ANNA UNIVERSITY, CHENNAI
NON AUTONOMOUS AFFILIATED COLLEGES
REGULATIONS 2021

M.TECH. REMOTE SENSING AND GIS

CHOICE BASED CREDIT SYSTEM

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

Graduates of the Programme M.Tech Remote Sensing and GIS will

PEO1 To prepare students to excel in research or to succeed in Remote Sensing and GIS profession through global, rigorous post graduate education.

PEO2 To provide students with a solid foundation in mathematical, scientific and engineering fundamentals, concepts and applications leading to modelling of earth resources management for solving Remote Sensing and Geomatics problems.

PEO3 To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate Remote Sensing and Geomatics issues to broader social context.

PEO4 To provide student with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career.

2. PROGRAMME OUTCOMES (POs):

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.
PO2: An ability to write and present a substantial technical report/document.
PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PSO1: Demonstrate in-depth knowledge of Remote Sensing and GIS engineering discipline with an ability to evaluate, analyse and synthesise existing and new knowledge.
PSO2: Critically analyze complex Remote Sensing and GIS problems, apply independent judgment for synthesizing information and make innovative advances in a theoretical, practical and policy context.
PSO3: Conceptualize and solve Remote Sensing and GIS 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

3. PEO/PO Mapping:

PEO	PO					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
I.	3	2	3	3	3	3
II.	2	3	3	2	3	2
III.	3	3	2	3	3	3
IV.	3	3	3	3	2	3

(3-High, 2- Medium, 1- Low)

MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Statistical Methods for Engineers	1.6	0.8	2.6	-	-	-
		Remote Sensing	2.4	3	2.8	2.6	1.6	2
		Geographical Information System	2.4	3	3	2.6	2.4	2
		Advanced Surveying	2.4	2.	2.8	1.6	2.2	2.4
		Research Methodology and IPR						
		Professional Elective I						
		Audit Course I*						
		Geographical Information System Laboratory	2.4	2.6	2.6	2.6	2.4	2.4
		Remote Sensing Laboratory	2.4	2.6	2.6	2.8	1.6	1.6
	SEMESTER II	Photogrammetry	3	3	3	3	2	3
		Satellite Image Processing	3	2	2	3	3	3
		Professional Elective II						
		Professional Elective III						
		Programming for Spatial Data Processing	3	2	2	3	3	3
		Audit Course II*						
		Satellite Image Processing Laboratory	3	3	3	3	3	3
		Photogrammetry Laboratory	3	3	3	2	3	3
YEAR II	SEMESTER III	Matlab Programming	3	3	2	3	3	3
		Professional Elective IV						
		Professional Elective V						
		Open Elective						
		Project Work I	3	3	3	3	3	3
		Practical Training (4 Weeks)	3	3	3	3	3	3
	SEMESTER IV	Project Work II	3	3	3	3	3	3

PROFESSIONAL ELECTIVE COURSES [PEC]

S. NO.	COURSE TITLE	PO1	PO2	PO3	PO4	PO5	PO6
1.	Geodesy	3	2	3	2	3	3
2.	Soft Computing Techniques	3	3	3	3	3	3
3.	Internet of Things	3	2	3	2	3	2
4.	GIS Applications	3	3	3	2	3	3
5.	Thermal and Hyper Spectral Remote Sensing	3	2	3	3	3	2
6.	Disaster Management and Geomatics Applications	3	3	3	3	3	3
7.	Geomatics for Hydrology and Water Resources Management	3	3	3	3	3	3
8.	Microwave Remote Sensing	3	3	3	3	3	3
9	Python and R Programming	3	3	3	3	3	3
10.	Geomatics for Urban Planning and Management	3	3	3	3	3	2
11.	Laser Scanning for Terrain Mapping	3	3	3	3	3	3
12.	Geomatics for Ocean and Coastal Zone Management	3	3	3	3	3	2
13.	Planetary Remote Sensing	3	3	3	3	3	3
14.	Spatial Data Modelling	3	3	3	3	3	3
15.	Web Technology Programming for GIS	3	2	3	3	3	3
16.	Satellite Meteorology	3	3	3	3	3	3
17.	Geomatics for Environmental Monitoring and Modeling	3	3	3	3	3	3
18.	Geomatics for Agriculture and Forestry	3	3	3	3	3	3
19.	Geomatics for Transportation Planning and Management	3	3	3	3	3	3

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CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABUS

SEMESTER I

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4159	Statistical Methods for Engineers	FC	4	0	0	4	4
2.	RS4101	Remote Sensing	PCC	3	0	0	3	3
3.	RS4102	Geographical Information System	PCC	3	0	0	3	3
4.	RS4103	Advanced Surveying	PCC	3	0	2	5	4
5.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Professional Elective I	PEC	3	0	0	3	3
7.		Audit Course I*	AC	2	0	0	2	0
PRACTICALS								
8.	RS4111	Geographical Information System Laboratory	PCC	0	0	4	4	2
9.	RS4112	Remote Sensing Laboratory	PCC	0	0	4	4	2
			TOTAL	**20**	**0**	**10**	**30**	**23**

*** Audit Course is optional**

SEMESTER II

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	RS4201	Photogrammetry	PCC	3	0	0	3	3
2.	RS4202	Satellite Image Processing	PCC	3	0	0	3	3
3.		Professional Elective II	PEC	3	0	0	3	3
4.		Professional Elective III	PEC	3	0	0	3	3
5.	RS4203	Programming for Spatial Data Processing	PCC	2	0	2	4	3
6.		Audit Course II*	AC	2	0	0	2	0
PRACTICALS								
7.	RS4211	Satellite Image Processing Laboratory	PCC	0	0	4	4	2
8.	RS4212	Photogrammetry Laboratory	PCC	0	0	4	4	2
			TOTAL	**16**	**0**	**10**	**26**	**19**

*** Audit Course is optional**

SEMESTER III

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	RS4301	Matlab Programming	PCC	2	0	2	4	3
2.		Professional Elective IV	PEC	3	0	0	3	3
3.		Professional Elective V	PEC	3	0	0	3	3
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	RS4311	Project Work I	EEC	0	0	12	12	6
6.	RS4312	Practical Training (4 Weeks)	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.	RS4411	Project Work 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.	MA4159	Statistical Methods for Engineers	4	0	0	4	1

PROFESSIONAL CORE COURSES (PCC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RS4101	Remote Sensing	3	0	0	3	1
2.	RS4102	Geographical Information System	3	0	0	3	1
3.	RS4103	Advanced Surveying	3	0	2	4	1
4.	RS4111	Geographical Information System Laboratory	0	0	4	2	1
5.	RS4112	Remote Sensing Laboratory	0	0	4	2	1
6.	RS4201	Photogrammetry	3	0	0	3	2
7.	RS4202	Satellite Image Processing	3	0	0	3	2
8.	RS4203	Programming for Spatial Data Processing	2	0	2	3	2
9.	RS4211	Satellite Image Processing Laboratory	0	0	4	2	2
10.	RS4212	Photogrammetry Laboratory	0	0	4	2	2
11.	RS4301	Matlab Programming	2	0	2	3	3
					TOTAL CREDITS	**30**	

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1
TOTAL CREDITS						**2**	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RS4311	Project Work I	0	0	12	6	3
2.	RS4312	Practical Training (4 Weeks)	0	0	0	2	3
3.	RS4411	Project Work II	0	0	24	12	4
TOTAL CREDITS						**20**	

LIST OF PROFESSIONALELECTIVE COURSES [PEC]

SEMESTER I, ELECTIVE I

S. NO.	COURSE CODE	COURSETITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	RS4001	Geodesy	3	0	0	3	3
2.	RS4002	Soft Computing Techniques	3	0	0	3	3
3.	RS4003	Internet of Things	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. NO.	COURSE CODE	COURSETITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	RS4004	GIS Applications	3	0	0	3	3
2.	RS4005	Thermal and Hyper Spectral Remote Sensing	3	0	0	3	3
3.	RS4006	Disaster Management and Geomatics Applications	3	0	0	3	3
4.	RS4007	Geomatics for Hydrology and Water Resources Management	3	0	0	3	3

SEMESTER II, ELECTIVE III

S. NO.	COURSE CODE	COURSETITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	RS4008	Microwave Remote Sensing	3	0	0	3	3
2.	RS4009	Python and R Programming	3	0	0	3	3
3.	RS4010	Geomatics for Urban Planning and Management	3	0	0	3	3
4.	RS4011	Laser Scanning for Terrain Mapping	3	0	0	3	3

SEMESTER III, ELECTIVE IV

S. NO.	COURSE CODE	COURSETITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	RS4012	Geomatics for Ocean and Coastal Zone Management	3	0	0	3	3
2.	RS4013	Planetary Remote Sensing	3	0	0	3	3
3.	RS4014	Spatial Data Modelling	3	0	0	3	3
4.	RS4015	Web Technology Programming for GIS	3	0	0	3	3

SEMSTER III, ELECTIVE V

S. NO.	COURSE CODE	COURSETITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	RS4016	Satellite Meteorology	3	0	0	3	3
2.	RS4017	Geomatics for Environmental Monitoring and Modeling	3	0	0	3	3
3.	RS4018	Geomatics for Agriculture and Forestry	3	0	0	3	3
4.	RS4019	Geomatics for Transportation Planning and Management	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.	AX4091	English for Research Paper Writing	2	0	0	0	**1/2**
2.	AX4092	Disaster Management	2	0	0	0	
3.	AX4093	Constitution of India	2	0	0	0	
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0	

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OIC431	Blockchain Technologies	3	0	0	3
2.	OIC432	Deep Learning	3	0	0	3
3.	OME431	Vibration and Noise Control Strategies	3	0	0	3
4.	OME432	Energy Conservation and Management in Domestic Sectors	3	0	0	3
5.	OME433	Additive Manufacturing	3	0	0	3
6.	OME434	Electric Vehicle Technology	3	0	0	3
7.	OME435	New Product Development	3	0	0	3
8.	OBA431	Sustainable Management	3	0	0	3
9.	OBA432	Micro and Small Business Management	3	0	0	3
10.	OBA433	Intellectual Property Rights	3	0	0	3
11.	OBA434	Ethical Management	3	0	0	3
12.	ET4251	IoT for Smart Systems	3	0	0	3
13.	ET4072	Machine Learning and Deep Learning	3	0	0	3
14.	PX4012	Renewable Energy Technology	3	0	0	3
15.	PS4093	Smart Grid	3	0	0	3
16.	CP4391	Security Practices	3	0	0	3
17.	MP4251	Cloud Computing Technologies	3	0	0	3
18.	IF4072	Design Thinking	3	0	0	3
19.	MU4153	Principles of Multimedia	3	0	0	3
20.	DS4015	Big Data Analytics	3	0	0	3
21.	NC4201	Internet of Things and Cloud	3	0	0	3
22.	MX4073	Medical Robotics	3	0	0	3
23.	VE4202	Embedded Automation	3	0	0	3
24.	CX4016	Environmental Sustainability	3	0	0	3
25.	TX4092	Textile Reinforced Composites	3	0	0	3
26.	NT4002	Nanocomposite Materials	3	0	0	3
27.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

SUMMARY

S. No	Name of the Programme: M. TECH. REMOTE SENSING AND GIS					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	14	13	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**	**23**	**19**	**20**	**12**	**74**

MA4159 STATISTICAL METHODS FOR ENGINEERS

L	T	P	C
4	0	0	4

OBJECTIVES :

- This course is designed to provide the solid foundation on topics in various statistical methods which form the basis for many other areas in the mathematical sciences including statistics, modern optimization methods and risk modeling. It is framed to address the issues and the principles of estimation theory, testing of hypothesis, correlation and regression, design of experiments and multivariate analysis.

UNIT I ESTIMATION THEORY 12

Estimators : Unbiasedness, Consistency, Efficiency and sufficiency – Maximum likelihood estimation – Method of moments.

UNIT II TESTING OF HYPOTHESIS 12

Sampling distributions - Small and large samples -Tests based on Normal, t, Chi square, and F distributions for testing of means, variance and proportions – Analysis ofr 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 co - efficient.

UNIT IV DESIGN OF EXPERIMENTS 12

Analysis of variance – One way and two way classifications – Completely randomized design – Randomized block design – Latin square design - 2^2 Factorial 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 :

After completing this course, students should demonstrate competency in the following topics:

- Consistency, efficiency and unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.
- Use statistical tests in testing hypotheses on data.
- Concept of linear regression, correlation, and its applications.
- List the guidelines for designing experiments and recognize the key historical figures in Design of Experiments.
- Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality.

The students should have the ability to use the appropriate and relevant, fundamental and applied mathematical and statistical knowledge, methodologies and modern computational tools.

REFERENCES :

1. Gupta.S.C., and Kapoor, V.K., “Fundamentals of Mathematical Statistics”,12th Edition, Sultan Chand and Sons, 2020.
2. Jay L. Devore, “Probability and statistics for Engineering and the Sciences”,8th Edition, Cengage Learning, 2020, 9th edition.
3. Johnson, R.A., Miller, I and Freund J., "Miller and Freund’s Probability and Statistics for Engineers", 9th Edition, Pearson Education, Asia, 2016.
4. Johnson, R.A. and Wichern, D. W. “Applied Multivariate Statistical Analysis”, 6th Edition, Pearson Education, Asia, 2018.
5. Rice, J.A. "Mathematical Statistics and Data Analysis", 3rd Edition, Cengage Learning, 2013.

COs- PO's & PSO's MAPPING

	PO01	PO02	PO03	PO04	PO05	PO06
CO1	2	1	3	-	-	-
CO2	2	1	3	-	-	-
CO3	2	1	3	-	-	-
CO4	-	-	1	-	-	-
CO5	2	1	3	-	-	-
Avg.	**1.6**	**0.8**	**2.6**	**-**	**-**	**-**

RS4101 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
- To extract useful information from satellite images

UNITI PHYSICS OF REMOTE SENSING 9

Remote Sensing - Definition - 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 -

UNITII 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 SENSORS 9

Classification of remote sensors – selection of sensor parameters - resolution concept - Spectral, Radiometric and temporal resolution – Quality of images – imaging mode – photographic camera – opto-mechanical scanners – pushbroom and whiskbroom cameras – Panchromatic, multi spectral , thermal,hyperspectral scanners and microwave sensors – geometric characteristics of scannerimagery –Operational Earth resource satellites - Landsat, SPOT, IRS, WorldView, hyperion and hysis, ERS, ENVISAT,Sentinel.

UNITIV 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

UNITV 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.- hybridclassification techniques – Knowledge based classification, Neural Network Classification, Fuzzy Classification.

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, 2017.
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. George Joseph, Fundamentals of Remote Sensing, Third Edition, Universities Press (India) Pvt Ltd, Hyderabad, 2018

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	2	2	3	3	2.4
PO2	3	3	3	3	3	3
PO3	3	3	3	2	3	2.8
PSO1	3	2	2	3	3	2.6
PSO2	1	2	2	1	2	1.6
PSO3	2	1	2	2	3	2

RS4102 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 – Digital Cartography concepts. - 3D 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 Merits - Architecture – Map Server – Spatial Data Infrastructure –Spatial Data Standards – OGC 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. Kang-tsung Chang, Introduction to Geographic Information Systems: 9th Edition, 9781259929649, McGraw-Hill Education, 2018
2. Lo, C.P. and Yeung, Albert K.W., Concepts and Techniques of Geographic Information Systems, Pearson, 2018, 9th edition.
3. Ian Heywood, Sarah Cornelius, Steve Carver, An Introduction to Geographical Information Systems, Pearson Education, 4th Edition, 2011.
4. Michael N. DeMers, Fundamentals of geographic information systems, Wiley, 2012, 4th edition
5. Borden D Dent, Jeff Torguson, Thomas W. Hodler, Cartography: Thematic Map Design 6th Edition, ISBN-13: 978-0072943825 McGraw-Hill Education – Europe, 2008

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	2	3	3	2	2.4
PO2	3	3	3	3	3	3
PO3	3	3	3	3	3	3
PSO1	2	2	3	3	3	2.6
PSO2	2	2	3	3	2	2.4
PSO3	2	2	2	3	2	2.2

RS4103 ADVANCED SURVEYING LT 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

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 ELECTRO OPTICAL AND MICRO WAVE TOTAL STATION 9+6

Computation of group Refractive Index for light, near infrared and microwaves - First velocity correction and Second velocity correction - 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.. Care and maintenance of Total Station instruments – Applications of COGO functions -Traversing and Trilateration – Topographic mapping - Recent trends.

UNIT III GPS SATELLITE SYSTEM AND DATA PROCESSING 9+6

GPS - Segments - Space, Control and User segments - satellite configuration - GPS signal structure - Orbit determination and representation - Anti Spoofing and Selective Availability - GPS receivers- GPS observables - code and carrier phase observation - linear combination and derived observables - concept of parameter estimation – 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 – Case studies.

UNIT IV LASER SCANNING 9+6

Airborne Topographic Laser Scanner – Ranging Principle – Pulse Laser and Continuous Wave Laser – First Return and Last Return – Ellipsoidal and Geoidal Height - Airborne Laser Scanner (ALS) – Components of ALS - GPS, IMU, LASER Scanner, Imaging Device - Terrestrial Laser Scanners (TLS) – Working Principle – Static, Dynamic and Vehicle Mounted TLS - Space Borne LiDAR Missions – Space Borne Radar Altimeter for mapping Sea Surface Topography.

UNIT V INTRODUCTION TO GEODESY 9+6

Definitions – Histrory, Classifications, Applications, Problem and purpose of Geodesy -. Reference Surfaces and their relationship. Engineering, Lunar, Planetary and interferometric Synthetic aperture radar Geodesy – Local and International Spheroid - Geometry of ellipsoid - fundamental mathematical relationship of Geodetic, Geocentric and Reduced latitudes and their relationship- Ellipsoidal Co-ordinates in terms of Reduced, Geodetic and Geocentric latitude.

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, 4th edition.
2. Satheesh Gopi, rasathishkumar, N.madhu, — Advanced Surveying , Total Station GPS and Remote Sensing — Pearson education , 2017, Second Edition.
3. Laurila, S.H. Electronic Surveying in Practice, John Wiley and Sons Inc, 1983.
4. Guocheng Xu, GPS Theory, Algorithms and Applications, Springer - Verlag, Berlin, 3rd Edition,2016.

5. Alfred Leick, GPS satellite surveying, John Wiley & Sons Inc., 4th Edition,2015.
6. Seeber G, Satellite Geodesy, Walter De Gruyter, Berlin, 2003, Revised Edition.
7. Petr Vanicek and Edward J. Krakiwsky, Geodesy: The concepts, North-Holland Publications Co., Amsterdam,2014, 2nd edition.
8. George Vosselman and Hans-Gerd Maas, Airborne and Terrestrial Laser Scanning, Whittles Publishing, 2014.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	1	2	3	3	3	2.4
PO2	3	3	3	2	3	2.8
PO3	2	3	3	3	3	2.8
PSO1	1	1	2	2	2	1.6
PSO2	2	2	2	3	2	2.2
PSO3	2	2	3	3	2	2.4

RM4151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

UNIT I RESEARCH DESIGN 6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS 6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL :30 PERIODS

REFERENCES

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

RS4111 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
7. Vector Analysis – Buffering, Overlay and Network analysis
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
13. Customisation and scripting
14. Mini Project :on the above relevant topics

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, 2018, 9th edition.
2. Ian Heywood, Sarah Cornelius, Steve Carver, An Introduction to Geographical Information Systems, Pearson Education, 4th Edition, 2011.
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, 4th edition.
6. Paul A. Longley, Michael F. Goodchild , David J. Maguire , David W. Rhind, Geographic Information Science and Systems, John Wiley & Sons Inc, 2015, 4th edition, ISBN 978111867695.
7. Tor Bernhardsen, Geographic Information Systems an Introduction, Willey, 3rd Edition, 2002.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	1	3	3	2	3	2.4
PO2	3	2	2	3	3	2.6
PO3	2	3	2	3	3	2.6
PSO1	3	3	2	2	3	2.6
PSO2	2	2	3	2	3	2.4
PSO3	2	2	3	2	3	2.4

RS4112 **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, 2017.
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, 3rd edition, 2021.
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,2nd edition, 2011

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	2	2	3	3	2.4
PO2	3	2	2	3	3	2.6
PO3	3	2	2	3	3	2.6
PSO1	3	3	3	3	2	2.8
PSO2	1	1	1	3	2	1.6
PSO3	1	1	1	3	2	1.6

RS4201 **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 stereogrammetry) – 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 relevant 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 assess 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.,2001, 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

COs- PO’s & PSO’s MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1		2	3	3	3	3
PO2	2	3	3	3	3	3
PO3	2	3	3	3	3	3
PSO1	2	3	2	3	3	3
PSO2	2	2	2	3	3	2
PSO3		2	2	3	3	3

RS4202 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’s Theorem – parametric Classification - Decision tree – other Non-parametric classifiers - sub-pixel and super-pixel classification - Hyper-spectral image analysis - Accuracy assessment.

UNIT V FEATURE EXTRACTION 9

Pattern recognition - boundary detection and representation - textural and contextual analysis - decision concepts: Fuzzy sets - evidential reasoning - Expert system concepts - Artificial Neural Network – Object based methods - recent trends- Case studies.

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, 2017.
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, 2013..
4. Digital Image Processing (4th Edition) Rafael C. Gonzalez, Richard E. Woods Prentice Hall, 2018, 4th edition.
5. W.G.Rees - Physical Principles of Remote Sensing, Cambridge University Press, 2nd edition, 2001.
6. Fundamentals of Digital Image Processing by Annadurai Pearson Education (2016)
7. Digital Image Processing: PIKS Scientific Inside by William K. Pratt 4th Edition,Wiley Interscience,2007.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1		2	2	3	3	3
PO2	2	2	2	3	3	2
PO3	2	2	2	3	3	2
PSO1	3	2	2	3	3	3
PSO2		2	2	3	3	3
PSO3		2	2	3	3	3

RS4203 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++ PROGRAMMING FUNDAMENTALS 6+6

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

UNIT III CLASSES AND 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, 6th 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,2006,
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.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1		2	2	3	3	3
PO2	2	2	2	3	2	2
PO3	2	2	2	3	2	2
PSO1		2	2	3	3	3
PSO2		2	2	3	3	3
PSO3			2	3	3	3

RS4211 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
16. Mini Project - MATLAB

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 2012.
4. Digital Image Processing by Rafael C. Gonzalez, Richard Eugene Woods- Pearson/ Prentice Hall,2018, 4th edition
5. Fundamentals of Digital Image Processing by Annadurai Pearson Education (2006)

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1			2	3	3	3
PO2	2	2	3	3	3	3
PO3	2	2	3	3	3	3
PSO1	2	3	3	3	3	3
PSO2		2	2	3	3	3
PSO3		2	2	3	3	3

RS4212 **PHOTOGRAMMETRY LABORATORY** **L T P C**
0 0 4 2

OBJECTIVE:

- To acquire practical knowledge in the field of Photogrammetry.

PHOTOGRAMMETRY EXERCISES

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

TOTAL :60 PERIODS

OUTCOMES:

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

CO1 Understand the basic concepts of stereovision perception.
CO2 Acquire the knowledge about the aerial photographs
CO3 Understand the basic concepts of 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., 2001, 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

COs- PO’s & PSO’s MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1		2	2	3	3	3
PO2	2	3	2	3	3	3
PO3	2	3	2	3	3	3
PSO1	2	2	2	3	3	2
PSO2	2	2	3	3	3	3
PSO3	2	2	3	3	3	3

RS4301 **MATLAB PROGRAMMING** **L T 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**

Basic Syntax - Variables and special variables – Commands - Operators – Data types and display formats – Array operations: array indexing, Scalar-matrix and matrices manipulations – Control structures – M-Files:Scripts and Functions – Solving linear equations – Differentiation and Integration.

UNIT II DATA VISUALIZATION AND MODELLING **6+6**

Plotting – Plots with multiple lines or functions - Subplots – Annotation: Title, axel title, color, label, data value, tic marks – bar, pie and polar graphs – Surface plots – contour generation - 3D plots - Regression analysis and presentation

UNIT III DIGITAL IMAGE PROCESSING WITH MATLAB **6+6**

Image types: Grey Scale, RGB and Indexed Color image – Basic Commands for Image reading, writing, displaying, reversing, mirroring, Image shift and image resize (Zoom in and Zoom out) – Image properties extraction – Image type conversions: HSI components extraction, image storage class conversion and graphics file formats conversion – Images in Bit planes – Histogram plotting – Image Noise : Salt and Pepper noise, Gaussian noise, Speckle noise and Periodic noise – Noise removal : methods of low pass and median filtering, outlier, Image averaging and Wiener filter.

UNIT IV SATELLITE IMAGE PROCESSING WITH MATLAB **6+6**

Pixel selection by pixval and impixel functions - Spatial resolution – Image enhancement: contrast stretching, histogram equalization and thresholding - Morphological operations :structure element, image dilation and erosion – Image convolutions : pillbox and Gaussian low pass filters and Edge enhancement :Sobel, prewitt and canny filters - display techniques : image rotate,image resize, image cropping – colorbar addition – image contouring – NDVI calculation – other image indices – Machine learning with Matlab : Unsupervise, Supervised learning methods - Support vector machine – model interpretability

UNIT V GIS WITH MATLAB **6+6**

Pixel relationships: neighbors of a pixel, adjacency, path between pixels and distance measures of pixels (Euclidean, Manhattan distance or city-block, shortest m-path distances) - image compaction techniques - Image arithmetic — Union, intersection and identity of images - Flow direction and flow accumulation calculation – image interpolation – Contour map from DEM –Transforms - affine transformation, collinearity, coplanarity and similarity.

TOTAL : 60 PERIODS

OUTCOMES:

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

CO1 Enable the student to understand basic MatLab functions and to know about the mathematical solvations
CO2 Enable to know about the concepts of visualization
CO3 Learn about the fundamental digital image processing functionalities
CO4 Learn about the tools and commands for satellite images to get proficient in map preparation
CO5 Acquire skills in space based operations using GIS

REFERENCES:

1. Holly Moore, " MATLAB for Engineers" Third Edition, 2011– Pearson Publications
2. Rafael C.Gonzalez, Richard E.Woods, Steven L.Eddins (2017) : Digital Image processing Using Matlab, Second Edition, MCGraw Hill Eduation,
3. Scott E Umbaugh, (2017), Digital Image Processing and Analysis Applications with Matlab and Cviptools, Taylor and Francis, Third Edition.

4. Giuseppe Ciaburro (2017):MATLAB for machine learning : Practical examples of regression, clustering and neural networks - Functions, Algorithms and use cases, Packt Publishing Limited.
5. Michael Paluszek and Stephanie Thomas , (2019): MATLAB Machine learning recipies: A Problem-Solution Approach.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1		2	3	2	3	3
PO2	2	2	3	3	3	3
PO3	2	2	2	3	3	2
PSO1	2	2	3	3	3	3
PSO2	2	2	3	3	3	3
PSO3	2	2	3	3	3	3

RS4311 **PROJECT WORK I** **L T P C**
0 0 12 6

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

OUTCOMES:

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

CO1 Identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
CO2 Develop the methodology to solve the identified problem.
CO3 Train the students in preparing project reports and
CO4 Face reviews and viva-voce examination
CO5 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.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	3	3	3	3	3
PO2	3	3	3	3	3	3
PO3	3	3	3	3	3	3
PSO1	3	3	3	3	3	3
PSO2	2	3	3	3	3	3
PSO3	2	3	3	3	3	3

RS4312 **PRACTICAL TRAINING (4 Weeks)** **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.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	2	3	3	3	3
PO2	2	3	3	3	3	3
PO3	3	3	3	3	3	3
PSO1	2	2	3	3	3	3
PSO2	2	2	3	3	3	3
PSO3	2	2	3	3	3	3

RS4411 **PROJECT WORK 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

OUTCOMES:

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

CO1 Solve the identified problem based on the formulated methodology.
CO2 Develop skills to analyze and discuss the test results, and make conclusions.
CO3 Train the students in preparing project reports and
CO4 To face reviews and viva-voce examination
CO5 On completion of the project work students will be in a position to take up any challenging practical problem and find better solutions.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	3	3	3	3	3	3
PO2	3	3	3	3	3	3
PO3	3	3	3	3	3	3
PSO1	3	3	3	3	3	3
PSO2	3	3	3	3	3	3
PSO3	3	3	3	3	3	3

RS4001 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. Fundamental 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 2016
2. Howard goreJ., Elements of Geodesy, Kessinger publishing 2016.
3. Wolf gang torge, Geodesy, Walter De Gruyter Inc. Berlin, 4th Edition,2012.
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, 2014.
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.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1			2	3	3	3
PO2	2	2	2	3	3	2
PO3	2	2	3	3	3	3
PSO1	2	2	2	3	3	2
PSO2		2	3	3	3	3
PSO3		2	3	3	3	3

RS4002 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 ARTIFICIAL NEURAL NETWORKS 9

Introduction - soft computing vs. hard computing - soft computing techniques – applications - ANN : definition - Structure and Function of a single neuron: Biological neuron, artificial neuron, Taxonomy of neural net, Difference between ANN and human brain, characteristics and applications of ANN, single layer network, Perceptron training algorithm, Linear separability, Widrow & Hebbian learning rule/Delta rule, ADALINE, MADALINE - Introduction of MLP – Deep Learning concepts- Geomatic Applications.

UNIT II FUZZY SYSTEMS 9

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

UNIT III NEURO-FUZZY MODELLING 9

Adaptive Neuro-Fuzzy Inference Systems – Architecture – Hybrid Learning Algorithm – Learning Methods that Cross-fertilize ANFIS and RBFN – Coactive Neuro Fuzzy Modeling – Framework Neuron Functions for Adaptive Networks – Neuro Fuzzy Spectrum.

UNIT IV GENETIC ALGORITHM 9

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

UNIT V APPLICATIONS INGEOMATICS 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, 2006.
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.
5. Laurene Fauseett: Fundamentals of Neural Networks. Prentice Hall India, New Delhi,Pearson, 2004.
6. George J.Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall Inc., New Jersey,2008
7. Nih.J. Ndssen Artificial Intelligence, Harcourt Asia Ltd.,Singapore,1998

CO COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1		2	3	2	3	3
PO2	2	2	3	3	3	3
PO3	2	2	3	3	3	3
PSO1		2	3	2	3	3
PSO2	2	3	3	2	3	3
PSO3	2	3	3	3	3	3

RS4003 INTERNET OF THINGS LT 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 IoT 9

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

UNIT II IoT PROTOCOLS 9

IoT 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 IoT: 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 - IoT 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 IoT, Python Web Application Framework - Django -AWS for IoT - System Management with NETGONF-YANG

UNIT V CASE STUDIES/INDUSTRIAL APPLICATIONS 9

Cisco IoT system - IBM Watson IoT 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:

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:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete. Rob Barton and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017
2. Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach‖,Universities Press, 2015
3. Olivier Hersent, David Boswarthick, Omar Elloumi, —The Internet of Things – Key applications and Protocols‖, Wiley, 2012 (for Unit 2)
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,_2020.

https://www.arduino.cc/
https://www.ibm.com/smarterplanet/us/en/?ca=v smarter planet

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	2	3	3	3	3
PO2	2	2	3	3	3	3
PO3	2	2	3	3	3	3
PSO1			2	3	3	3
PSO2	2	2	3	3	3	3
PSO3	2	2	2	3	3	2

RS4004 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- Smart city applications.

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 - IoT based applications.

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 –

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, Tele geoinformatics: Location- based Computing and Services, CRC Press, 2007, 1st edition.
6. Allan Brimicombe, GIS Environmental Modeling and Engineering, Taylor & Francis,2nd edition 2010.
7. Van Dijk, M.G. Bos, GIS and Remote Sensing Techniques in Land-And-Water-Management, Kluwer Academic Publisher, 2013.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	3	3	3	3	3
PO2	2	3	3	3	3	3
PO3	2	3	3	3	3	3
PSO1	2	2	2	3	3	2
PSO2	2	2	3	3	3	3
PSO3	2	3	3	3	3	3

RS4005 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 – data products - thermal and optical RS for plant biophysics – hydrology, Forestry and Agriculture applications - case studies: UHI, forest fire, coal fires, mine fires and climate studies inputs.

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 optimization: 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 – moon and mars mission.

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 Interpret the hyperspectral data 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.

COs- PO’s & PSO’s MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1		2	2	3	3	3
PO2	2	2	2	3	3	2
PO3	2	3	3	3	3	3
PSO1	3	3	3	3	3	3
PSO2	2	2	3	3	3	3
PSO3	2	2	2	3	3	2

RS4006 DISASTER MANAGEMENT AND GEOMATICS APPLICATIONS L T P C

3 0 0 3

OBJECTIVES:

- To impart the students with fundamental concepts of disaster and applicability of Remote Sensing and GIS on disaster mitigation and management strategies.

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 – Utilization 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 (2019), Disaster Management, Laxmi Publications, ISBN-10:9380386427, ISBN-13:978-9380386423.
2. Tushar Bhattacharya (2017), 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, 2019
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 2016, 1st edition: Vulnerable India: A Geographical study of Disasters, IIAS and sage Publishers, New Delhi.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	3	3	3	3	3
PO2	2	3	3	3	3	3
PO3	2	3	3	3	3	3
PSO1	2	2	3	3	3	3
PSO2	2	2	3	3	3	3
PSO3	2	2	3	3	3	3

RS4007 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 erodibility - 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 1990.
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.
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COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	3	3	3	3	3
PO2	3	3	3	3	3	3
PO3	3	3	3	3	3	3
PSO1	2	2	3	3	3	3
PSO2	2	2	3	3	3	3
PSO3	2	2	3	3	3	3

RS4008 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 – Radar frequency bands - Antenna Configuration, SLAR- Imaging Geometry - Resolution Concepts, SAR – Concepts-Doppler principle &Processing System Parameters and fading concepts – SAR focusing, Geometric Distortions, Operational limitations, RADAR energy quantification, Interaction with Earth surface and vegetation , Scattering Models- Surface and volume scattering.

UNIT III 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 - Hybrid classification of optical microwave.

UNIT V TECHNIQUES AND APPLICATIONS 9

Polarimetry, interferometry, Altimetry, Scatterometry – Principles – Data & Resource availability – Principle & Applications in Agriculture, Forestry, ocean, Geology, Hydrology, cryospace studies, landuse mapping and ocean related studies

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Understand 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, 2017, Speckled Press; 1st edition,ISBN-13: 978-0415271233
3. Floyd.M.Handerson and Anthony, J.Lewis “Principles and applications of Imaging RADAR”, Manual of Remote sensing, 3rd edition, vol.2, ASPRS, Jhumurley and sons, Inc, 1998.
4. Philippe Lacomme,Jean clande Marchais,Jean-Philippe Hardarge and Eric Normant, Air and spaceborne radar systems - An introduction, Elsevier publications,1st Edition,2007.
5. Roger J Sullivan, Knovel, Radar foundations for Imaging and Advanced Concepts, SciTech Pub, 2004.
6. Ian Faulconbridge, Radar Fundamentals, Argos Press, 2nd Edition, 2019.
7. Eugene A.Sharkov,Passive Microwave Remote Sensing of the Earth: Physical Foundations,1st Edition, Springer, reprint 2010.

COs- PO’s & PSO’s MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1		2	2	3	3	3
PO2	2	3	2	3	3	3
PO3	2	3	3	3	3	3
PSO1	3	3	3	3	3	3
PSO2	2	2	3	3	3	3
PSO3	2	2	3	3	3	3

RS4009 **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

1. Larry Pace, Joshua Wiley, Beginning R -An Introduction to Statistical Programming, 2nd Edition, Apress, ISBN: 9781484203743, 2015
2. David I. Schneider, Introduction to Programming Using Python, 1st Edition, Pearson, ISBN: 9780134058221, 2015
3. Y. Daniel Liang, Introduction to Programming Using Python, 1st edition, Pearson, ISBN: 9780132747189, 2017
4. Lawhead Joel, QGIS Python Programming Cookbook,2nd Revised Edition, Packt Publishing, ISBN: 9781783984985, 2017.
5. Chaowei Yang, Introduction to GIS Programming and Fundamentals with Python and ArcGIS, 1st Edition,2017, CRC Press, ISBN: 9781466510081
6. Chris Brunsdon, Lex Comber, An Introduction to R for Spatial Analysis and Mapping, 1st Edition, Sage Publications Ltd (UK), ISBN: 9781446272954,2nd Edition, 2019.
7. Hamid Reza Pourghasemi, Spatial Modeling in GIS and R for Earth and Environmental Sciences, Elsevier (S&T), ISBN: 9780128152263, 2019

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1		2	3	3	3	3
PO2	2	2	3	3	3	3
PO3	2	2	3	3	3	3
PSO1	2	2	3	3	3	3
PSO2	2	2	3	3	3	3
PSO3		2	3	3	3	3

RS4010 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 in Urban 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 Modelling Urban Systems

REFERENCES:

1. Netzband, Maik; Stefanov, William L.; Redman, Charles (Eds.)¸Applied Remote Sensing for Urban Planning, Governance and Sustainability, Springer, 1st Edition, 2012
2. Rashed, Tarek; Jürgens, Carsten (Eds.), Remote Sensing of Urban and Suburban Areas, Springer, 1st Edition. 2010
3. Jean-Paul Donnay, Michael John Barnsley, Remote sensing and urban analysis, 1st Edition, Taylor & Francis e-Library, 2014,1st edition
4. QihaoWeng, Dale A. Quattrochi (Eds), Urban Remote Sensing, 2nd edition, CRC Press, 2020.
5. Soergel, Uwe (Eds.), Radar Remote Sensing of Urban Areas, Remote Sensing and Digital Image Processing, Vol. 15, 1st Edition, Springer, 2010
6. BasudebBhatta, Analysis of Urban Growth and Sprawl from Remote Sensing Data, 1st Edition, Springer-Verlag, 2010.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1		2	3	2	3	3
PO2	2	3	3	3	3	3
PO3	2	3	3	3	3	3
PSO1	3	3	3	3	3	3
PSO2	2	2	3	3	3	3
PSO3	2	2	3	2	3	2

RS4011 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-Space Technology Experiment (LITE), Chandrayaan, 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 - Synchronization of Laser Scanner and PoS- LASER Scanners Specification and Salient Features – Concept of Multi return – 3D Cloud Points – Reflectivity of Ground features – Range Correction Factor

UNIT III LIDAR DATA PROCESSING 9

Pre Processing: Direct Georeferencing, Combining Inertial and Navigation Data - Determination of optimal Flight Trajectory - Data processing – 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 Understand types of LASER and its classication, types of LiDAR and Satellite Laser Scanning Missions

CO2 Understand components of ALS, various scanning mechanism and concept of multi returns

CO3 Analyze and process the Navigation and Inertial data for optimal flight path selection and coordinate transformation techniques for geolocating laser foot prints

CO4 Apply derived products of ALS in various application domains with reference to case studies

CO5 Understand the concepts of TLS and ABS and its application

REFERENCES:

1. Jie Shan and Charles K. Toth, Topographic Laser Ranging and Scanning – Principles and Processing,Second Edition, CRC Press, Taylor & Francis Group, 2018
2. Pinliang Dong, Qi Chen, LiDAR Remote Sensing and Applications, 1st Edition, CRC Press 2018
3. George Vosselman and Hans-Gerd Maas, Airborne and Terrestrial Laser Scanning, Whittles Publishing, 2010.
4. Matti Maltamo, Erik Næsset, Jari Vauhkonen, Forestry Applications of Airborne Laser Scanning-Concepts and Case Studies, Springer, Dordrecht 2014, reprint edition, ISBN 978-94-017-8662-1
5. Michael Renslow, Manual of Airborne Topographic LiDAR, The American Society for Photogrammetry and Remote Sensing , 2013.
6. Zhilin Li, Qing Zhu, Chris Gold, Digital terrain modeling: principles and methodology, CRC Press, 2005
7. Roger Read and Ron Graham, Manual of Aerial Survey: Primary Data Acquisition, Whittles Publishing, 2002.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1		2	3	3	3	3
PO2	2	3	3	3	3	3
PO3	3	3	3	3	3	3
PSO1	3	3	3	3	3	3
PSO2	2	2	3	3	3	3
PSO3		2	3	3	3	3

RS4012 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 water samples–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–sea surface temperature-significant wave height – wind speed and wind direction- coastal Bathymetry–sea level rise.

UNITV COASTAL ZONE MANAGEMENT 10

Introduction – Major issues/problems –Thematic maps on coastal resources-wet land classification-mapping of shoreline changes - creation of CZIS –Coastal aquifer modelling-Integrated coastal zone Management–Resolving conflict on resources utilization – CRZ Mapping.

TOTAL:45 PERIODS

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

1. Vasilis D.Valavanis,GIS in oceanography &Fisheries, Taylor &Francis London & New York, 2002
2. Alasdair J. Edward, Remote Sensing Handbook for Tropical Coastalagement, UNESCO publishing, 2000.
3. GrantGross, M.,Oceangraphy, Merrill Publishing company,Columbus,U.S.A.,1996
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,2004.
6. PaulD.Komar,Beach process and sedimentation.PrenticeHallInc.,NewJersey,2nd edition, 1987.
7. Robin Davidson-Arnott, Introduction to Coastal Processes and Geomorphology, Cambridge University Press, 2019

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1		2	3	3	3	3
PO2	2	3	3	3	3	3
PO3	3	3	3	3	3	3
PSO1	3	3	3	3	3	3
PSO2	2	3	3	3	3	3
PSO3	2	2	2	3	3	2

RS4013 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 Identify the components of Solar System and understand the payloads of related exploratory missions
CO2 Understand the mineralogy and petrology of terrestrial planets
CO3 Describe the exo –endogenic process of Planetary Atmosphere
CO4 Apply Remote Sensing Techniques for Planetary Surface Analysis
CO5 Describe the various past and present planetary missions

REFERENCES:

1. Shuanggen Jin, Planetary Geodesy and Remote Sensing 1st Edition, CRC PRESS, 2019
2. Bo Wu, Kaichang Di, Jürgen Oberst, Irina Karachevtseva, Planetary Remote Sensing and Mapping 1st Edition, CRC Press,2018
3. Principles of Planetary Climate by Raymond T.Pierrehumbert, University of Chicago, Publication date: December 2010.
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,2-010
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

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	2	3	3	3	3
PO2	2	3	3	3	3	3
PO3	3	3	3	3	3	3
PSO1	3	3	3	3	3	3
PSO2		2	3	3	3	3
PSO3		2	3	3	3	3

RS4014 SPATIAL DATA MODELLING L T P C
3 0 0 3

OBJECTIVES :

- 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 GEOSPATIALMODELING 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 : 2D, 3D visualization – VR- AR concepts -Case studies

UNIT V MACHINE LEARNING TOOLS 9

Artificial Intelligence: definition,types – Expert system - sources of Knowledge-Knowledge Acquisition Methods - Representation schemes -types of inference: forward and backward chaining-Artificial Neural network-BPN-Fuzzy Logic- Integration with GIS- Case studies

TOTAL : 45 PERIODS

OUTCOMES:

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

CO1 Understand the descriptive and process spatial models
CO2 Understand model builder in GIS environment
CO3 Apply geostatistical analysis and modeling
CO4 Study various Spatio-Temporal 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), 2018, 1st Edition, SAGE Publications Ltd
4. Noel Cressie, Christopher K. Wikle,2011,Wiley Publishers, 1 edition, Statistics for Spatio-Temporal Data 1st Edition
5. Maguire, D., M. Batty, and M. Goodchild. 2005. GIS, spatial analysis, and modeling. ESRI Press, 2005
6. Andrew Crooks, Nick Malleson, Ed Manley, Alison Heppenstall, "Agent-Based Modelling and Geographical Information Systems": A Practical Primer (Spatial Analytics and GIS) 1st Edition,2019,
7. Mastering Geospatial Development with QGIS 3.x: An in-depth guide to becoming proficient in spatial data analysis using QGIS 3.4 and 3.6 with Python,Packt Publishing; 3 edition (28 March 2019)
8. TsungChang-Kang, Introduction to Geographic Information Systems, Tata McGraw Hill Publishing Company and Limited NewDelhi, 4th Edition, 2017.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1		2	3	3	3	3
PO2	2	2	3	3	3	3
PO3	2	3	3	3	3	3
PSO1	3	3	3	3	3	3
PSO2	2	2	3	3	3	3
PSO3		2	3	3	3	3

RS4015 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 ISPATIAL DATA STRUCTURES AND DATABASE MANAGEMENT 9

Spatial Data structures and Formats, Basic file formats (vector, raster) – JSON, GeoJSON, Geodatabase, Projections and EPSG Co-ordinate Systems, Attribute Tables – Spatial and Attribute Table linkage – Spatial Data modeling – design standards – Centralized / Distributed data model –

Spatial Database administration – Data management and optimization - OGC Web Map services - WMS, WFS, WCS, WPS – Styling, tiling & caching

UNIT II INTRODUCTION TO WEBGIS AND ARCHITECTURE 9

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

UNIT III WEB PROGRAMMING CONCEPTS 9

Design Principles – Programming basics - Variables and constants – Strings and Arrays – Operators, Control structures and looping structures – Procedure and Functions – Reading Data in Web Pages - Establishing connectivity with database Client Side Programming –- Web Security – Client Side and Server side Programming – Performance metrics and optimization – Single Page Applications - Software Stack –WebGIS clients – Webserver Software, Current Trends

UNIT IV INTRODUCTION TO HTML & CSS, JAVASCRIPT 9

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

UNIT V INTRODUCTION TO PHP, GEOSERVER 9

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

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:

1. Harvey & Paul Deitel & Associates, Harvey Deitel and Abbey Deitel, “Internet and World Wide Web - How To Program”, Fifth Edition, Pearson Education, 2011. ISBN- 13: 978-0132151009
2. Thomas Powell, "HTML & CSS: The Complete Reference" Fifth Edition, McGraw-Hill, 2017ISBN-13: 978-0071496292
3. Thomas Powell, Fritz Schneider "JavaScript The Complete Reference" 3rd Edition, TATA McGraw Hill, 2013 ISBN-13: 9781259064685
4. Steven Holzner, "PHP: The Complete Reference" 1st Edition TATA McGraw Hill ,2008 ISBN: 9780070223622
5. Stefano Iacovella, Brian Youngblood "GeoServer Beginner’s Guide" Packt Publishing , 2nd Revised Edition, 2017, ISBN-13: 978-1849516686
6. Scott Davis, GIS for Web Developers, Pragmatic Bookshell, 2007, ISBN: 0974514098
7. Anuj Tiwari, Kamal Jain, Concepts and Applications of WEBGIS, Nova Science Publishers,2017, ISBN-1536127795.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2		2	3	3	3
PO2	2	2	2	3	3	2
PO3	3	2	3	3	3	3
PSO1	3	2	3	3	3	3
PSO2	2	2	3	3	3	3
PSO3	2	2	3	3	3	3

RS4016 SATELLITE 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 Thornth waithe, energy in the atmosphere - Indian monsoons - weather systems and seasons, Indian Climatology - Radiation transfer- radiation spectrum – Absorption and emission of radiation by molecules- Radiation laws-scattering principles – atmospheric particles and radiations - Mechanism of cloud formation- Types of Clouds- Precipitation processes-weather stations, data, maps and symbols.

UNIT II RADIO METEOROLOGY 9

Principles and classifications of Radar- Meteorological Applications of radar – atmospheric sounding Radio Sonde - pilot balloons - Wind estimation through Radar - 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 METEOROLOGICAL MISSIONS 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 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 sub global events – tracking of large weather system – Cloud motion vector – Dvorak"s techniques of Cylone Intensity estimation - T-phi and other climatic charts - T number and current

intensity No. – Applications to storm surge estimation - Satellite soundings – Global Warming – Sea level changes and Consequences.

TOTAL: 45 PERIODS

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

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	2	3	3	3	3
PO2	3	3	3	3	3	3
PO3	3	3	3	3	3	3
PSO1	3	3	3	3	3	3
PSO2	2	2	3	3	3	3
PSO3	2	2	3	3	3	3

RS4017 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, 2nd edition.
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
4. David N.Miclsen, Environmental Site Characterization and Ground water Monitoring, 2nd edition, CRC Press, 2005, ISBN: 978-1566705899
5. Roger D.Griffin, Principles of Air Quality Management, 2nd edition, 2006, CRC Press 2016.
6. Donald L.Wise, Remediation for Hazardous waste contaminated soils, CRC Press; 1st Edition (1994)
7. Michele Campagna, GIS for sustainable development, CRC Press; 1st Edition, 2005.
8. Tchobanoglous George, Hilary Theisen, Samuel Vigi, Integrated Solid Waste Management, Mc Graw – Hill Inc, Singapore. 2014.
9. Dr Owen Harrop, “Air Quality Assessment & Management”, CRC Press; 1st edition, 2001
10. Robert Scally, “GIS for Environmental Management”, ESRI Press, 2006
11. ShuklaP R , Subobh K Sarma, NH Ravindranath, Amit Garg and Sumana Bhattacharya, Climate Change and India: Vulnerability assessment and adaptation, University Press (India) Pvt Ltd, Hyderabad, 2003.

COs- PO’s & PSO’s MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	2	3	3	3	3
PO2	3	3	3	3	3	3
PO3	3	3	3	3	3	3
PSO1	3	3	3	3	3	3
PSO2	2	3	3	3	3	3
PSO3	2	3	3	3	3	3

RS4018 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

UNIT II 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.

UNIT III 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.

UNIT IV FORESTRY 9

Forest taxonomy – inventory of forest land – forest types and density mapping – Forest stock mapping – factors influencing degradation of forest – Delineation of degraded forest - Forest change detection and monitoring – Forest fire mapping & damage assessment — biomass estimation - carbon storage – ALTM for Forest studies – urban forestry issues

UNIT V 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, 2014.
4. Joe Boris dexon, Soil mineralogy with environmental application, Library of congress catalog, 2002.
5. James B, Introduction to Remote sensing, Third edition Campbell, 4th edition Guilford Press, 2008, 4th edition.
6. David H. White, S. Mark Howden, Climate Change: Significance for Agriculture and Forestry, Springer,1994.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	2	3	3	3	3
PO2	3	3	3	3	3	3
PO3	3	3	3	3	3	3
PSO1	3	3	3	3	3	3
PSO2	2	3	3	3	3	3
PSO3	2	2	3	3	3	3

RS4019 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- multi modal transport system

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 – iRAD- 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, 1st edition .
2. John Stillwell, Graham Clarke, Applied GIS and Spatial Analysis, John Wiley & Sons Ltd, 2003, 1st edition.
3. C.S. Papacostas, P.D. Prevedouros, Transportation Engineering and Planning, Prentice-Hall India, 2012, 3rd 3dition .
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.

COs- PO's & PSO's MAPPING

PO	Course Outcome					Average
	CO1	CO2	CO3	CO4	CO5	
PO1	2	2	3	3	3	3
PO2	3	3	3	3	3	3
PO3	3	3	3	3	3	3
PSO1	3	3	3	3	3	3
PSO2	2	3	3	3	3	3
PSO3	2	2	3	3	3	3

AUDIT COURSES

AX4091 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

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, 7th edition.
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, 2nd edition.

AX4092 **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

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, 1st edition.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX4093 **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

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

AX4094	நற்றமிழ் இலக்கியம்	L T P C 2 0 0 0

UNIT I சங்க இலக்கியம் 6

1. தமிழின் துவக்கநூல்தொல்காப்பியம்
   – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கைஇன்னிசைஅரங்கம்
3. குறிஞ்சிப் பாட்டின்மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரைநிறுத்தியஔவையார்

UNIT II அறநெறித்தமிழ் 6

1. அறநெறி வகுத்ததிருவள்ளுவர்
   - அறம்வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்
2. பிறஅறநூல்கள் - இலக்கியமருந்து
   – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை
   (தூய்மையைவலியுறுத்தும்நூல்)

UNIT III இரட்டைக்காப்பியங்கள் 6

1.கண்ணகியின்புரட்சி
- சிலப்பதிகாரவழக்குரைகாதை
  சமூகசேவைஇலக்கியம்மணிமேகலை
- சிறைக்கோட்டம்அறக்கோட்டமாகியகாதை

UNIT IV அருள்நெறித்தமிழ் 6

1. சிறுபாணாற்றுப்படை
   - பாரிமுல்லைக்குத்தேர்கொடுத்தது, பேகன்மயிலுக்குப் போர்வைகொடுத்தது,
   அதியமான்ஔவைக்குநெல்லிக்கனிகொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரியபுன்னைசிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம்நியமம்விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனேவள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்
   ஆகியவைபற்றியசெய்திகள்

UNIT V நவீனதமிழ்இலக்கியம் 6

1. உரைநடைத் தமிழ்,
- தமிழின் முதல்புதினம்,
- தமிழின் முதல்சிறுகதை,
- கட்டுரை இலக்கியம்,
- பயண இலக்கியம்,
- நாடகம்.
2. நாட்டு விடுதலைபோராட்டமும்தமிழ்இலக்கியமும்,
3. சமுதாய விடுதலையும்தமிழ்இலக்கியமும்,
4. பெண் விடுதலையும்விளிம்புநிலையினரின்மேம்பாட்டில்தமிழ்இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில்தமிழ்இலக்கியம்.

TOTAL: 30 PERIODS

தமிழ்இலக்கியவெளியீடுகள் / புத்தகங்கள்

1. தமிழ்இணையகல்விக்கழகம் (Tamil Virtual University)- www.tamilvu.org
2. தமிழ்விக்கிப்பீடியா (Tamil Wikipedia)-https://ta.wikipedia.org
3. தர்மபுரஆதீனவெளியீடு
4. வாழ்வியல்களஞ்சியம் - தமிழ்ப்பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக்களஞ்சியம் - தமிழ்வளர்ச்சித்துறை (thamilvalarchithurai.com)
6. அறிவியல்களஞ்சியம் - தமிழ்ப்பல்கலைக்கழகம், தஞ்சாவூர்

OPEN ELECTIVES

OIC431 **BLOCKCHAIN TECHNOLOGIES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts,, Transactions, Receiving Ethers, Smart Contracts.

UNIT IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

CO1: Understand and explore the working of Blockchain technology
CO2: Analyze the working of Smart Contracts
CO3: Understand and analyze the working of Hyperledger
CO4: Apply the learning of solidity to build de-centralized apps on Ethereum
CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O’Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

OIC432 **DEEP LEARNING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS **6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS **9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK **10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT IV NATURAL LANGUAGE PROCESSING USING RNN **10**

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING **10**

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data
CO2: Implement Image Segmentation and Instance Segmentation in Images
CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)
CO4: Traffic Information analysis using Twitter Data
CO5: Autoencoder for Classification & Feature Extraction

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

OME431 VIBRATION AND NOISE CONTROL STRATEGIES L T P C
3 0 0 3

OBJECTIVES

- To appreciate the basic concepts of vibration in damped and undamped systems
- To appreciate the basic concepts of noise, its effect on hearing and related terminology
- To use the instruments for measuring and analyzing the vibration levels in a body
- To use the instruments for measuring and analyzing the noise levels in a system
- To learn the standards of vibration and noise levels and their control techniques

UNIT I BASICS OF VIBRATION 9

Introduction – Sources and causes of Vibration-Mathematical Models - Displacement, velocity and Acceleration - Classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear vibration - Single Degree Freedom Systems - Vibration isolation - Determination of natural frequencies

UNIT II BASICS OF NOISE 9

Introduction - Anatomy of human ear - Mechanism of hearing - Amplitude, frequency, wavelength and sound pressure level - Relationship between sound power, sound intensity and sound pressure level - Addition, subtraction and averaging decibel levels - sound spectra -Types of sound fields - Octave band analysis - Loudness.

UNIT III INSTRUMENTATION FOR VIBRATION MEASUREMENT 9

Experimental Methods in Vibration Analysis.- Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings - Vibration Exciters - Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments -. System Identification from Frequency Response -Testing for resonance and mode shapes

UNIT IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS 9

Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters - Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

UNIT V METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL 9

Specification of Vibration Limits – Vibration severity standards - Vibration as condition Monitoring Tool – Case Studies - Vibration Isolation methods - Dynamic Vibration Absorber – Need for Balancing - Static and Dynamic Balancing machines – Field balancing - Major sources of noise - Noise survey techniques – Measurement technique for vehicular noise - Road vehicles Noise standard – Noise due to construction equipment and domestic appliances – Industrial noise sources and its strategies – Noise control at the source – Noise control along the path – Acoustic Barriers – Noise control at the receiver -- Sound transmission through barriers – Noise reduction Vs Transmission loss - Enclosures

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.
5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

REFERENCES:

1. Singiresu S. Rao, “Mechanical Vibrations”, Pearson Education Incorporated, 2017.
2. Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd., 2007.
3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2000.

4. William T. Thomson, “Theory of Vibration with Applications”, Taylor & Francis, 2003.
5. G.K. Grover, “Mechanical Vibrations”, Nem Chand and Bros.,Roorkee, 2014.
6. A.G. Ambekar, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., 2014.
7. David A. Bies and Colin H. Hansen, “Engineering Noise Control – Theory and Practice”, Spon Press, London and New York, 2009.

OME432 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To learn the present energy scenario and the need for energy conservation.
- To understand the different measures for energy conservation in utilities.
- Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
- To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
- To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT I ENERGY SCENARIO **9**

Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.

UNIT II HEATING, VENTILLATION & AIR CONDITIONING **9**

Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.

UNIT III LIGHTING, COMPUTER, TV **9**

Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.

UNIT IV ENERGY EFFICIENT BUILDINGS **9**

Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.

UNIT V ENERGY STORAGE TECHNOLOGIES **9**

Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Understand technical aspects of energy conservation scenario.
2. Energy audit in any type for domestic buildings and suggest the conservation measures.
3. Perform building load estimates and design the energy efficient landscape system.
4. Gain knowledge to utilize an appliance/device sustainably.
5. Understand the status and current technological advancement in energy storage field.

REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment
3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001

4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com)
6. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
7. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
8. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

OME433 ADDITIVE MANUFACTURING L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.

UNIT III VAT POLYMERIZATION 9

Stereolithography Apparatus (SLA)- Materials -Process -Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION 9

Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation - Bio-Additive Manufacturing Computer Aided Tissue Engineering (CATE) – Case studies

POWDER BASED PROCESS

Selective Laser Sintering (SLS): Process –Mechanism– Typical Materials and Application- Multi Jet Fusion - Basic Principle-– Materials- Application and Limitation - Three Dimensional Printing - Materials -Process - Benefits and Limitations. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters -Materials - Benefits -Applications.

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES 9

Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

TOTAL: 45 PERIODS

REFERENCES:

1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590

4. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
5. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

OME434 ELECTRIC VEHICLE TECHNOLOGY L T P C
3 0 0 3

UNIT I NEED FOR ELECTRIC VEHICLES 9

History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges

UNIT II ELECTRIC VEHICLE ARCHITECHTURE 9

Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.

UNIT III ENERGY STORAGE 9

Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell

UNIT IV ELECTRIC DRIVES AND CONTROL 9

Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor -drives and control , AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers

UNIT V DESIGN OF ELECTRIC VEHICLES 9

Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

TOTAL: 45 PERIODS

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained - Wiley, 2003.
4. Ehsani, M, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2005

OME435	NEW PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.
2. Identfying opportunity and planning for new product design and development.
3. Conducting customer need analysis; and setting product specification for new product design and development.
4. Generating, selecting, and testing the concepts for new product design and development.
5. Appling the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCTDESIGN & DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development – Duration and Cost of Product Development – The Challenges of Product Development – The Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations.

UNIT II OPPORTUNITY DENTIFICATION & PRODUCT PLANNING 9

Opportunity Identification: Definition – Types of Opportunities – Tournament Structure of Opportunity Identification – Effective Opportunity Tournaments – Opportunity Identification Process – Product Planning: Four types of Product Development Projects – The Process of Product Planning.

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

Identifying Customer Needs: The Importance of Latent Needs – The Process of Identifying Customer Needs. Product Specifications: Definition – Time of Specifications Establishment – Establishing Target Specifications – Setting the Final Specifications

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

Concept Generation: Activity of Concept Generation – Structured Approach – Five step method of Concept Generation. Concept Selection: Methodology – Concept Screening and Concepts Scoring. Concept testing: Seven Step activities of concept testing.

UNITV INDUSTRIAL DESIGN & PROTOTYPING 9

Industrial Design: Need and Impact–Industrial Design Process. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Apply the principles of generic development process; and understand the organization structure for new product design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.
4. Generate, select, and test the concepts for new product design and development.
5. Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, “Product Design and Development “McGraw-Hill Education; 7 edition, 2020.

REFERENCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.
2. Rosenthal S.,“Effective Product Design and Development”, Business One Orwin, Homewood, 1992,ISBN1-55623-603-4.

3. Pugh.S,"Total Design Integrated Methods for Successful Product Engineering", Addison Wesley Publishing,1991,ISBN0-202-41639-5.
4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

OBA431 SUSTAINABLE MANAGEMENT LT P C
3 0 0 3

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY 9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainability performances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II CREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman's stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model. Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1. Familiarise the students with the concept of small business
CO2. In depth knowledge on small business opportunities and challenges
CO3. Ability to devise plans for small business by building the right skills and marketing strategies
CO4. Identify the funding source for small start ups
CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME's.

OBA433 INTELLECTUAL PROPERTY RIGHTS L T P C
3 0 0 3

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS 9

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES 9

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS 9

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Understanding of intellectual property and appreciation of the need to protect it
CO2: Awareness about the process of patenting
CO3: Understanding of the statutes related to IPR
CO4: Ability to apply strategies to protect intellectual property
CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
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5. WIPO Intellectual Property Hand book.

OBA434 ETHICAL MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVE

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY 9

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS 9

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT 9

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT 9

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Role modelling and influencing the ethical and cultural context.
CO2: Respond to ethical crises and proactively address potential crises situations.
CO3: Understand and implement stakeholder management decisions.
CO4: Develop the ability, knowledge, and skills for ethical management.
CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

ET4251 IoT FOR SMART SYSTEMS LT P C
3 0 0 3

COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE 9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture**,** IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9

PROTOCOLS:

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS **9**

Services/Attributes: Big-Data Analytics for IOT, Dependability,Interoperability, Security, Maintainability.

Embedded processors for IOT :Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES **9**

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.
CO2: Compare and contrast different platforms and infrastructures available for IoT
CO3: Explain different protocols and communication technologies used in IoT
CO4: Analyze the big data analytic and programming of IoT
CO5: Implement IoT solutions for smart applications

REFERENCES:

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.
9. Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
10. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, “ Smart Grid Technology and Applications”, Wiley, 2015.
13. UpenaDalal,”Wireless Communications & Networks,Oxford,2015.

ET4072 MACHINE LEARNING AND DEEP LEARNING **L T P C**
3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS 9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS 9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

PX4012 RENEWABLE ENERGY TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:
To impart knowledge on
- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION 9
Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO_2 Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS 9
Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9
Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9
Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9
Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL: 45 PERIODS

OUTCOMES:
After completion of this course, the student will be able to:
CO1: Demonstrate the need for renewable energy sources.
CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
CO3: Design a stand-alone and Grid connected PV system.
CO4: Analyze the different configurations of the wind energy conversion systems.
CO5: Realize the basic of various available renewable energy sources

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

PS4093 **SMART GRID** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.
CO2: Explain the function of Smart Grid.
CO3: Experiment the issues of Power Quality in Smart Grid.
CO4: Analyze the performance of Smart Grid.
CO5**:** Recommend suitable communication networks for smart grid applications

REFERENCES

1. Stuart Borlase ‘Smart Grid: Infrastructure, Technology and Solutions’, CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, ‘Smart Grid: Technology and Applications’, Wiley, 2012.
3. Mini S. Thomas, John D McDonald, ‘Power System SCADA and Smart Grids’, CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, ‘Communication Networks for Smart Grids’, Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

CP4391 **SECURITY PRACTICES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY 9

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II NETWORK SECURITY 9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT 9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012
6. Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

MP4251 CLOUD COMPUTING TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization –– Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE 12

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III AWS CLOUD PLATFORM - IAAS 9

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

UNIT IV PAAS CLOUD PLATFORM 9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

UNIT V PROGRAMMING MODEL 9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Employ the concepts of virtualization in the cloud computing
CO2: Identify the architecture, infrastructure and delivery models of cloud computing
CO3: Develop the Cloud Application in AWS platform
CO4: Apply the concepts of Windows Azure to design Cloud Application
CO5: Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.

4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner‟s Guide‖, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

IF4072 DESIGN THINKING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I UX LIFECYCLE TEMPLATE 8

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

UNIT II CONTEXTUAL INQUIRY 10

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING 9

Design-informing models: second span of the bridge . Some general “how to” suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

UNIT IV UX GOALS, METRICS, AND TARGETS 8

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V ANALYSING USER EXPERIENCE 10

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with

Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

SUGGESTED ACTIVITIES:

1: Hands on Design Thinking process for a product
2: Defining the Look and Feel of any new Project
3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
4: Identify a customer problem to solve.
5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Build UI for user Applications
CO2: Use the UI Interaction behaviors and principles
CO3: Evaluate UX design of any product or application
CO4: Demonstrate UX Skills in product development
CO5: Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012
3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153 PRINCIPLES OF MULTIMEDIA L T P C
3 0 0 3

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION 9

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA 9

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS 9

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS 9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Suggested Activities:

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS 9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

Suggested Activities:

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Handle the multimedia elements effectively.
CO2: Articulate the concepts and techniques used in multimedia applications.
CO3: Develop effective strategies to deliver Quality of Experience in multimedia applications.
CO4: Design and implement algorithms and techniques applied to multimedia objects.
CO5: Design and develop multimedia applications following software engineering models.

REFERENCES:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017

DS4015 BIG DATA ANALYTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

UNIT I INTRODUCTION TO BIG DATA 9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II SEARCH METHODS AND VISUALIZATION 9

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies –Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III MINING DATA STREAMS 9

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV FRAMEWORKS 9

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE 9

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays - Lists -Data frames -Classes, Input/output, String manipulations

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1:understand the basics of big data analytics

CO2: Ability to use Hadoop, Map Reduce Framework.

CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.

CO4:gain knowledge on R language

CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

REFERENCE:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.

2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.

3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.

4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.

5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

NC4201 INTERNET OF THINGS AND CLOUD L T P C

3 0 0 3

COURSE OBJECTIVES:

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

UNIT I FUNDAMENTALS OF IoT 9

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

UNIT II PROTOCOLS FOR IoT 9

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS 9

Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION 9

Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

UNIT V IoT AND CLOUD 9

IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core -Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1: Understand the various concept of the IoT and their technologies..

CO2: Develop IoT application using different hardware platforms

CO3: Implement the various IoT Protocols
CO4: Understand the basic principles of cloud computing.
CO5: Develop and deploy the IoT application into cloud environment

REFERENCES

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley publishers, 2015.
4. Simon Walkowiak, “Big Data Analytics with R” PackT Publishers, 2016
5. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2015.

MX4073 MEDICAL ROBOTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS 9

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

Sensors and Actuators

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS 9

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning

Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS 9

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS 9

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Describe the configuration, applications of robots and the concept of grippers and actuators
CO2: Explain the functions of manipulators and basic kinematics
CO3: Describe the application of robots in various surgeries
CO4: Design and analyze the robotic systems for rehabilitation
CO5: Design the wearable robots

REFERENCES

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008
8. Howie Choset, Kevin Lynch, Seth Hutchinson, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, “An Introduction to Robot Technology”, Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011
11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

VE4202 EMBEDDED AUTOMATION L T P C

3 0 0 3

COURSE OBJECTIVES:

- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

UNIT I INTRODUCTION TO EMBEDDED C PROGRAMMING 9

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT II AVR MICROCONTROLLER 9

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS 9

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT IV VISION SYSTEM 9

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

UNIT V HOME AUTOMATION 9

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor - Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, students will be able to

CO1: analyze the 8-bit series microcontroller architecture, features and pin details
CO2: write embedded C programs for embedded system application
CO3: design and develop real time systems using AVR microcontrollers
CO4: design and develop the systems based on vision mechanism
CO5: design and develop a real time home automation system

REFERENCES:

1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.
2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.

CX4016 ENVIRONMENTAL SUSTAINABILITY L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

UNIT II CONCEPT OF SUSTAINABILITY 9

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

UNIT III SIGNIFICANCE OF BIODIVERSITY 9

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

UNIT IV POLLUTION IMPACTS 9

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

UNIT V ENVIRONMENTAL ECONOMICS 9

Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

TOTAL : 45 PERIODS

REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

TX4092 TEXTILE REINFORCED COMPOSITES L T P C
3 0 0 3

UNIT I REINFORCEMENTS 9

Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

UNIT II MATRICES 9

Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

UNIT III COMPOSITE MANUFACTURING 9

Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

UNIT IV TESTING 9

Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS 9

Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

TOTAL: 45 PERIODS

REFERENCES

1. BorZ.Jang,“Advanced Polymer composites”,ASM International,USA,1994.
2. Carlsson L.A. and Pipes R.B., “Experimental Characterization of advanced composite Materials”,SecondEdition,CRCPress,NewJersey,1996.
3. George LubinandStanley T.Peters, “Handbook of Composites”, Springer Publications,1998.
4. Mel. M. Schwartz, “Composite Materials”, Vol. 1 &2, Prentice Hall PTR, New Jersey,1997.
5. RichardM.Christensen,“Mechanics of compositematerials”,DoverPublications,2005.
6. Sanjay K. Mazumdar, “Composites Manufacturing: Materials, Product, and Process Engineering”,CRCPress,2001

NT4002 NANOCOMPOSITE MATERIALS L T P C
3 0 0 3

UNIT I BASICS OF NANOCOMPOSITES 9

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES 9

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES 9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL : 45 PERIODS

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

BY4016 IPR, BIOSAFETY AND ENTREPRENEURSHIP L T P C
3 0 0 3

UNIT I IPR 9

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY 9

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS 9

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT 9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS

REFERENCES

1. Bouchoux, D.E., "Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal", 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., "Biological Safety: Principles and Practices", 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., "Intellectual Property Rights for Engineers", 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., "Patent Law", 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., "Genetically Modified Organisms and Biosafety: A Background Paper for Decision-Makers and Others to Assist in Consideration of GMO Issues" 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, "Entrepreneurial Development", S.Chand & Company LTD, New Delhi, 2007.