR ENVIRONMENTAL MONITORING AND MODELLING

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge		M	M	M	M	M
PO2	Problem analysis		H	H	H		H
PO3	Design / development of solutions		H	H	H		H
PO4	Conduct Investigation of complex problems		M	M	M	M	M
PO5	Modern Tool Usage		M	M	M	M	M
PO6	The Engineer and society	M	H	H	H	H	H
PO7	Environment and Sustainability	M	H	H	H	H	H
PO8	Ethics		H	H	H	H	H
PO9	Individual and Team work		M	M	M	M	M
PO10	Communication		H	H	H	H	H
PO11	Project Management and Finance		H	H	H	H	H
PO12	Life Long Learning	H	H	H	H	H	H
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	H	M	M	M	M	M
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation		H	H	H	H	H
PSO3	Conceptualization and evaluation of Design solutions		H	H	H	H	H

RG5014 GEOMATICS FOR AGRICULTURE AND FORESTRY L T P C
3 0 0 3

OBJECTIVE:

- The content of this course enable the students to understand the application potentialities of remote sensing data separately and in combination with GIS techniques for Agriculture and Forestry.

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 modeling – crop condition assessment – command area monitoring and management – Microwave RS for crop inventory – Case studies

UNITII SOILMAPPING 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.

UNITIII DAMAGE ASSESSMENT 9

Detection of pest & diseases – Flood mapping and Assessments of crop loss – drought assessment – Land degradation – Soil erosion & sedimentation – Soil loss assessment – Soil conservation – Agriculture damage prediction modeling.

UNITIV 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

UNITV CLIMATICIMPACTOFAGRICULTUREANDFORESTRY 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

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 sub tropical 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, Third 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 – GEOMATICS FOR AGRICULTURE AND FORESTRY

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	M	M	M	M	M	M
PO2	Problem analysis	L	L	L		L	L
PO3	Design / development of solutions	H	H	M		H	H
PO4	Investigation	M	M	M		M	M
PO5	Modern Tool Usage	H	H	M	H	H	H
PO6	The Engineer and society	H	H			H	H
PO7	Environment and Sustainability						
PO8	Ethics						
PO9	Individual and Team work	H	H	M	H	H	H
PO10	Communication				H		
PO11	Project Management and Finance						
PO12	Life Long Learning	H	H	H		H	H
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	M	M	H	L	H	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation	L	L	H	M	H	H
PSO3	Conceptualization and evaluation of Design solutions	L	L	L	L	L	L

RG5015 GEOMATICS FOR URBAN PLANNING AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To expose students the relevance of Geomatics to Urban Planning and Management
- To introduce the latest developments in Remote Sensing methods useful for Urban Planning and Management
- To impart knowledge on possible applications of Geomatics for Urban planning and Management

UNIT I INTRODUCTION 9

Remote Sensing – Developments - Relevance inUrban Planning - Scope and Limitations –Scale and Resolution requirements – Spectral characteristics of Urban Features– High Resolution, Thermal, Hyperspectral and Microwave Remote Sensing for Urban Analysis – Stereo Data Products – Aerial and Ground based Sensors – UAVs – Laser Scanners

UNIT II REMOTE SENSING FOR URBAN MAPPING 9

Urban Area Definition and Characterization–Base Map Preparation – Urban Landuse Classification – Visual and Digital Techniques for Landuse Mapping - Urban Structure and Patterns– Urban LandCover Classification –Feature Extraction techniques –Change Detection – Sprawl Detection and Characterization - Mapping of Urban Morphology - Urban Heat Island –Building Typology

UNIT III GEOMATICS FOR URBAN PLANNING 9

Urban Information System– Master and Detailed Development Plans - Objectives and Contents of Plans – Role of Geomatics in Plan Formulation and Review – Population Estimation– Property Tax Assessment and Management - Urban Solid Waste Management Planning –Urban Renewal Planning – Utility Network Planning and Management – case studies

UNIT IV GEOMATICS FOR URBAN ANALYSIS 9

Geodemographic Analysis – Land Value Analysis -Optimization of Facility Locations - Site suitability Analysis for Infrastructure – Optimal Route Analysis - Accident Analysis –Road Alignment Planning - Traffic and Parking Studies - case studies.

UNIT V VISUALIZATION, SIMULATION AND MODELING OF URBAN AREAS 9

Urban Growth Modelling - Air quality indexing and mapping - Noise pollution modelling - 3D City Modelling –Flood Modeling in Urban Areas - Geomatics for Smart Cities –Recent Advancements - Case Studies

TOTAL :45 PERIODS

OUTCOMES:

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

CO1	Understand the Relevance and Limitations of various Remote Sensing data products in Urban Planning
CO2	Generate Spatial Information about Urban Areas from Remote Sensing data
CO3	Evaluate the use of Geomatics Technology for Efficient Urban Planning
CO4	Analyse Urban Elements and Events using Geomatics Technology
CO5	Understand the modeling tools used for Modellign Urban Systems

REFERENCES:

1. Netzband, Maik; Stefanov, William L.; Redman, Charles (Eds.), Applied Remote Sensing for Urban Planning, Governance and Sustainability, Springer, 1st Edition, 2007
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3. Jean-Paul Donnay, Michael John Barnsley, Remote sensing and urban analysis, 1st Edition, Taylor & Francis e-Library, 2005
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6. BasudebBhatta, Analysis of Urban Growth and Sprawl from Remote Sensing Data, 1st Edition, Springer-Verlag, 2010.

CO – PO Mapping – GEOMATICS FOR URBAN PLANNING AND MANAGEMENT

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	L	M	M	M	L	M
PO2	Problem Analysis		L	H	H	M	H
PO3	Design / development of Solutions		M		H	M	M
PO4	Conduct investigations of complex problems	L	L	H	H	M	H

PO5	Modern Tool Usage	M	H	H	H	H	H
PO6	The Engineer and society	L		M	M	M	M
PO7	Environment and Sustainability		L	L	L	M	L
PO8	Ethics						
PO9	Individual and Team work		M				M
PO10	Communication					L	L
PO11	Project Management and Finance	L	M	M	M	M	M
PO12	Life Long Learning						
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	L	H	H	H	M	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation		L		M	H	M
PSO3	Conceptualization and evaluation of Design solutions	M	M	H	H	H	H

RG5016 GEOMATICS FOR OCEAN AND COASTAL ZONE MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

- To familiarize the students about the basics and application of Remote Sensing and GIS in the field of Ocean Engineering and Coastal Management.

UNITI 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.

UNITII OCEAN GENERALSTUDIES 8

Physical properties of seawater–chemistry of seawater-Biological parameters–Oceanographic instruments–collection of watersamples–current measuring devices–deep sea coring devices.

UNITIII COASTAL ENGINEERING 8

Coastal Hydrodynamic–Coastal erosion-various protection structures-Estuaries and impact of coastal processes–Hydrodynamics of pollution dispersion-Modelling of suspended sediment.

UNITIV REMOTE SENSING APPLICATION FOR OCEAN 10

Various Satellite and sensors for Ocean and Coastal applications – Application of CZCS–chlorophyll and suspended sediment estimation–Retrieval of physical oceanographic parameters–seasurfacetemperature-significantwaveheight-windspeedandwinddirection- coastal Bathymetry–sea level rise.

UNITV COASTAL ZONE MANAGEMENT 10

Introduction – Major issues/problems –Thematicmapson coastal resources-wet land classification-mapping of shoreline changes - creation of CZIS –Coastal aquifer modelling-Integrated coastal zone Management–Resolving conflicton resources utilization.

TOTAL:45 PERIODS

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 bio-physical parameters through Remote observation.
CO5	Impart the skills required to identify and analyze the major coastal issues relevant to coastal resource and the applicability of Remote Sensing for its sustainable management.

REFERENCES

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2. Alasdair J. Edward, Remote Sensing Handbook for Tropical Coastalagement, UNESCO publishing, 2000.
3. GrantGross, M.,Oceangraphy, Merrill Publishing company,Columbus,U.S.A.,2002.
4. Karsten Manager, Shoreline Management Guidelines, DHI Water & Environment, Denmark, 2004.
5. Dean, R.G.nd Dalrymple, R.A.,Coastal Process with Engineering Application, Cambridge university press,Cambridge,2006.
6. PaulD.Komar,Beach process and sedimentation.PrenticeHallInc.,NewJersey,2002.
7. Robin Davidson-Arnott, Introduction to Coastal Processes and Geomorphology, Cambridge University Press, 2009

CO – PO Mapping – GEOMATICS FOR OCEAN AND COASTAL ZONE MANAGEMENT

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	H	H	M			H
PO2	Problem Analysis			H	M	H	H
PO3	Design / development of Solutions				H	H	H
PO4	Conduct Investigation of Complex problems	M	M	M	H	H	M
PO5	Modern tool usage				H	M	M
PO6	The Engineer and society				H	H	H
PO7	Environment and Sustainability				H	H	H
PO8	Ethics		M	M	H	H	M
PO9	Individual and Team work		H		M	H	H
PO10	Communication	M	M	M	H	H	H
PO11	Project Management and Finance			H	H	H	H
PO12	Life Long Learning	M	M	M	H	H	M
PSO1	Knowledge of Remote Sensing and Geomatics discipline			M	H	H	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering problems and innovation			H	H	H	H
PSO3	Conceptualization and evaluation of design solutions	M	M	M	H	H	M

RG5017 DISASTER MANAGEMENT AND GEOMATICS APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:

- To understand various types of disasters and infrastructural facilities available for managing disasters
- To understand disaster mitigation principles
- To understand the requirements for disaster preparedness, response and recovery
- To gain knowledge about safety evaluation of essential social infrastructures
- To expose the applications of remote sensing and GIS in disaster management

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 frame work 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

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 (2010), Disaster Management, Laxmi Publications, ISBN-10:9380386427, ISBN-13:978-9380386423.
2. Tushar Bhattacharya (2012), Disaster Science and Management, McGraw Hill India Education Pvt Ltd., ISBN-10: 1259007367, ISBN-13:978-1259007361.
3. Bell, F.G. Geological Hazards: Their assessment, avoidance and mitigation. E & F.N SPON Routledge, London. 1999.

4. George G. Penelis and Andreas J. Kappos - Earthquake Resistant concrete Structures. E & F.N SPON, London, 1997
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. 2011 Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi.
7. Kapur Anu 2010: Vulnerable India: A Geographical study of Disasters, IIAS and sage Publishers, New Delhi.

CO – PO Mapping – DISASTER MANAGEMENT AND GEOMATICS APPLICATIONS

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	M			M	M	M
PO2	Problem analysis	L		H	M	M	M
PO3	Design / development of solutions			H	H	M	H
PO4	Conduct Investigations of complex problems			H	H	H	H
PO5	Modern Tool Usage					H	H
PO6	The Engineer and society	H		H	H		H
PO7	Environment and Sustainability	H		H	M	M	H
PO8	Ethics	H	M	H			H
PO9	Individual and Team work	H	H	H			H
PO10	Communication	H	H	H			H
PO11	Project Management and Finance	M	M	H			M
PO12	Life Long Learning					H	H
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline			M		H	M
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation			L		H	M
PSO3	Conceptualization and evaluation of Design solutions	M	M	M	M	H	M

RG5018 GEOMATICS FOR TRANSPORTATION PLANNING AND MANAGEMENT **L T P C 3 0 0 3**

OBJECTIVES:

- To understand various highway geometric elements and surveys carried out for highway alignment
- To understand the factors involved urban transportation planning
- To expose the potential applications of remote sensing in transportation
- To expose the potential applications of GIS in transportation
- To impart knowledge on latest developments in transportation planning

UNIT I ENGINEERING SURVEYS AND GEOMETRIC DESIGN 9

Road ways and railways – development - necessity for planning – classification of roads and railways –Alignment surveys and investigations using conventional and remote sensing techniques (preliminary, reconnaissance and final location surveys) – 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 modeling - Traffic congestion - Plan evaluation and implementation - Planning and financing –Critiques of transportation modeling 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 TRANSPORT INTERACTION MODELS AND ITS 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

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 urban transportation planning
CO3	apply remote sensing technique 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. C.S. Papacostas, P.D. Prevedouros, Transportation Engineering and Planning, Prentice-Hall India, 2005 .
4. L.R.Kadiyali, Transportation Engineering, Khanna Book publishing Co (P) Ltd, New Delhi, 2016
5. C.Jotin Khisty and B.Kent Lall, Transportation Engineering-An Introduction, Prentice Hall of India Private Limited, New Delhi, 2002
6. Igor Ivan, Itzhak Benenson, Bin Jiang, Jiri Horak and James Haworth, Geoinformatics for Intelligent transportation System, Springer International Publishing AG, 2014
7. Barry Boots, Atsuyuki Okabe and Richard Thomas, Modelling Geographical Systems – Statistical and computational applications, Kluwer Academic Publishers, 2014.

CO – PO Mapping – GEOMATICS FOR TRANSPORTATION PLANNING AND MANAGEMENT

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	H		L	M		M
PO2	Problem analysis				H		H

PO3	Design / development of solutions	L			H	H	H
PO4	Conduct Investigations of complex problems	H			L		M
PO5	Modern Tool Usage	M		H	H		H
PO6	The Engineer and society	M				M	M
PO7	Environment and Sustainability	M	H			M	M
PO8	Ethics		L				L
PO9	Individual and Team work					M	M
PO10	Communication			H	H	H	H
PO11	Project Management and Finance		M				M
PO12	Life Long Learning					H	H
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline			H	H	M	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and innovation			H	H	M	H
PSO3	Conceptualization and evaluation of Design solutions	M	H	H	H	H	H

RG5019 GEOMATICS FOR HYDROLOGY AND WATER RESOURCES MANAGEMENT **L T P C 3 0 0 3**

OBJECTIVE:

- This subject deals with the basics of hydrology and also various remote sensing and GIS applications in the field of hydrology and water resources.

UNIT I FUNDAMENTALS OF HYDROLOGY **9**

Hydrological cycle – estimation of various components of hydrological cycle – clouds – rainfall – runoff – evaporation – transpiration – evapotranspiration – interception – depression storage – spectral properties of water – Case studies using Geomatics.

UNIT II DRAINAGE BASIN ASSESSMENT **9**

Watershed divide – stream networks – Delineation and codification of watersheds – basin morphometric analysis – linear, aerial, relief aspects – Rainfall - runoff modeling – urban hydrology –flood forecasting, risk mapping, damage assessment - soil moisture area – drought forecasting and damage assessment – mitigation - Mapping of snow covered area – snow melt runoff - Case studies using Geomatics.

UNIT III IRRIGATION AND WATER QUALITY **9**

Project investigation – implementation - maintenance stage - location of storage / diversion works – canal alignment – depth - area capacity curve generation - water quality parameters – physical, chemical, biological properties - water quality mapping and monitoring – correlation model for pollution detection and suspended sediment concentration– Case studies using Geomatics.

UNIT IV GROUND WATER **9**

Ground water prospects – surface water indicators – vegetation, geology, soil – aquifer parameters – well hydraulics – estimation of ground water potential – hydrologic budgeting – mathematical models – ground water modeling – sea water intrusion – modeling – Case studies using Geomatics.

UNIT V WATERSHED MANAGEMENT 9

Mapping and monitoring the catchment and command area – conjunctive use of surface and ground water – artificial recharge of groundwater – water harvesting structures – erosivity and erodability - Universal Soil Loss Equation – sediment yield – modeling of reservoir siltation – prioritization of watershed – modeling of sustainable development – information system for Natural resource management – Case studies using Geomatics.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course students shall be able to

CO1	Understand the challenges faced by the scientific community in the management of water in the past as well as present situation in the face of ever changing climate and socioeconomic condition.
CO2	Develop knowledge on the previously used scientific methods and environment development with particular reference to the environment status and scope of geospatial technology to address the WRM issues.
CO3	Comprehend the current research trends and the remote sensing data sources, products and tools that are of value along with their limitation so as to find solutions to the issue of various phenomena and domain of WRM.
CO4	Analyze the complicated and multi source and layered problems of water resources management with state of the art, tools and techniques for sustained livelihood.
CO5	Apply the knowledge in the conceptualization of extraction and implementation of the Geospatial based solutions sets and to interpret them with tools from ancillary sources for dependable policy making.

REFERENCES:

1. Eric C. Barrett, Clare H.Power, Satellite Remote Sensing for Hydrology and Water Management, Gordon @ Breach Science publications - New York 1998.
2. Dr. David Maidment, Dr. Dean Djokic, Hydrologic and Hydraulic Modeling Support with Geographic Information Systems, Esri Press 2000,
3. Wilfried Brutsaert, Hydrology: An Introduction Cambridge University Press, 2005.
4. Andy D. Ward and Stanley W. Trimble, Environmental Hydrology, 3rd Edition, Lewis Publishers, 2015.
5. U.M. Shamsi, GIS Applications for Water, Wastewater, and Storm water Systems, CRC; Ist edition 2005.
6. Hoalst-Pullen, Nancy; Patterson, Mark W; Geospatial Technologies in Environmental Management, 2012, Springer.
7. Baxter E nieux," Distributed hydrologic modeling using GIS, Springer, Third Edition, 2016.

CO – PO Mapping – GEOMATICS FOR HYDROLOGY AND WATER RESOURCES MANAGEMENT

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering knowledge	L	M	H	H	H	H
PO2	Problem analysis	L	M	M	H	H	H
PO3	Design / development of solutions	L	L	M	M	H	H
PO4	Conduct Investigations of complex problems	L	L	M	H	H	H
PO5	Modern Tool Usage	L	L	H	H	H	H
PO6	The Engineer and society	L	L	M	M	H	H
PO7	Environment and Sustainability	M	M	M	M	H	H
PO8	Ethics	H	H	H	H	H	H
PO9	Individual and Team work	M	M	L	L	M	M
PO10	Communication	M	M	M	M	H	M

PO11	Project Management and Finance	L	L	M	H	H	M
PO12	Life Long Learning	H	H	M	H	H	H
PSO1	Knowledge of Remote Sensing and Geomatics Engineering discipline	L	L	H	M	H	H
PSO2	Critical analysis of Remote Sensing and Geomatics Engineering issues and Innovations	L	L	M	M	H	H
PSO3	Conceptualization and evalution of design solutions.	L	L	L	H	H	H

OPEN ELECTIVE COURSES (OEC)

OE5091 BUSINESS DATA ANALYTICS L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student will be able to:

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.

5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

Business Data Analytics

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

OE5092 INDUSTRIAL SAFETY L T P C
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING 9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive

maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn ,Foundation Engineering Handbook, Chapman & Hall London,2013.
4. Higgins & Morrow , Maintenance Engineering Handbook,Eighth Edition,2008

OE5093 OPERATIONS RESEARCH LT P C
3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method,Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member,Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES

CO1 – Understand the costing concepts and their role in decision making
CO2–Understand the project management concepts and their various aspects in selection
CO3–Interpret costing concepts with project execution
CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE5095 COMPOSITE MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓	✓	✓	✓						✓	
CO3			✓	✓	✓		✓				✓	
CO4			✓	✓	✓		✓				✓	
CO5				✓	✓		✓					

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 **WASTE TO ENERGY** **L T P C**
3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNITI INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNITII BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNITV BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓		✓							✓

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990

AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX5092 **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS 6

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES 6

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS 6

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

AX5094 **VALUE EDUCATION** **L T P C**
2 0 0 0

OBJECTIVES
Students will be able to
- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I
Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III
Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.
Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV
Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to
- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

Suggested reading
1. Chakroborty, S.K.“Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

AX5095 **CONSTITUTION OF INDIA** **L T P C**
2 0 0 0

OBJECTIVES
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

District's Administration head: Role and Importance, • Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION:

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

Suggested reading

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX5096 PEDAGOGY STUDIES L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Suggested reading

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

AX5097 STRESS MANAGEMENT BY YOGA L T P C
2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do‘s and Don’t’s in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING

1. ‘Yogic Asanas for Group Tarining-Part-I”:Janardan Swami Yoga bhyasi Mandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses-29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont’s) - Verses-71,73,75,78 (do’s)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

Suggested reading

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari’s Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.