ANNAUNIVERSITY, CHENNAI

NON-AUTONOMOUS AFFILIATED COLLEGES

M. E. INFRASTRUCTURE ENGINEERING AND MANAGEMENT

REGULATIONS 2021

CHOICE BASED CREDIT SYSTEM

1.PROGRAMME EDUCATIONAL OBJECTIVES (PEO'S):

Graduates of the Programme M E Infrastructure Engineering & Management will

I. Graduates will apply management and economic theories to formulate strategies to enable organizations to achieve their goals
II. Graduates of the programme will serve as project leaders with critical-thinking and analytical decision-making capabilities
III. Graduates will be capable of integrating their knowledge of multi-disciplines of management to analyze construction industry problems
IV. Graduates of the programme will contribute as team members adding value through innovation, customer focus, prudence, and professional responsibility, consistent with the objectives of the projects in which they are involved and the organizations they support.
V. Graduate of the programme will have competence of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career.

2. PROGRAMME OUTCOMES (POs):

POs describe what students are expected to know or be able to do by the time of post-graduation from the program. The Program Outcomes of M.E Infrastructure Engineering and Management are as follows:

	POs	Courses
PO 1	An ability to independently carry out research /investigation and development work to solve practical problems.	Research Methodology and IPR, Project Management for Infrastructure, Urban Transportation Systems Planning, Infrastructure Planning and Management, BIM and Project Management Laboratory, Geographical Information Systems for Infrastructure Planning, Advanced Structural Design, Geo Technical Engineering for Infrastructures, GIS Laboratory, Infrastructure Material testing lab, Project Work I, Project Work II
PO 2	An ability to write and present a substantial technical report/document	Infrastructure Contract Management, BIM and Project Management Laboratory, GIS Laboratory, Infrastructure Material testing lab, Project Work I, Project Work II
PO 3	Students should be able to demonstrate a degree of mastery over the area of infrastructure engineering and management.	Project Management for Infrastructure, Infrastructure Planning and Management, Geographical Information Systems for Infrastructure, Geo Technical Engineering for Infrastructures

4. PEO/PO Mapping:

PEO	PO1	PO2	PO3
I.	2	1	2
II.	1	1	3
III.	2	2	3
IV.	1	1	2
V.	2	1	2

Mapping of Course Outcomes and Programme Outcomes

		COURSE NAME	PO1	PO2	PO3
YEAR I	SEMESTER I	Statistical Methods for Engineers	1.6	0.8	2.6
		Project Management for Infrastructure	1		2
		Urban Transportation Systems Planning	1		3
		Research Methodology and IPR	3		
		Infrastructure Planning and Management	1		3
		Audit course I			
		Professional Elective I			
		BIM and Project Management Laboratory	2		
	SEMESTER II	Infrastructure contract Management		2	
		Geographical Information Systems for Infrastructure Planning			1
		Advanced Structural Design			2
		Geo Technical Engineering for Infrastructures	3		3
		Professional Elective II			
		Professional Elective III			
		Audit course II			
		GIS Laboratory	2		3
		Infrastructure Material testing Laboratory	1	1	3
YEAR II	SEMESTER III	Professional Elective IV			
		Professional Elective V			
		Open Elective			
		Seminar			
		Industrial Training (4 Weeks)			
		Project Work I			
	SEMESTER IV	Project Work II			

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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 L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	MA4159	Statistical Methods for Engineers	FC	4	0	0	4	4
2.	IM4101	Project Management for Infrastructure	PCC	2	1	0	3	3
3.	IM4102	Urban Transportation Systems Planning	PCC	3	0	0	3	3
4.	IM4103	Infrastructure Planning and Management	PCC	3	0	0	3	3
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.	IM4111	BIM and Project Management Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**1**	**4**	**24**	**20**

* Audit Course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PERWEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	IM4201	Infrastructure Contract Management	PCC	3	0	0	3	3
2.	IM4202	Geographical Information Systems for Infrastructure Planning	PCC	2	1	0	3	3
3.	IM4203	Geotechnical Engineering for Infrastructure	PCC	3	0	0	3	3
4.	IM4204	Advanced Structural Design	PCC	3	0	0	3	3
5.		Professional Elective II	PEC	3	0	0	3	3
6.		Professional Elective III	PEC	3	0	0	3	3
7.		Audit Course II*	AC	2	0	0	2	0
PRACTICALS								
8.	IM4211	GIS Laboratory	PCC	0	0	4	4	2
9.	IM4212	Infrastructure Material Testing Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**1**	**8**	**28**	**22**

* Audit Course is optional

SEMESTER III

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective IV	PEC	3	0	0	3	3
2.		Professional Elective V	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
4.	IM4311	Seminar	EEC	0	0	2	2	1
5.	IM4312	Industrial Training (4 weeks)	EEC	-	-	-	-	2
6.	IM4313	Project Work I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**14**	**23**	**18**

SEMESTER IV

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	IM4411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 72

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.	IM4101	Project Management for Infrastructure	2	1	0	3	1
2.	IM4102	Urban Transportation Systems Planning	3	0	0	3	1
3.	IM4103	Infrastructure Planning and Management	3	0	0	3	1
4.	IM4111	BIM and Project Management Laboratory	0	0	4	2	1
5.	IM4201	Infrastructure Contract Management	3	0	0	3	2
6.	IM4202	Geographical Information Systems for Infrastructure Planning	2	1	0	3	2
7.	IM4203	Geotechnical Engineering for Infrastructure	2	0	2	3	2
8.	IM4204	Advanced Structural Design	3	0	0	3	2
9.	IM4211	GIS Laboratory	0	0	4	2	2
10.	IM4212	Infrastructure Material Testing Laboratory	0	0	4	2	2
			TOTAL CREDITS			**27**	

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	

LIST OF PROFESSIONAL ELECTIVES (PEC)

SEMESTER I, ELECTIVE I

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	ST4073	Maintenance, Repair and Rehabilitation of Structures	3	0	0	3	3
2.	IM4001	Material Procurement and Management	3	0	0	3	3
3.	CN4072	Economics and Finance Management in Construction	3	0	0	3	3
4.	CN4074	Organizational behavior	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	IM4002	Management of Human Resource and Quality	3	0	0	3	3
2.	CN4092	Supply Chain Management and Logistics in Construction	3	0	0	3	3
3.	CN4091	Lean Construction Concepts, Tools and Practices	3	0	0	3	3
4.	IM4003	Value Engineering	3	0	0	3	3

SEMESTER II, ELECTIVE III

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	IM4004	Safety in Construction Engineering	3	0	0	3	3
2.	ST4091	Design of Bridge Structures	3	0	0	3	3
3.	IM4005	Modern Construction Material and Technology	3	0	0	3	3
4.	ST4071	Advanced Prestressed Concrete	3	0	0	3	3

SEMESTER III, ELECTIVE IV

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	IM4006	Environmental Impact Assessment for Infrastructure Projects	3	0	0	3	3
2.	IM4007	Urban Environmental Management	3	0	0	3	3
3.	IM4008	Life Cycle Analysis and Design for the Environment	3	0	0	3	3
4.	IM4009	Sustainable Development and Urban Planning	3	0	0	3	3

SEMESTER III, ELECTIVE V

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	IM4010	Infrastructure for SMART City Planning	3	0	0	3	3
2.	IM4011	Pavement Management System	3	0	0	3	3
3.	IM4012	Airport System Planning and Design	3	0	0	3	3
4.	IM4013	Urban Infrastructure and Asset Management	3	0	0	3	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	IM4311	Seminar	0	0	2	1	3
2.	IM4312	Industrial training (4 weeks)	-	-	-	2	3
3.	IM4313	Project Work I	0	0	12	6	3
4.	IM4411	Project Work II	0	0	24	12	4
		TOTAL				21	

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

	Name of the Programme: M.E. Infrastructure Engineering and Management					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	11	16	00	00	27
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	09	12	21
7.	Non Credit/Audit Course	✓	✓			
8.	**TOTAL CREDIT**	**20**	**22**	**18**	**12**	**72**

8

MA4159   **STATISTICAL METHODS FOR ENGINEERS**   **L T P C**
                                                                    4 0 0 4
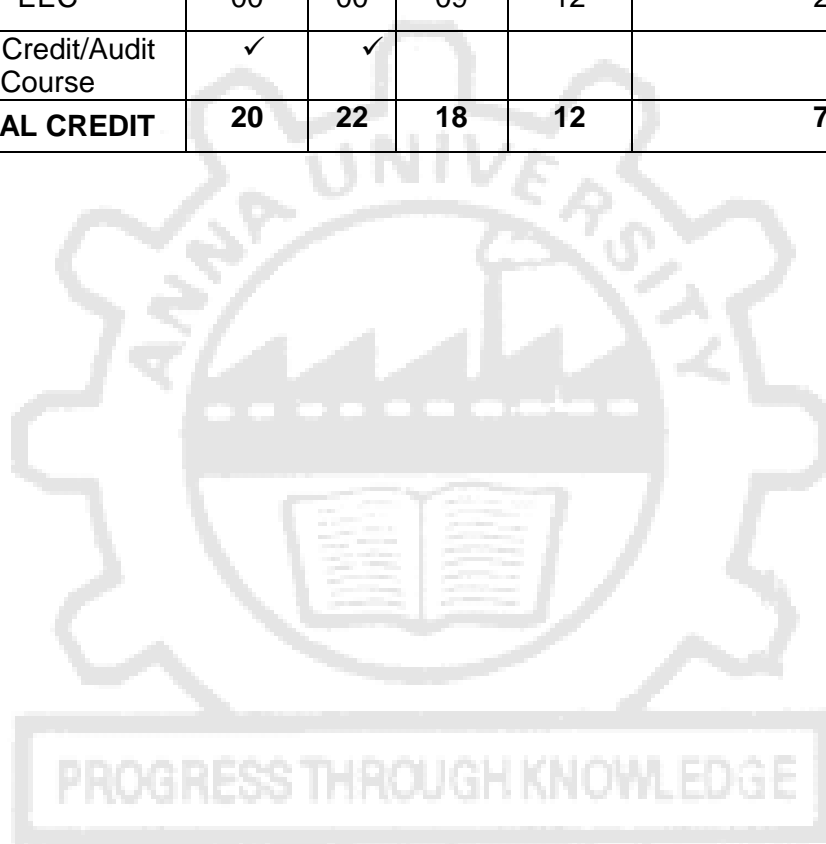
OBJECTIVES:
- This course is designed to provide the solid foundation on topics in various statistical methods which form the basis for many other areas in the mathematical sciences including statistics, modern optimization methods and risk modeling. It is framed to address the issues and the principles 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 of r x c tables – Goodness of fit.

UNIT III   CORRELATION AND REGRESSION   12
Multiple and partial correlation – Method of least squares – Plane of regression – Properties of residuals – Coefficient of multiple correlation – Coefficient of partial correlation – Multiple correlation with total and partial correlations – Regression and partial correlations in terms of lower order 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, 2014.
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, 2012.
5. Rice, J.A. "Mathematical Statistics and Data Analysis", 3rd Edition, Cengage Learning, 2015.

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	-	-	-

IM4101   PROJECT MANAGEMENT FOR INFRASTRUCTURE   L T P C
2 1 0 3

OBJECTIVES:
- To Understand and Explain Project Management Process, Project Planning and Time Management, Organizing for Project Management, Resource Planning and Cost Estimation.

UNIT I   PROJECT MANAGEMENT - AN OVERVIEW: 6+3
Introduction, Project Management process, Project Management techniques, Relationship to other management disciplines, Related endeavors, Concentric project management, Project formulation and development

UNIT II   PROJECT PLANNING AND TIME MANAGEMENT: 6+3
Purpose, Project scheduling, activity definition, activity sequencing, activity duration estimating, schedule development, schedule control, project management using CPM\PERT- Network basics, Network development, PERT analysis, advantages. Computerized network analysis- features of PM software, capabilities of PM software, multi project analysis,

UNIT III   ORGANIZING FOR PROJECT MANAGEMENT: 6+3
Project Management – modern trends - Strategic Planning - Effects of Project Risks on Organization - Organization of Project Participants -Traditional Designer-Constructor Sequence - Professional Construction Management - Owner-Builder Operation - Turnkey Operation - Leadership and Motivation for the Project Team.

UNIT IV   RESOURCE PLANNING: 6+3
Introduction, Inputs, Tools, Outputs, Resource scheduling, Resource leveling, Resource restrained scheduling, strategies for shortening the schedule Assigning resources: Work, duration, resources, Effort driven scheduling, create a resource list, Exercise on resource planning using software, Level now command, leveling Gantt chart, assigning rate to resources, techniques of duration cost trade-off.

UNIT V   COST ESTIMATION: 6+3
Costs Associated with Constructed Facilities - Approaches to Cost Estimation - Type of Construction Cost Estimates - Effects of Scale on Construction Cost - Unit Cost Method of Estimation - Methods for Allocation of Joint Costs - Historical Cost Data - Cost Indices - Applications of Cost Indices to Estimating - Estimate Based on Engineer's List of Quantities - Estimation of Operating Costs.
TOTAL: 45 PERIODS

OUTCOMES:
CO1   Explain project, project management, life cycle and project formulation
CO2   Analyze and Manage time in projects through Gantt charts, and network techniques.
CO3   Analyze and manage time in projects through CPM and PERT, update and monitor projects
CO4   Optimize resources of projects using scheduling, fast tracking and re-estimation techniques
CO5   Explain different approaches for estimating cost

REFERENCES:
1. Harold Kerzner – Project Management – systems approach to planning, scheduling & controlling – 7th edition, John Wiley & sons, Canada.
2. Microsoft Project for Windows 2000 –Microsoft Press, USA 2000.
3. Tim Pyron – Microsoft Project 2000 in 24 hours – Sama Teach yourself series- Tech Media Published New Delhi.
4. Chit Kara, K.K. "Construction Project Management: Planning, Scheduling and Control", Tata McGraw-Hill Publishing Company, New Delhi, 1998.
5. Choudhury S, "Project Management", McGraw-Hill Publishing Company, New Delhi, 1988.
6. Chris Hendrickson and Tung Au, "Project Management for Construction – Fundamental Concepts for Owners, Engineers, Architects and Builders", Prentice Hall, Pittsburgh, 2000.
7. Frederick E. Gould," Construction Project Management", Wentworth Institute of Technology, Vary E. Joyce, Massachusetts Institute of Technology, 2000.
8. George J. Ritz, "Total Construction Project Management" - McGraw-Hill Inc, 1994.

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3
CO1	1	2	2
CO2	2	3	3
CO3	2	3	3
CO4	1	1	3
CO5	1	1	2

IM4102	URBAN TRANSPORTATION SYSTEMS PLANNING	L T P C
		3 0 0 3

OBJECTIVES:
- To make the leaners to understand and explain the principles of the transportation system planning, covering both passenger and freight transports and the methodology of effective management of transport systems.

UNIT I   INTRODUCTION   9
Introduction and concepts; demand for transport – nature of demand, temporal and special variations; factors influencing demand for transport; effect of land use and socioeconomic activities on the demand; conceptual difference between urban, interurban and regional transport planning processes; Interaction of land-use and transport planning processes; urban transport planning process (morphology).

UNIT II   TRIP GENERATION AND DISTRIBUTION   9
Trip production process; household characteristics; classification based on trip purpose – trips for work, education, shopping, social and recreational purposes; influencing variables of trips made for different purposes; modelling trip production. Trip attraction process; attraction of trips for different purposes, factors influencing trip attraction for different trip purposes; modelling trip attraction. Presentation of trip distribution data – OD matrix, PA matrix to depict trip distribution among zones; factors influencing trip distribution; variable formulation, modelling trip distribution; Gravity model of trip distribution; calibration of Gravity models.

UNIT III   MODE CHOICE ANALYSIS   9
Mode choice for different trip purposes; Influencing factors – socioeconomic characteristics of travelers and characteristics of the different modes of transport; influence of trip purpose on mode choice; modelling mode choice of travelers - trip-end and trip-interchange modelling; Disaggregate mode-choice models; utility concept; Logit model of mode choice; model calibration; model validation.

UNIT IV   ROUTE ASSIGNMENT AND TRANSPORTATION SURVEYS   9

Route assignment – description of transport network for route assignment; influencing variables and assignment algorithms; all-or-nothing assignment; multipath traffic assignment; capacity restrained traffic assignment. Transportation surveys – inventory of existing travel pattern, transport facilities and land-use and economic characteristics; definition of the study area; cordon lines; zoning; types of movements in the study area; types of planning related surveys.

UNIT V   THE OTHER RELATED TOPICS   9

Transport related land-use models – Land-use estimation procedure; the Lowry model of land use; the equation system; allocation functions; zonal constraints. Urban Structure – urban activity systems; urban movement hierarchies; types of urban structure - centripetal, grid and linear types. Urban goods movement – factors influencing urban goods movement; classification of urban goods movement; principles of modeling urban goods movement.

TOTAL: 45 PERIODS

OUTCOMES:
C01 Explain transportation planning concepts, the planning morphology and distinction between urban and interurban transportation planning processes.
C02 Explain trip generation and trip distribution processes; formulate causal variables and develop trip generation and trip distribution models.
C03 Identify and analyze the factors influencing mode-choice of urban travelers, calibrate logit model of mode choice to apply for the given urban area.
C04 Develop route assignment variables and calibrate route choice models for assignment of trips distributed to the traffic zones in an urban area.
C05 Explain the conceptual analytical aspects transport related land-use models; describe the principals involved in urban structure and urban goods movement.

REFERENCES:
1. Juan de Dios Orituzar and Luis G. Willum son, "Modelling Transport', A john Wiley and Sons, Inc., 4th edition 2017.
2. Norbert Oppenheim, "Urban Travel Demand Modelling" A John Wiley and Sons, Inc., 3rd Edition, 2010.
3. Thomas A. Domenici and Daniel Mc Fadden, "Urban Travel Demand A Behavioral Analysis", American Elsevier Publishing Company Inc., 5th Edition, 2019
4. Gee tam Tiwari, "Urban Transport for Growing Cities", Macmillan India Ltd., 1st Edition, 2002.
5. B.G. Hutchinson, "Principles of Urban Transport Systems Planning", McGraw-Hill Book Company, 10th Reprint, 2010
6. Jason C.yu, "Transportation Engineering: Introduction to Planning, Design and Operations", Elsevier,1992.

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3
CO1	2	1	3
CO2	2	1	3
CO3	1	1	2
CO4	3	1	3
CO5	1	1	2

IM4103   **INFRASTRUCTURE PLANNING AND MANAGEMENT**   **L T P C**
                                                                          3 0 0 3

OBJECTIVES:
• To understand and explain concepts of infrastructure, private involvement in infrastructure, challenges to successful infrastructure planning and implementation, strategies for successful infrastructure project implementation, sustainable development of infrastructure

UNIT I   AN OVERVIEW OF BASIC CONCEPTS RELATED TO INFRASTRUCTURE: 9

Introduction to Infrastructure, an overview of the Power Sector in India., an Overview of the Water Supply and Sanitation Sector in India., an overview of the Road, Rail, Air and Port Transportation Sectors in India., an overview of the Telecommunications Sector in India, an overview of the Urban Infrastructure in India, an overview of the Rural Infrastructure in India, an Introduction to Special Economic Zones, Organizations and layers in the field of Infrastructure, The Stages of an Infrastructure Project Lifecycle., an overview of Infrastructure Project Finance.

UNIT II   PRIVATE INVOLVEMENT IN INFRASTRUCTURE: 9

A Historical Overview of Infrastructure Privatization. The Benefits of Infrastructure Privatization, Problems with Infrastructure Privatization, Challenges in Privatization of Water Supply: A Case Study, Challenges in Privatization of Power: Case Study, Privatization of Infrastructure in India: Case Study, Privatization of Road Transportation Infrastructure in India.

UNIT III   CHALLENGES TO SUCCESSFUL INFRASTRUCTURE PLANNING AND
**   IMPLEMENTATION: 9**

Mapping and Facing the Landscape of Risks in Infrastructure Projects, Economic and Demand Risks: The Case study for Political Risks, Socio-Environmental Risks, Cultural Risks in International Infrastructure Projects, Legal and Contractual Issues in Infrastructure, Challenges in Construction and Maintenance of Infrastructure.

UNIT IV   STRATEGIES FOR SUCCESSFUL INFRASTRUCTURE PROJECT
**   IMPLEMENTATION: 9**

Risk Management Framework for Infrastructure Projects, Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Introduction to Fair Process and Negotiation, Negotiating with multiple Stakeholders on Infrastructure Projects.

UNIT V   SUSTAINABLE DEVELOPMENT OF INFRASTRUCTURE: 9

Information Technology and Systems for Successful Infrastructure Management, - Innovative Design and Maintenance of Infrastructure Facilities, Infrastructure Modeling and Life Cycle Analysis Techniques, Capacity Building and Improving the Governments Role in Infrastructure Implementation, An Integrated Framework for Successful Infrastructure Planning and Management - Infrastructure Management Systems and Future Directions.

**   TOTAL: 45 PERIODS**

OUTCOMES:
CO1 Explain the basic concepts related to Infrastructure Projects
CO2 Discuss the role of private sector in infrastructure growth.
CO3 Describe the strategies for successful Infrastructure Project implementation.
CO4 Develop Infrastructure modeling and Life Cycle Analysis Techniques.
CO5 Explain Sustainable development of Infrastructure

REFERENCES:
1. Grigg, Neil, Infrastructure engineering and management, Wiley, (1988).
2. Haas, Hudson, Zaniewski, Modern Pavement Management, Krieger, Malabar, (1994).
3. Hudson, Haas, Uddin, Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation, McGraw Hill, (1997).

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3
CO1	1	1	2
CO2	1	1	2
CO3	2	1	3
CO4	3	1	2
CO5	2	1	2

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, Licenses, 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, 2007.
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.

IM4111   BIM AND PROJECT MANAGEMENT LABORATORY   L T P C
                                                                  0 0 4 2

OBJECTIVES
- To Conduct Laboratory tests on BIM and hands on practice in Project Management Package.

EXPERIMENTS:

BIM Lab
1. Introduction to BIM
2. 2D and 3D Exercises
3. Infrastructure Modelling
4. Introduction to GEOBIM exercises

Project Management Lab
5. Breaking down project components.
6. Defining custom data items.

7. Planning resources and costs.
8. Resource leveling.
9. Quantity and Cost Estimation
10. Hands on practice in MS Project and Primavera software packages.
11. Mini project

TOTAL: 60 PERIODS

SYSTEM SPECIFICATIONS
HP Desktops Computers - 18 Nos
(Intel i7 core, 4 GB RAM, 1 TB HDD and 1 GB Graphics card)

SOFTWARES
1. MS Project – 10 users (latest Version)
2. Primavera – 10 users (latest Version)
3. MS Office – Excel
4. Revit
5. AutoCAD

OUTCOMES:
CO1- Explain the importance of BIM in Infrastructure Projects
CO2- Develop 2D and 3D Exercises using BIM
CO3- Apply the concept of Modelling in Infrastructure Projects
CO4- Implement MS project in planning infrastructure projects
CO5- Practice MS Project and Primavera Software packages

REFERENCES:
1. Harris P.E., Project Management using Primavera, Eastern Harris Publications, 2nd Edition,2008.
2. M.S. Project – Microsoft Press, 1st Edition,2003
3. Harris P.E., Project Management using Primavera, Eastern Harris Publications, 2nd Edition,2008.
4. M.S. Project – Microsoft Press, 1st Edition,2003

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3
CO1	2	1	1
CO2	3	1	2
CO3	3	2	3
CO4	2	2	3
CO5	2	1	2

IM4201   **INFRASTRUCTURE CONTRACT MANAGEMENT**   **L T P C**
                                                                         3 0 0 3

OBJECTIVES:
- To study the various types of construction contracts and their legal aspects and provisions. To study the of tenders, arbitration, legal requirement, and labour regulations.

UNITI   CONSTRUCTION CONTRACTS   9
Indian Contracts Act – Elements of Contracts – Types of Contracts – Features – Suitability – Design of Contract Documents – International Contract Document – Standard Contract Document – Law of Torts.

15

UNITII   TENDERS   9
Prequalification – Bidding – Accepting – Evaluation of Tender from Technical, Contractual and Commercial Points of View – Contract Formation and Interpretation – Potential Contractual Problems – World Bank Procedures and Guidelines – Tamilnadu Transparency in Tenders Act.

UNITIII   ARBITRATION   9
Comparison of Actions and Laws – Agreements – Subject Matter – Violations – Appointment of Arbitrators – Conditions of Arbitration – Powers and Duties of Arbitrator – Rules of Evidence – Enforcement of Award – Costs.

UNITIV   LEGALREQUIREMENTS   9
Insurance and Bonding – Laws Governing Sale, Purchase and Use of Urban and Rural Land – Land Revenue Codes – Tax Laws – Income Tax, Sales Tax, Excise and Custom Duties and their Influence on Construction Costs – Legal Requirements for Planning – Property Law – Agency Law
   – Local Government Laws for Approval – Statutory Regulations.
   –
UNITV   LABOURREGULATION   9
Social Security – Welfare Legislation – Laws relating to Wages, Bonus and Industrial Disputes, Labour Administration – Insurance and Safety Regulations – Workmen's Compensation Act – Indian Factory Act – Tamilnadu Factory Act – Child Labour Act - Other Labour Laws.

TOTAL: 45 PERIODS

OUTCOME:
CO1- Explain different types of contracts in construction, arbitration and legal aspect and its provisions.
CO2-Analyse the Tenders based on Technical, Contractual and Commercial points of View
CO3- Describe the powers and duties of Arbitrator
CO4- Examine the legal Requirements of Purchase of Urban and Rural land
CO5- Discuss the laws relating to Wages, Bonus and Industrial Disputes

REFERENCES:
1. Gajaria G.T., Laws Relating to Building and Engineering Contracts in India,
2. Jimmie Hinze, Construction Contracts, McGraw Hill,2001.
3. Joseph T. Bockrath, Contracts and the Legal Environment for Engineers and Architects, McGraw Hill,2000.
4. Kwaku, A., Tenah, P.E. Jose M. Guevara, P.E., Fundamentals of Construction Management and Organisation, Printice Hall, 1985.M.M. Tripathi Private Ltd., Bombay,1982.
5. Patil. B.S, Civil Engineering Contracts and Estimates, Universities Press (India) Private Limited,2006.

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3
CO1	1	2	2
CO2	1	3	2
CO3	1	2	3
CO4	1	2	3
CO5	1	1	2

IM4202	GEOGRAPHICAL INFORMATION SYSTEMS FOR INFRASTRUCTURE PLANNING	L T P C
		2 1 0 3

OBJECTIVES:
- To Understand and Explain maps and GIS, DBMS, GIS data model, Data input, Data Analysis, GIS output design and presentation.

UNITI   INTRODUCTION TO MAPSANDGIS   6+3

Maps – Definition – Scale - Types of Maps – Elements of Map – Projection – purpose - types – Coordinate Systems: Geographic, Rectangular and Polar – Transformations - types and application – GIS: Introduction - History– Components – Applications of GIS - Popular GIS software – Open source GIS software

UNITII   DBMS AND GIS DATAMODEL   6+3

Database Management system – function – types – advantages - Entity Relationship Model - Normalization - GIS Data Model - Introduction- Data Encoding - Vector Data Structure - Raster Data structure – Network Data Structure - Comparison of Vector and Raster Data Structure – ODBC

UNITIII   GIS DATAINPUT   6+3

Sources for GIS Data - Vector Data Input – Georeferencing – Topology – Topological Relationship - Raster Data Input – Errors in input – Data Editing – Linking Attribute Data – Raster File Formats – Vector File Formats – Raster to Vector and Vector to Raster Conversion - OGC standards

UNITIV   GIS DATAANALYSIS   6+3

Introduction to spatial analysis - Raster Data Spatial Analysis: Local, Neighborhood, Zonal Operations - Vector Operations and Analysis: Topological and Non-topological operations - Network Analysis – DEM – Surface Analysis

UNITV   GIS OUTPUT DESIGNAND PRESENTATION   6+3

Introduction - Spatial and non-spatial data presentation - Map layout – Charts, graphs and multimedia output – Elements of spatial data quality – Meta data - introduction to web GIS – Applications in civil Engineering

TOTAL:45 PERIODS

OUTCOMES:
On completion of the course, the student is expected to be able to
CO1 Understand the fundamentals of maps, their characteristics and GIS, its components
CO2 Appreciate various spatial data models and their advantages
CO3 Produce an error free GIS database for civil engineering applications
CO4 Apply various spatial analysis tools for deriving GIS based outcome
CO5 Present the spatial information along with quality assessment for applications

TEXT BOOKS
1. Jonathan Campbell and Michael Shin, Essentials of GeographicInformationSystems,2011, **Saylor Foundation**, ISBN: 9781453321966
2. Michael N. Demers, **Fundamentals of Geographic Information Systems, 4th Edition, 2009,** Wiley, ISBN:978047012

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3
CO1	2	1	2
CO2	1	1	2
CO3	2	2	3
CO4	2	1	3
CO5	1	1	2

IM4203   GEOTECHNICAL ENGINEERING FOR INFRASTRUCTURE   L T P C
                                                              3 0 0 3

OBJECTIVES:
- To explain the soil investigation and instrumentation in the field.
- To explain the different types of dewatering and method for safe excavation.
- To design safe foundation on different soil and quality assurance in piling.
- To understand different ground improvement techniques.
- To learn about sustainability in geotechnical projects.

UNIT I   GEOTECHNICAL FIELD INVESTIGATION   9
Field exploration – Direct, Semidirect, Indirect exploration – Insitu testing SPT, Plate bearing, Field Vane, Pressurement - Groundwater Conditions – Measurement of Properties — Hydraulic Properties – Field Instrumentation – Surface movements – Subsurface Deformation - Soil Engineering Reports Interpretation – Shrink and Swell from Borrow to Fill.

UNIT II   DEWATERING, EXCAVATION AND ITS SUPPORTS   9
Drainage - Dewatering methods & Specifications – Underwater Excavations, Caissons, Cofferdams – Seepage Barriers, Slurry Trench Methods, Freezing, Grouting – Wells and WellPoint Systems, – Electroosmosis – Planning Dewatering Operations – Design of Excavation Slopes, Slope Stability, Slope Protection – Shallow Trenches and Excavation Safety-Excavations Support Methods – Planning for Excavation Supports.

UNIT III   FOUNDATION CONSTRUCTION   9
Shallow and Deep Foundations - Settlement Analysis - Footing and Raft Construction - Pile Types, Pile Hammers, Jetting, Spudding, and Predrilling, Pile Dynamics, Contract Provisions, Driving Effects – Bored and Driven Pile Construction – Pile Integrity Testing – Pile Load Test – Foundation on difficult soil – Collapsible Soil – Expansive Soil - Foundation Considerations for Expansive Soils - Construction on Expansive Soils.

UNIT IV   GROUND IMPROVEMENT TECHNIQUES   9
Introduction – Improvement of soils by mechanical and chemical means - General Principles of Compaction - Properties of Compacted Soils – Field Compaction - Compaction Equipment for Shallow Lifts – Compaction Control Testing - Compaction Control for Clay Hydraulic Barriers - Vibroflotation - Blasting - Precompression - Sand Drains - Prefabricated Vertical Drains - Lime Stabilization - Cement Stabilization - Fly-Ash Stabilization - Stone Columns - Sand Compaction Piles - Dynamic Compaction - Jet Grouting - Deep Mixing.

UNIT V   GEOTECHNICS TOWARDS SUSTAINABILITY   9
Introduction to sustainability - Sustainability in geotechnical practice - Geosynthetics types and characteristics - Geosynthetic-Reinforced Slopes, Embankments, Foundations, Roads – Design considerations – Design Parameters and Procedures – Quality control and Assurance.

TOTAL:45 PERIODS

COURSE OUTCOMES:
CO1   Apply the basic elements of site investigation and explain the interpretation of the soil field/lab testing report and collect pertinent information for geotechnical design.
CO2   Critically assess the effectiveness of dewatering and various excavation methods and promote the safety of construction.
CO3   Determine the bearing capacity of shallow and deep foundations on different terrain, including their expected settlement.
CO4   Identify an appropriate method of ground improvement and design remedial measures where necessary.
CO5   Evaluate the key challenges associated with ensuring the sustainability of the project and recommend appropriate state-of-the-art design solutions using geosynthetics for specific problem scenarios.

REFERENCES:
1. Braja M. Das, "Principles of Foundation Engineering", Cengage Learning, 2015 Eighth Edition.
2. Jie Han, "Principles and Practices of Ground Improvement", John Wiley & Sons., 2015.
3. Ming Xiao, "Geotechnical Engineering Design", Wiley Blackwell, 2015.
4. ICE Manual of Geotechnical Engineering: Vol I & II, Institution og Civil Engineers Publication, J.B. Burland, Tim Chapman eds.,2012.
5. W.L. Schroeder, Don C. Warrington, S. E. Dickenson, "Soils in Construction", Pearson Education, Fifth Edition, 2012.
6. Murthy, V.N.S., "Advanced Foundation Engineering", CBS Publishers & Distributors, New Delhi,2007.
7. Purushothama Raj, P., Ground Improvement Techniques, Laxmi Publications (P) Ltd., New Delhi,2007.
8. IS 1888: 1982 Method of Load Test on Soils.
9. IS 1892: 1979 Code of Practice for Subsurface Investigation for Foundations
10. IS 2131: 1981 Method for Standard Penetration Test for Soils.
11. IS 2720: All parts: 1990 Methods of Test for Soils
12. IS 4434: 1978 Code of practice for in-situ vane shear test for soils.
13. IS 4453: 1980 Code of Practice for Subsurface Exploration by Pits, Trenches, Drifts and Shafts
14. IS 4464: 1985 Code of Practice for Presentation of Drilling Information and Core Description in Foundation Investigation.
15. IS 1080: 1985 Code of Practice for Design and Construction of Shallow Foundations in Soils (Other than Raft, Ring and shell).
16. IS2911: Part I: Sec 1 to IV: 1979 Code of Practice for Design and Construction of Pile Foundations.

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3
CO1	3	3	3
CO2	3	1	3
CO3	3	1	3
CO4	2	2	3
CO5	1	1	3

IM4204	ADVANCED STRUCTURAL DESIGN	L T P C
		3 0 0 3

OBJECTIVES:

- To understand and explain the design of special RC Elements, Steel Structures, Industrial Buildings, Tall Building and special structures.

UNITI   DESIGN OF SPECIALRC ELEMENTS   9

Design of slender columns - Design of RC walls. Strut and tie method of analysis for corbels and deep beams, Design of corbels, Deep-beams and grid floors.

UNIT II   DESIGN OF COLD FORMED STEEL STRUCTURES   9

Introduction to Direct Strength Method - Behavior of Compression Elements - Effective width for load and deflection determination – Behavior of Unstiffened and Stiffened Elements – Design of webs of beams – Flexural members – Lateral buckling of beams – Shear Lag – Flange Curling – Design of Compression Members –Wall Studs.

UNITIII   TALL BUILDING   9

The Tall Building in the Urban Context - The Tall Building and its Support Structure - Development of High Rise Building Structures - General Planning Considerations. Dead Loads - Live Loads-

Construction Loads -Snow, Rain, and Ice Loads - Wind Loads-Seismic Loading – Water and Earth Pressure Loads - Loads - Loads Due to Restrained Volume Changes of Material - Impact and Dynamic Loads - Blast Loads -Combination of Loads.

UNIT IV   ANALYSIS AND DESIGN OFSPECIALSTRUCTURES   9
The Rigid Frame Structure Approximate Analysis for Vertical Loading - Approximate Analysis for Lateral Loading - Approximate Design of Rigid Frame Buildings- Shear Wall Structure - The Vierendeel Structure - The Hollow Tube Structure.

UNIT V   PRESTRESSED CONCRETE   9
Principles of Pre-stressing - Types and Systems of Pre-stressing, need for High Strength materials, Analysis, methods losses, deflection (short- long term), camber, cable layouts - Behavior of flexural members, determination of ultimate flexural strength - Codal provisions - Design of flexural members, Design for shear, bond and torsion. Design of end blocks.

TOTAL: 45 PERIODS

COURSE OUTCOME
CO1 Design various concrete structures and structural elements by limit state design and detailing for ductility as per codal requirements.
CO2 Describe the design procedure for special structures such as Deep beams, Corbels, Deep beams, and Grid floors
CO3 Design steel structures for different load conditions.
CO4 Explain the design procedure for different types of industrial structures
CO5 Analyze and Design Bunkers, Silos and Chimneys.

REFERENCES:
1. Gambhir.M. L., "Design of Reinforced Concrete Structures", Prentice Hall of India,2012.
2. Purushothaman, P, "Reinforced Concrete Structural Elements: Behavior Analysis and Design", Tata McGraw Hill,1986
3. Unnikrishna Pillai and Devdas Menon "Reinforced Concrete Design', Third Edition, Tata McGraw Hill Publishers Company Ltd., New Delhi,2007.
4. Varghese, P.C, "Advanced Reinforced Concrete Design", Prentice Hall of India,2005.
5. Varghese, P.C., "Limit State Design of Reinforced Concrete", Prentice Hall of India,2007.
6. Lynn S. Beedle, Plastic Design of Steel Frames, John Wiley and Sons,1990.
7. Narayanan.R.et.al., Teaching Resource on Structural Steel Design, INSDAG, Ministry of Steel Publishing,2000.
8. Subramanian.N, Design of Steel Structures, Oxford University Press,2014.
9. Wie Wen Yu, Design of Cold Formed Steel Structures, McGraw Hill Book Company,1996
10. Taranath B S, "Structural Analysis and Design of Tall Buildings" Tata McGraw Hill Education Pvt Ltd, New Delhi,2011

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3
CO1	1	1	3
CO2	1	1	3
CO3	1	2	3
CO4	1	1	2
CO5	2	2	3

IM4211   **GIS LABORATORY**   **L T P C**
                                                                       0 0 4 2

OBJECTIVES:
- To Demonstrate and Acquire skills in using GIS software package.

EXERCISES:
- Data Input – Onscreen Digitization – Creation of Point, Line and Polygon layers
- Projection, Re-projection and Coordinate Transformation of Maps
- Attribute data input and Measurement of Distance, Area
- Linking External Database and Tabular Data Analysis using SQL commands
- Generating Graphs, Charts and Diagrams from Tabular data
- Data Conversion – Vector to Raster and Raster to Vector
- Map Joining, Edge Matching and Layout Design
- Map compilation and Design

TOTAL: 60 PERIODS

SYSTEM SPECIFICATIONS
HP Desktop Computers - 18 Nos
(Intel i7 core, 4 GB RAM, 1 TB HDD and 1 GB Graphics card).

SOFTWARES
   i) ESRI – ArcGIS (latest Version) – 18Users
   ii) Quantum GIS (Open Source) – 18Users

OUTCOMES:
CO1 Describe the Projection Systems and their applications
 CO2 Compile and Design a typical map with suitable map elements
CO3 Generate Spatial Databases through spatial and non-spatial data input
CO4 Analyze attribute data using SQL commands
CO5 Present the outcome in spatial and pictorial form

REFERENCE:
1. H. Robinson et al, Elements of Cartography, 7th Edition, John Wiley and Sons,2004.
2. C.P. Lo Albert K.W. Yeung, "Concepts and Techniques of Geographic Information Systems", Prentice Hall of India Publishers,2006.
3. Munnell, Alicia, Editor, Is There a Shortfall in Public Capital Investment? Proceedings of a Conference Held in June (1990).
4. World Development Report 1994: Infrastructure for Development (1994).
5. Zimmerman, K. and F. Botelho, "Pavement Management Trends in the United States," 1st European Pavement Management Systems Conference, Budapest, September (2000).

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3
CO1	1	1	2
CO2	2	2	2
CO3	3	1	3
CO4	2	1	3
CO5	1	1	2

IM4212   **INFRASTRUCTURE MATERIAL TESTING LABORATORY**   **L T P C**
                                                                                  0 0 4 2

OBJECTIVES
- To conduct experiments on construction materials by providing advanced tools & expertise for the pursuit of industrial, field and academic research.
- To understand the application of computational tools in infrastructure engineering design and analysis.
- To prepare, interpret and comprehend the field and laboratory testing for sustainable design and construction of infrastructure.
- To understand the importance of QC/AQ in field construction practices.

EXPERIMENTS
Concrete Engineering Lab
1. Cube Testing – Mix Design
2. Rheology of concrete
3. Fabrication, casting and testing of simply supported Reinforced Concrete Beam for Strength and Deflection behaviour
4. Testing of Simply Supported Steel Beam for Strength and Deflection Behavior.
5. Non -Destructive Testingusing Concrete Test Hammers, Ultrasonic pulse velocity testers.
6. Multibay portal frame Analysis using STADDPRO software

Geotechnical Engineering Lab
1. Direct Shear Test
2. Consolidation Test
3. Unconfined Compressive test
4. Triaxial shear test (Drained and Un-drained test)
5. CBR Test.
6. Geotextile Testing
7. Slope stability, bearing capacity and settlement analysis using PLAXIS software.

Environmental Engineering Lab
1. Water testing for construction as stated in IS 456.

EQUIPMENTS
1. Loading frame of 100-ton capacity with required accessories
2. Compression Testing Machine (CTM) with required accessories
3. RCPT test Apparatus/ Sulphate resistance Apparatus
4. V- funnel and L-box Apparatus
5. CBR test Apparatus
6. Sorptivity test Apparatus
7. Tri-axial equipment
8. Consolidometer Accessories include Consolidation Ring Porous Stones, Consolidation Cell, Dial Gauges, Loading Device, Equipment for measuring Initial Height of Test Specimen to an accuracy of 0.1 mm
9. Unconfined compressive strength test equipment consists of trimmers, saws, extruders, and moulding components.
10. Direct shear test consists of shear box, soil container, loading unit, proving ring, dial gauge to measure shear deformation and volume changes
11. NDT equipment consists of Concrete Test Hammers, Ultrasonic pulse velocity testers
12. STAAD PRO & PLAXIS Software
13. Geotextile Permeameter
14. Water testing equipment & Chemicals

Course Outcomes
CO1- Characterize the operational principles of various types of material testing apparatuses and distinguish the merits and pitfalls of different types of tests.

CO2- Apply rigorous standard testing methods to conduct laboratory tests and interpret test Results.
CO3- Perform QC/QA on the materials used for infrastructure engineering and Quantify aspects of the sustainability in the selection of the materials.
CO4- Demonstrate the computational tools in the analysis of infrastructure projects
CO5- Prepare testing report based on field, laboratory and computational techniques.

REFERENCES:
1. IS 2720: All parts: 1990 Methods of Test for Soils
2. IS 3025: Methods of sampling and testing of water
3. IS 456: (2000) – Plain and Reinforced Concrete – Code of practice.
4. IS 516 (1959): Methods of tests for strength of concrete.
5. IS 1199 (1959): Methods of sampling and analysis of concrete.

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3
CO1	3	1	3
CO2	2	2	3
CO3	2	1	3
CO4	3	2	3
CO5	3	3	2

IM4311 **SEMINAR** **L T P C**
0 0 2 1

OBJECTIVE:
- To work on a specific technical topic in Infrastructure Engineering in order to acquire the skills of oral presentation and to acquire technical writing abilities for seminars and conferences.

SYLLABUS: The students will work for two hours per week guided by a group of staff members. They will be asked to talk on any topic of their choice related to Infrastructure Engineering and to engage in dialogue with the audience. A brief copy of their talk also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will also answer the queries on the topic. The students as audience also should interact. Evaluation will be based on the technical presentation and the report and also on the interaction during the seminar.

TOTAL: 30 PERIODS

OUTCOME:
- On completion of the course, the student is expected to be able to acquire the skills of oral presentation and to acquire technical writing abilities for seminars and conferences.

IM4312 **INDUSTRIAL 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 Infrastructure Engineering in carrying out engineering tasks.

SYLLABUS: The students individually undertake training in reputed engineering companies doing Infrastructure Engineering during the summer vacation for a specified duration of four weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the

commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

OUTCOME:
* On completion of the course, the student is expected to be able to develop skills in facing and solving the problems experiencing in the Infrastructure Engineering field.

IM4313	PROJECT WORK I	L T P C
		0 0 12 6

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

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

TOTAL: 180 PERIODS

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

IM4411	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

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

ST4073   **MAINTENANCE, REPAIR AND REHABILITATION OF STRUCTURES**   **L T P C**
                                                                          3 0 0 3

OBJECTIVE:
- To study the damages, repair and rehabilitation of structures

UNIT I   MAINTENANCE AND REPAIR STRATEGIES   9
Maintenance, Repair and Rehabilitation, retrofit and strengthening, need for rehabilitation of structures- Service life behaviour - importance of Maintenance, causes and effects of deterioration. Non-destructive Testing Techniques

UNIT II   STRENGTH AND DURABILITY OF CONCRETE   9
Quality assurance for concrete based on Strength , Durability and Microstructure of concrete - NDT techniques- Cracks- different types, causes – Effects due to Environment, Fire , Earthquake, Corrosion of steel in concrete, Mechanism, quantification of corrosion damage

UNIT III   REPAIR MATERIALS AND SPECIAL CONCRETES   9
Repair materials-Various repair materials, Criteria for material selection, Methodology of selection, Special mortars and concretes- Polymer Concrete and Grouting materials- Bonding agents-Latex emulsions, Epoxy bonding agents, Protective coatings-Protective coatings for Concrete and Steel, FRP sheets

UNIT IV   PROTECTION METHODS AND STRUCTURAL HEALTH MONITORING   9
Concrete protection methods – reinforcement protection methods- cathodic protection - Sacrificial anode - Corrosion protection techniques – Corrosion inhibitors, concrete coatings-Corrosion resistant steels, Coatings to reinforcement, Structural health monitoring.

UNIT V   REPAIR, RETROFITTING AND DEMOLITION OF STRUCTURES   9
Various methods of crack repair, Grouting, Routing and sealing, Stitching, Dry packing, Autogenous healing, Repair to active cracks, Repair to dormant cracks. Repair of various corrosion damaged of structural elements (slab, beam and columns) Jacketing Techniques, Strengthening Methods for Structural Elements. Engineered Demolition -Case studies

                                                                     TOTAL: 45 PERIODS
REFERENCES:
1. Dodge Woodson, Concrete Structures, Protection, Repair and Rehabilitation, Butterworth-Heinemann,Elsevier,New Delhi 2012
2. DovKominetzky.M.S., - Design and Construction Failures, Galgotia Publications Pvt.Ltd., 2001
3. Ravishankar.K.,Krishnamoorthy.T.S, Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures, Allied Publishers, 2004.
4. Hand book on Seismic Retrofit of Buildings, CPWD and Indian Buildings Congress, Narosa Publishers, 2008.
5. Hand Book on "Repair and Rehabilitation of RCC Buildings" – Director General works CPWD ,Govt of India , New Delhi – 2002
6. BS EN 1504 - Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity

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

CO1	Explain the importance of maintenance assessment and repair strategies
CO2	Acquire knowledge on strength and durability properties and their effects due to climate and temperature.
CO3	Gain knowledge in recent developments in repair
CO4	Explain the techniques for repair and protection methods
CO5	Explain the repair, rehabilitation and retrofitting of structures and demolition methods.

COs- PO's & PSO's MAPPING

CO	PO			PSO		
	1	2	3	1	2	3
1	3	-	2	3	2	2
2	3	1	-	2	2	1
3	3	-	2	2	3	1
4	3	1	-	3	2	2
5	3	2	1	2	2	1
Avg	3	1.33	1.67	2.40	2.20	1.40

IM4001   **MATERIAL PROCUREMENT AND MANAGEMENT**   **L T P C**
                                                                           3 0 0 3

OBJECTIVES:
- To Understand and Explain various types of Material Procurement, Management, Stores management and Quality Control

UNIT I   **INTRODUCTION:**   **9**
Importance of material management and its role in construction industry scope, objectives and functions, Integrated approach to materials management, Role of materials manager.

UNIT II   **CLASSIFICATION AND CODIFICATION OF MATERIALS OF CONSTRUCTION: 9**
ABC,FSN, VED, SOS analysis- Procedure and its use, Standardization in materials and their management, Procurement, identification of sources of procurement, vendor analysis. Vendor analysis concept of (MRKP) Material requirement planning, planning, purchase procedure, legal aspects
.
UNIT III   **INVENTORY MANAGEMENT**   **9**
Store Purchase Manual, Contractors Obligation. Inventory Control techniques. EOQ, Advantages and limitation of use of EOQ, Periodic ordering, order point control, safety stock, stock outs, application of AC analysis in inventory control, concept of (JIT) - Just in time management, Indices used for assessment of effectiveness of inventory management.

UNIT IV   **STORES MANAGEMENT:**   **9**
Receipt and inspection, care and safety in handling, loss on storage, wastage, Bulk purchasing, site layout and site organization, scheduling of men, materials and equipment.

UNIT V   **QUALITY CONTROL**   **9**
Conventional methods of quality control of Construction materials. Statistical method of quality control, Sampling techniques quality control in process. Quality Management and its economics. Project procurement processes. Use of (MMS) – Materials Management Systems in materials planning, procurement, inventory control, cost control etc. Project evaluation: Discounted Cash Flow, Real Options Theory. Project delivery methods, Competitive bidding.
Risk allocation and management. Integrated project delivery. Contract negotiation.

                                                       TOTAL: 45 PERIODS
OUTCOMES:
CO1   Identify the need and role of material management Understand
CO2   Classify materials, identify sources of procurement, conduct vendor analysis
CO3   Exercise control for effective management of inventory
CO4   Manage stores and exercise quality control on materials
CO5   Apply MMS in planning, procurement, inventory and cost control, evaluate projects and manage risks

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REFERENCES

1. "A Guide to the Project Management Body of Knowledge (PMBOK Guide) - Fourth Edition, An American National Standard, ANSI/PMI 990001-2008"
2. Chitale A.K. and R.C. Gupta, "Material Management – Text and Cases", Prentice Hall of India Pvt. Ltd., 2007
3. Denise Bower, "Management of Procurement", Construction Management Series, Thomas Telford Publishing, 2003
4. Joseph Philips, PMP, Project Management and Professional (Certification Study Guides), McGraw Hill Publication, 2013
5. Jhamb L.C., "Inventory Management", Everest Publishing house, 2005
6. Menon K.S., "Purchasing and Inventory Control", Wheeler Publication, 1993
7. Ministry of Rural Development, GOI, "Procurement Manual", National Rural Livelihoods Project, 2010
8. Peter Holm Andersen, "Dynamics of Procurement Management – A Complexity Approach", Copenhagen Business School, 2012
9. Peter Baily, David Farmer, Barry Crocker, David Jessop & David Jones, "Procurement Principles and Management", FT Prentice Hall, 2010
10. Manual for Ministry of Roads, Transport and Highways (MoRTH), GOI, 2007, 4th Revision

CN4072   ECONOMICS AND FINANCE MANAGEMENT IN CONSTRUCTION   L T P C
3 0 0 3

OBJECTIVE:

- To introduce the various aspects of Construction economics and finance with the systematic evaluation of cost and benefit associated with different projects.

UNIT I   BASIC PRINCIPLES   9

Time Value of Money – Cash Flow diagram – Nominal and effective interest- continuous interest. Single Payment Compound Amount Factor (P/F,F/P) – Uniform series of Payments (F/A,A/F,F/P,A/P)– Problem time zero (PTZ)- equation time zero (ETZ). Constant increment to periodic payments – Arithmetic Gradient(G), Geometric Gradient (C).

UNIT II   COMPARING ALTERNATIVES PROPOSALS   9

Comparing alternatives- Present Worth Analysis, Annual Worth Analysis, Future Worth Analysis, Rate of Return Analysis (ROR) and Incremental Rate of Return (IROR)Analysis, Benefit/Cost Analysis, Break Even Analysis.

UNIT III   EVALUATING ALTERNATIVE INVESTMENTS   9

Real Estate - Investment Property, Equipment Replace Analysis, Depreciation – Tax before and after depreciation – GST– Input Tax Credit (ITC) – Assessment and Administration of GST – Inflation.

UNIT IV   FUNDS MANAGEMENT   9

Project Finance – Sources of finance - Long-term and short -term finance, Working Capital Management, Inventory valuation, Mortgage Financing - International financial management- foreign currency management.

UNIT V   FUNDAMENTALS OF MANAGEMENT ACCOUNTING   9

Management accounting, Financial accounting principles- basic concepts, Financial statements – accounting ratios - funds flow statement – cash flow statement.

TOTAL : 45 PERIODS

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

CO1 Summarize the basic principles of Economic in construction
CO2 Evaluate alternate proposals
CO3 Evaluate alternative investments
CO4 Select best source of finance for a project
CO5 Elaborate the finance and accounting

REFERENCES:
1. Patel, B M Project management- strategic Financial Planning, Evaluation and Control, Vikas Publishing House Pvt. Ltd. New Delhi, 2000
2. Shrivastava,U.K., Construction Planning and Management,2nd Edn. Galgotia Publications Pvt. Ltd. New Delhi., 2001.
3. Blank, L.T., and Tarquin,a.J Engineering Economy,4th Edn. Mc-Graw Hill Book Co., 1988
2. Collier C and GlaGola C Engineering Economics & Cost Analysis, 3nd Edn. Addison Wesley Education Publishers.,1998.
5. Steiner, H.M. Engineering Economic principles, 2nd Edn. McGraw Hill Book, 1996

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	1	1	3	3	1
CO2	2	2	1	2	2	1
CO3	1	2	2	3	3	2
CO4	2	2	1	2	2	1
CO5	1	1	2	1	1	3

CN4074   **ORGANIZATIONAL BEHAVIOUR**   **L T P C**
                                                                      3 0 0 3
OBJECTIVE:
- To learn basic concepts of organizational behavior.
- To gain a solid understanding of human behavior in the workplace from an individual.
- To gain a solid understanding of human behavior in the workplace in the group.
- To learn the concepts of Leadership and power.
- To learn the dynamics of organizational behavior.

UNIT I   INTRODUCTION TO ORGANIZATIONAL BEHAVIOUR   9
Definition, need, and importance of organizational behaviour –Nature and scope –Frame work – Organizational behaviour models.

UNIT II   INDIVIDUAL BEHAVIOUR   9
Personality: types –Factors influencing personality, theories–Types of learners –The learning process –Learning theories –Organizational behaviour modification –Misbehaviour: Types and Management Intervention - Emotions: Emotional Labour –Emotional Intelligence –Theories – Attitudes: Characteristics, Components, Formation, Measurement, and Values - Perceptions: Importance, Factors influencing perception –Interpersonal perception -Impression Management Motivation –importance –Types –Effects on work behavior.

UNIT III   GROUP BEHAVIOUR   9
Organization structure –Formation –Groups in organizations –Influence –Group dynamics – Emergence of informal leaders and working norms –Group decision-making techniques –Team building -Interpersonal relations –Communication –Control.

UNIT IV   LEADERSHIP AND POWER   9
Meaning –Importance–Leadership styles –Theories –Leaders Vs Managers –Sources of power – Power centers –Power and Politics.

UNIT V   DYNAMICS OF ORGANIZATIONAL BEHAVIOUR   9
Organizational culture and climate –Factors affecting organizational climate –Importance of Job satisfaction –Determinants–Measurements – Influence on behavior - Organizational change – Importance –Stability Vs Change – Proactive Vs Reaction change– The change process – Resistance to change – Managing change - Stress - Work Stressors–Prevention and Management of stress – Balancing work and Life - Organizational development –Characteristics and objectives – .Organizational effectiveness.

                                                                    TOTAL: 45 PERIODS

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

CO1	Identify the need and importance of organizational behavior and the framework of organizational models
CO2	Explain the various learning theories and develop alternative organizational behavior approaches in the workplace
CO3	Describe the importance of group dynamics and team building.
CO4	Explore the various leadership styles and politics.
CO5	Explain the dynamics of organizational behaviour with the balance of work life.

REFERENCES:
1. Stephen P. Robins, "Organisational Behavior", PHI Learning / Pearson Education, 15th edition,2012.
2. FredLuthans, "Organisational Behavior", McGraw Hill, 12th Edition, 2005.
3. Schermerhorn, Hunt, and Osborn, "Organisational Behavior", John Wiley, 12th Edition, 2011.
4. UdaiPareek, "Understanding Organisational Behaviour", 2nd Edition, Oxford Higher Education, 2008.
5. Mc Shane & Von Glinov, "Organisational Behaviour", 6th Edition, Tata McGraw Hill, 2012.

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	1	3	2	1	2
CO2	2	1	1	2	3	2
CO3	1	2	2	2	2	3
CO4	1	1	1	2	3	1
CO5	1	1	1	3	2	1

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IM4002   **MANAGEMENT OF HUMAN RESOURCE AND QUALITY**   **L T P C**
                                                                       3 0 0 3

OBJECTIVES :
   - To understand and Explain Management of Human Resources, Labour Legislation, Quality Assurance and Control, Quality management in Construction and Total Quality Management.

UNIT I   HUMAN RESOURCES MANAGEMENT   9
Introduction – Concept- Growth – Role and function. Manpower Planning for Construction Companies – Line and Staff function. Recruitment, selection, placement, induction and training; over staffing; Time office and establishment functions; wage and salary administration – Discipline-Separation Process.

UNIT II   LABOUR LEGISLATION   9

Labour laws- labour law relating to construction industry- Interstate Migration-Industrial relations- Collective bargaining- Worker's participation in management. Grievancehandling- discipline-role of law enforcing agencies and judiciary – women in construction industry.

UNIT III   QUALITY ASSURANCE AND CONTROL   9

Objectives –   Regularity agent, owner, design, contract and construction oriented objectives, methods – Techniques and needs of QA/QC – Different aspects of quality – Appraisals, Factors influencing construction quality – Critical, major failure aspects and failure mode analysis, – Stability methods and tools, optimum design – Reliability testing, reliability coefficient and reliability Prediction.

UNIT IV   QUALITY MANAGEMENT IN CONSTRUCTION   9

Importance of quality; Elements of quality- quality characteristics- quality by design - quality conformance, contractor quality control- identification and traceability, Continuous Chain Management – brief concept and application. Importance of specifications- Incentives and penalties in specifications – Workmanship as a mark of quality – Final Inspection. Quality assurance techniques – Inspection, testing, sampling. Documentation – Organization for quality control, Cost of quality.

UNIT V   TOTAL QUALITY MANAGEMENT   9

Overview of the contributions of Deming, Juran Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio. Concepts of Quality circle, Japanese 5S principles and 8D methodology–Introduction to IS/ISO 9004:2000 – quality management systems – guidelines for performance improvements. Quality Audits. TQM culture, Leadership – quality council, employee involvement, motivation, empowerment, recognition and reward - TQM framework, benefits, awareness and obstacles.

TOTAL: 45 PERIODS

COURSE OUTCOME:

CO1   Explain the need and importance of human resource management, labour laws relating to Construction industry
CO2   Identify the need and measures to improve safety in construction industry and safety audit
CO3   Explain the need for applying ergonomics to construction industry
CO4   Enumerate the need, importance, elements of quality and significance of quality assurance in industry
CO5   Explain the principles of Total Quality Management.

REFERENCES:

1. James, J.O' Brian, "Construction Inspection Handbook" – Total Quality Management, Van Nostrand, 1997
2. John L. Ashford, "The Management of Quality in Construction", E & F. N. Spon, 1989.
3. Juran Frank, J.M. and Gryna, F.M. "Quality Planning and Analysis", McGraw Hill, 2001
4. Kwaku.A., Tena, Jose, M. Guevara, "Fundamentals of Construction Management and Organisation", Reston Publishing Co., Inc., 1985.
5. Steven McCabe, "Quality Improvement Techniques in Construction", Addison Wesley Longman Ltd, 1998.
6. Dale H. Bester filed, "Total Quality Management", Pearson Education Asia, (Indian reprint 2011).
7. John Bank, The essence of total quality management PHI 2000.
8. Greg Bounds, Lyle York's et al, Beyond Total Quality Management, McGraw Hill, 1994.
9. Takashi Osada, The 5S's The Asian Productivity Organization, 1991.

CN4092   SUPPLY CHAIN MANAGEMENT AND LOGISTICS IN CONSTRUCTION   L T P C
                                                                        3 0 0 3

OBJECTIVE:
- To gain knowledge about construction supply chain management.
- To understand the concepts of strategic perspectives.
- To understand the concepts of integrated data management.
- To understand the concepts of construction logistics and sustainability.
- To understand the concepts of logistics operations.

UNIT I   INTRODUCTION   9
Definition of Logistics and SCM: Evolution, Scope, Importance - Supply chain stages and decision phases process view of a supply chain - Supply chain flows- Examples of supply chains- Competitive and supply chain strategies- Achieving strategic fit- Expanding strategic scope- Drivers of supply chain performance- Framework for structuring drivers -Obstacles to achieving fit.

UNIT II   STRATEGIC PERSPECTIVES   9
Challenge of construction logistics-Aggregating global products for just-in-time delivery to construction sites – Construction Logistics – Supply of bulk materials – Effective management of a construction project supply chain – Construction supply chain management strategy.

UNIT III   INTEGRATED DATA MANAGEMENT   9
Impact of BIM and new data management capabilities on supply chain management in construction – Data management for integrated supply chains in construction

UNIT IV   CONSTRUCTION LOGISTICS AND SUSTAINABILITY   9
Role of logistics in achieving sustainable construction – Resource efficiency benefits of effective logistics

UNIT V   LOGISTICS OPERATIONS   9
Role of the construction logistics manager – Third-party logistics operators in construction – Managing construction logistics for confined sites in urban areas - Consolidation centers in construction logistics – Delivery management systems.
                                                        TOTAL: 45 PERIODS

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

CO1 Describe the conceptual and theoretical backgrounds of Supply Chain Management and logistics
CO2 Apply the strategy in logistics functions ranging from planning to execution and control.
CO3 Identify the Impact of BIM and new data management capabilities on supply chain management in construction.
CO4 Analyze the implications of various strategic choices and decide on a better course of action.
CO5 Understand the role of construction logistic Managers and Delivery management systems.

REFERENCES:
1. GregerLundesjö, Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment, Kogan Page Publishers, 2015.
2. Supply Chain Management, Strategy, Planning, and Operation – Sunil Chopra, Peter Meindl, and Kalra, Pearson Education, 2011
3. A. Ravi Ravindran, Donald P. Warsing, Supply Chain Engineering: Models and Applications, CRC Press, 2012.
4. G Srinivasan, Quantitative Models in Operations and Supply Chain Management, PHI Learning (P) Ltd, New Delhi, 2010
5. David J.Bloomberg, Stephen Lemay and Joe B.Hanna, Logistics, PHI 2010

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	1	1	3	1	3
CO2	3	3	3	3	2	1
CO3	1	1	1	3	3	2
CO4	3	1	3	3	2	2
CO5	3	3	3	3	2	3

CN4091   LEAN CONSTRUCTION CONCEPTS, TOOLS, AND PRACTICES   L T P C
3 0 0 3

OBJECTIVE:
- To impart knowledge about the basics of lean construction.
- To impart knowledge about the lean principles.
- To impart knowledge about the core concepts of lean construction.
- To impart knowledge about the lean tools and techniques.
- To impart knowledge about the basics of lean implementation in the construction industry.

UNIT I   INTRODUCTION   9
Introduction and overview of the construction project management -Review of Project Management& Productivity Measurement Systems – Productivity in Construction– Daily Progress Report-The state of the industry for its management practices –construction project phases - Essential features of contemporary construction management techniques - The problems with current construction management techniques– Current production planning.

UNIT II   LEAN MANAGEMENT   9
Introduction to lean management – Toyota's management principle-Evolution of lean in the construction industry - Production theories in construction –Lean construction value - Value in construction - Target value design – Lean project delivery system- Forms of waste in the construction industry – Waste Elimination.

UNIT III   CORE CONCEPTS IN LEAN   9
Concepts in lean thinking – Principles of lean construction – Variability and its impact – Traditional construction and lean construction – Traditional project delivery - Lean construction and workflow reliability – Work structuring – Production control.

UNIT IV   LEAN CONSTRUCTION TOOLS AND TECHNIQUES   9
Value Stream Mapping – Work sampling – Last planner system – Flow and pull-based production – Last Planner System – Look ahead schedule – constraint analysis – weekly planning meeting- Daily Huddles – Root cause analysis – Continuous improvement – Just in time.

UNIT V   LEAN CONSTRUCTION IMPLEMENTATION   9
Lean construction implementation- Enabling lean through information technology – Lean in design - Design Structure Matrix Location Based Management System-BIM (Building Information Modelling) - IPD (Integrated Project Delivery) – Sustainability through lean construction approach
TOTAL : 45 PERIODS

OUTCOME:
On completion of this course, the student is expected to be able to
CO1 Explains the contemporary management techniques and the issues in the present scenario.
CO2 Apply the basics of lean management principles and their evolution from the manufacturing industry to the construction industry.
CO3 Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.
CO4 Apply lean techniques to achieve sustainability in construction projects.
CO5 Apply lean construction techniques in design and modeling

REFERENCES:
1. Corfe, C. and Clip, B., Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.
2. Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.
3. Dave, B., Koskela, L., Kiviniemi, A., Owen, R., andTzortzopoulos, P., Implementing lean in construction: Lean construction and BIM, CIRIA, 2013.
4. Ballard, G., Tommelein, I., Koskela, L. and Howell, G., Lean construction tools and techniques, 2002.
5. Salem, O., Solomon, J., Genaidy, A. and Luegring, M., Site Implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.
6. Lincoln H. Forbes , Syed M. Ahmed, Lean Project Delivery and Integrated Practices in Modern Construction, Routledge Publishers, 2nd Edition, 2020.

COs- PO's & PSO's MAPPING

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	1	2	3	2	2
CO2	2	1	1	3	3	2
CO3	2	1	1	3	1	2
CO4	3	1	1	3	2	1
CO5	2	1	1	3	2	1

IM4003	VALUE ENGINEERING	L T P C
		3 0 0 3

OBJECTIVES:
- To Understand and Explain Value Engineering, Estimation, Job Plan, Reliability estimation and Various Phases.

UNIT I   INTRODUCTION   9
Value Engineering (VE) and Value Analysis (VA) - Life Cycle of a product- Methodology of value engineering – Difference from the conventional methods of cost reduction- Unnecessary costs reasons- Quantitative definition of value- Use value and Prestige value.

UNIT II   ESTIMATION   9
Estimation of product Quality/performance- Types of functions- Relationship between Use functions and Esteem Functions in product design – Functional cost and Functional Worth – Effect of Value improvement on profitability- Test for poor value –Aims of Systematic Approach.

UNIT III   JOB PLAN   9
Functional approach to value improvement-various phases and techniques of Job Plan – Factors governing project selection – Types of Projects-Life Cycle Costing (LCC) for managing the Total Value- Concepts in LCC – Present value concept- Annuity concept- Net Present value- Payback period -Internal rate of return on Investment (IRR)-Examples and Illustrations.

UNIT IV   RELIABILITY ESTIMATION   9
Creative thinking and creative judgment- positive or constructive discontent- Tangible and Intangible costs of Implementation-False material-labour and overhead saving – Relationship between savings and probability of success- Reliability Estimation-System reliability- Reliability elements in series and parallel.

UNIT V   VARIOUS PHASES   9
General Phase-Information Phase – Type of costs- Function Phase – Evaluation of Functional Relationships- Checks for Consistency-Function –cost-weight-matrix-VIP Index – High cost and Poor

value areas- Creativity/Speculation Phase – Rules of Creativity-Brainstorming- Idea activators-Result accelerators – Evaluation Phase – Estimation of costs of ideas- Evaluation by comparison.

TOTAL :45 PERIODS

COURSE OUTCOME
CO1 Establish the Value engineering methodology
CO2 Recognize the various phases of value engineering
CO3 Perform function cost worth analysis
CO4 Create the ideas for solving the problems
CO5 Analyze the functional importance and functional cost

REFERENCES
1. Arthur E Mudge, "Value Engineering", McGraw Hill Book Company,1971
2. A.D. Raven, Profit Improvement through Value Analysis, value Engineering and Purchase Price Analysis, Cassell and Co. London. (1971)
3. Richard J Park, "Value Engineering – A Plan for Inventions", St. Lucie Press, London,1999
4. S SIyer," Value Engineering – A How to Manual", 3rd edition, New Age Publishers, Chennai, ISBN:978-81-224-2405-8,2006
5. Value engineering, Mukhopadhyaya, Anil Kumar, Response Books, New Delhi, ISBN: 0-7619-9788-1, 2003.

IM4004	SAFETY IN CONSTRUCTION ENGINEERING	L T P C
		3 0 0 3

OBJECTIVES:
- To Understand and Explain the of construction accidents, safety programmes, contractual obligations, and design for safety.

UNIT I   CONSTRUCTION ACCIDENTS   9
Accidents and their Causes – Human Factors in Construction Safety – Costs of Construction Injuries – Occupational and Safety Hazard Assessment – Legal Implications.

UNIT II   SAFETY PROGRAMMES   9
Problem Areas in Construction Safety – Elements of an Effective Safety Programme – Job-Site Safety Assessment – Safety Meetings – Safety Incentives.

UNIT III   CONTRACTUAL OBLIGATIONS   9
Safety in Construction Contracts – Substance Abuse – Safety Record Keeping.

UNIT IV   DESIGNING FOR SAFETY   9
Safety Culture – Safe Workers – Safety and First Line Supervisors – Safety and Middle Managers – Top Management Practices, Company Activities and Safety – Safety Personnel – Sub contractual Obligation – Project Coordination and Safety Procedures – Workers Compensation.

UNIT V   OWNER'S AND DESIGNERS' OUTLOOK   9
Owner's responsibility for safely – Owner preparedness – Role of designer in ensuring safety – Safety clause in design document.

TOTAL :45 PERIODS

COURSE OUTCOME
CO1 Explain the construction accidents
CO2 Explain the safety programme.
CO3 Describe contractual obligations.
CO4 Explain the safety design.
CO5 Explain the outlook of owner and designer.

REFERENCES:
1. Jimmy W. Hinze, "Construction Safety", Prentice Hall Inc.,1997.
2. Richard J. Coble, Jimmie Hinze and Theo C. Haupt Construction Safety and
3. Tamilnadu Factory Act, Department of Inspectorate of factories, Tamilnadu. Health Management, Prentice Hall Inc.,2001

ST4091	DESIGN OF BRIDGE STRUCTURES	L T P C
		3 0 0 3

OBJECTIVE:
- To study the loads, forces on bridges and design principles of several types of bridges.

UNIT I   INTRODUCTION   9
Introduction-Selection of Site and Initial Decision Process - Classification of Bridges- General Features of Design- Standard Loading for Bridge Design as per different codes - Road Bridges – Railway Bridges -   Design Codes - Working Stress Method- Limit State Method of Design

UNIT II   SUPERSTRUCTURES   9
Selection of main bridge parameters, design methodologies -Choices of superstructure types - Orthotropic plate theory, load distribution techniques - Grillage analysis - Finite element analysis Different types of superstructure (RCC and PSC); Longitudinal Analysis of Bridge - Transverse Analysis of Bridge

UNIT III   BRIDGE DESIGN PRINCIPLES   9
Analysis and Design of RCC solid slab culverts -Design of RCC Tee beam and slab bridges - Design principles of continuous girder bridges, box girder bridges, balanced cantilever bridges – Arch bridges – Box culverts – Segmental bridges–Design principles only

UNIT IV   SUBSTRUCTURE, BEARINGS AND DECK JOINTS   9
Design of bridge bearings and substructure

UNIT V   PRESTRESSED CONCRETE BRIDGES & STEEL BRIDGES   9
Design principles of PSC bridges – PSC girders –Design principles of steel bridges - Plate girder bridges – Box girder bridges – Truss bridges – Vertical and Horizontal stiffeners.3

TOTAL: 45 PERIODS

OUTCOMES:
- On completion of this course, student will be able to

CO1	Explain the different types of bridges and design philosophies
CO2	Design an RC solid slab culvert bridge
CO3	Design an RC Tee Beam and Slab bridge
CO4	Design the bridge bearings and substructure
CO5	Explain the design principles of PSC bridges, box girder bridges, truss bridges

REFERENCES:
1. Jagadeesh. T.R. and Jayaram. M.A., "Design of Bridge Structures", Second Edition, Prentice Hall of India Pvt. Ltd. 2009.
2. Johnson Victor, D. "Essentials of Bridge Engineering", Sixth Edition, Oxford and IBH Publishing Co. New Delhi, 2019.
3. Ponnuswamy, S., "Bridge Engineering", Third Edition, Tata McGraw Hill, 2017.
4. Raina V.K." Concrete Bridge Practice" Tata McGraw Hill Publishing Company, New Delhi,2014.
5. Design of Highway Bridges, Richard M. Barker & Jay A. Puckett, John Wiley & Sons, Inc., 2021

COs- PO's & PSO's MAPPING

CO	PO			PSO		
	1	2	3	1	2	3
1	3	-	-	3	1	2
2	3	2	2	2	3	3
3	3	2	2	2	3	2
4	3	2	2	2	3	3
5	3	2	2	2	3	3
Avg	3	2	2	2.20	2.60	2.60

IM4005   MODERN CONSTRUCTION MATERIALS ANDTECHNOLOGY   L T P C
3 0 0 3

OBJECTIVES:
- To Understand and Explain Special Concrete, Metals, Composite and other materials, Sub structure construction and super structure construction.

UNIT I   SPECIAL CONCRETES   9
Concretes, Behavior of concretes – Properties and Advantages of High Strength and High Performance Concrete – Properties and Applications of Fiber Reinforced Concrete, Self- compacting concrete, Alternate Materials to concrete on high performance & high Strength concrete.

UNIT II   METALS   9
Types of Steels – Manufacturing process of steel – Advantages of new alloy steels – Properties and advantages of aluminum and its products – Types of Coatings & Coatings to reinforcement – Applications of Coatings.

UNIT III   COMPOSITES ANDOTHER MATERIALS   9
Types of Plastics – Properties & Manufacturing process – Advantages of Reinforced polymers– Types of FRP–FRP on different structural elements – Applications of FRP -Types and properties of Water Proofing Compounds – Types of Non- Weathering Materials and its uses – Types of Flooring and Facade Materials and its application Types & Differences between Smart and Intelligent Materials - Special features – Case studies showing the applications of smart & Intelligent Materials.

UNIT IV   SUB STRUCTURE CONSTRUCTION: **9**
Box jacking- pipe jacking- under water construction of diaphragm walls and basement tunneling Techniques - cable anchoring and grouting-driving diaphragm walls, sheet piles, laying operations for built up offshore system- shoring for deep cutting- large reservoir construction –trenchless technology.

UNIT V   SUPERSTRUCTURE CONSTRUCTION FORBUILDINGS: 9
Vacuum dewatering of concrete flooring - concrete paving Technology, Techniques of construction for continuous concreting, Operation in tall buildings of various shapes and varying sections – launching techniques- suspended form work -erection techniques of tall structures, Large span structures- launching techniques for heavy decks, in situ pre-stressing in high rise structures, aerial transporting, handling, erecting lightweight components on tall structures

TOTAL: 45 PERIODS

COURSE OUTCOME:
CO1 Explain the properties and applications of special concretes, composites, smart and intelligent materials
CO2 Identify and explain advanced construction techniques used for sub structure construction
CO3 Select appropriate techniques for super structure construction of buildings

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CO4 Select suitable techniques for construction of special structures
CO5 Choose relevant technique for demolition and dismantling works

REFERENCES:
1. ACI Report 440.2R-02, "Guide for the design and construction of externally bonded RP systems for strengthening concrete structures", American ConcreteInstitute,2002.
2. Aitkens, High Performance Concrete, McGrawHill,1999
3. Ashby, M.F. and Jones. D.R.H.H. "Engineering Materials 1: An introduction to Properties, applications and designs", ElsevierPublications,2005.
4. Deucher, K.N, Korfiatis, G.P and Ezeldin, A.S, Materials for civil and Highway Engineers, Prentice HallInc.,1998.
5. Ganapathy, C. "Modern Construction Materials", EswarPress,2015.
6. Mamlouk, M.S. and Zaniewski, J.P., Materials for Civil and Construction Engineers, Prentice HallInc.,1999.
7. Santhakumar.A.R. "Concrete Technology", Oxford University press, New Delhi.
8. Shan Somayaji, Civil Engineering Materials, Prentice Hall Inc., 2001 9. Shetty M.S, Concrete Technology: Theory and Practice, S.Chand& CompanyLtd.,2005.
9. Jerry Irvine, "Advanced Construction Techniques", C.A. Rocketr,1984
10. Sankar S.K. and Saraswathi. S, "Construction Technology", Oxford University Press, New Delhi,2008

ST4071	ADVANCED PRESTRESSED CONCRETE	L T P C
		3 0 0 3

OBJECTIVE:
- To develop an understanding of the philosophy of design of prestressed concrete
- To be able to design indeterminate prestressed concrete structure
- To design the prestressed concrete bridge and composite sections.

UNIT I   INTRODUCTION   9
Concepts of Prestressing – Materials and methods of prestressing – Design philosophy- Analysis methods, Time-dependent deformation of concrete and losses of prestress.

UNIT II   DESIGN FOR FLEXURE, SHEAR AND TORSION   9
Behaviour of flexural members, determination of ultimate flexural strength using various Codal provisions - Design for Flexure, Shear, torsion and bond of pre-stressed concrete elements – Transfer of prestress – Box girders - Camber, deflection and crack control.

UNIT III   DESIGN OF CONTINUOUS AND COMPOSITE BEAMS   9
Statically indeterminate structures - Analysis and design of continuous beams and frames– Choice of cable profile - Methods of achieving continuity – concept of linear transformations, concordant cable profile and gap cables – Composite sections of prestressed concrete beam and cast in situ RC slab - Design of composite sections - Partial prestressing - Limit State design of partially prestressed concrete beams

UNIT IV   DESIGN OF TENSION AND COMPRESSION MEMBERS   9
Pre-stressed concrete compression and tension members – application in the design of prestressed pipes and prestressed concrete cylindrical water tanks – Design of compression members with and without flexure – its application in the design of piles, flag masts and similar structures – Two way pre-stressed concrete floor systems – Connections for pre-stressed concrete elements

UNIT V   DESIGN OF PRESTRESSED CONCRETE BRIDGES   9
Review of IRC and IRS loadings. Effect of concentrated loads on deck slabs, load distribution methods for concrete bridges. Analysis and Design of superstructures - Design of pre-stressed

concrete bridges incorporating long-term effects like creep, shrinkage, relaxation, and temperature effects, Dynamic response of bridge decks.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1	Identify the various methods of prestressing and estimate the loss
CO2	Design the beams for flexure, shear, bond and torsion
CO3	Design the continuous beams and composite beams
CO4	Design the water tank, piles and masts
CO5	Analyze and design the prestressed concrete bridge

REFERENCES:

1. Arthur H. Nilson, "Design of Prestressed Concrete", John Wiley and Sons Inc, New York, 2004.
2. Krishna Raju, "Prestressed Concrete", Tata McGraw Hill Publishing Co., New Delhi, 6th Edition, 2018.
3. Lin.T.Y.andBurns.H "Design of Prestressed Concrete Structures", John Wiley and Sons Inc, 3rd Edition, 2010.
4. Rajagopalan.N, "Prestressed Concrete", Narosa Publications, New Delhi, 2014.
5. Sinha.N.C.and.Roy.S.K, "Fundamentals of Prestressed Concrete", S.Chand and Co., 1998.
6. Johnson Victor, D., Essentials of Bridge Engineering, Oxford and IBH Publishing Co., New Delhi 2019

COs- PO's & PSO's MAPPING

CO	PO			PSO		
	1	2	3	1	2	3
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

IM4006   ENVIRONMENTAL IMPACT ASSESSMENT FOR INFRASTRCTURE PROJECTS

L T P C
3 0 0 3

OBJECTIVES:

- To understand and Explain Overview, Prediction and Assessment, Health Assessment, Environmental management plan and Case studies.

UNIT I   OVERVIEW   9

Sustainable Development challenges and need- Key approaches for Impact Assessment Assessing Environmental Impacts - E I A Approach: Historical development, Legal and Regulatory aspects in India, Types and Objectives, Components, Process of EIA.

UNIT II   PREDICTIONANDASSESSMENT: 9

Tools, impact on air, water, soil & Noise, Role of Biodiversity Impact Assessment, Identification Prediction &Evaluation of Impacts on Biodiversity, Techniques of Biodiversity impact assessment, E I A Report Preparation

UNIT III   HEALTH ASSESSMENT   9

Impact of Environment on Health, Developing framework for Health impact analysis, tools and techniques, Case studies. Socio-Economic Impact Assessment: Overview and Scope of Social Impact Assessment, S I A model and the planning process, Land acquisition -Legal aspects, Resettlement &Rehabilitation and Development

UNIT IV   ENVIRONMENTAL MANAGEMENTPLAN   9

Preparation and implementation, Mitigation and Rehabilitation plans, Post Project Audit. Integrated Analysis Of Environmental, Social And Health Impacts: Challenges for Integrated Approach, Scope for Integrated approach in economic analysis- C B A Social C B A ,and Cost effectiveness Analysis, the Analytic Hierarchy process based approach to project appraisal, Emerging Dimensions and future Directions-Strategic Environmental Assessment, Technological Assessment and Risk Assessment.

UNIT V   CASE STUDIES   9

Extraction of natural resources and power generation, Primary Processing and Material production, Material Processing, Manufacturing/Fabrication, Service Sectors, Physical Infrastructure including Environmental Services, Building/Construction Projects/Area Development Projects & townships.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1 Understand the necessity to study the impacts that will be caused by projects or industries and the methods to assess these impacts

CO2 Describe the legal requirements of environmental impact assessment for projects

CO3 Prepare terms of reference for environmental impact and socio- economic impact for any Developmental project

CO4 Prepare environmental management plan and mitigation measures by considering environmental aspects, impacts and potential hazards respectively for any project

CO5 Understand the primary processing and extraction of natural resources with case studies

REFERENCES

1.   Canter, L.W.,"Environmental Impact Assessment",McGrawHill, NewYork,1996.
2.   Anjaneyulu, Yerramilli, and Valli   Manickam,   "Environmental   impact   assessment methodologies", Hyderabad: BS Publications,2007.
3.   Lawrence, D.P.,"Environmental Impact Assessment- Practical Solution store current problems", Wiley-Interscience, NewJersey,2003.
4.   Petts, J., "Handbook of Environmental Impact Assessment', Vol., I and II, Blackwell science, London,1999.

IM4007   **URBAN ENVIRONMENTAL MANAGEMENT**   **L T P C**
                                                                        3 0 0 3

OBJECTIVES:

* To understand and Explain Urban Environmental issues, Urban waste resources management, Urban water supply, Urban waste water management, Municipal solid waste management.

UNIT I   URBAN ENVIRONMENTAL ISSUES   9

Urbanization- Population growth scenario Migration-Pollution of surface water resources rivers, tanks, channels ground water exploitation - wastewater - characteristics - pollution problems - Solid waste - air pollution – CPCB norms. Urban master plans- Planning and organizational aspects.

UNIT II   URBAN WASTE RESOURCES MANAGEMENT   9

Water in urban ecosystem – urban water resources planning and organization aspects-storm water management practices-types of storage-magnitude of storage-storage capacity of urban components - percolation ponds - temple tanks- rainwater harvesting.

UNIT III   URBAN WATER SUPPLY   9

Demandestimation-populationforecasting-sourceidentification-waterconveyance- storage reservoirs - fixing storage capacity -Distribution network - types - analysis – computer Applications-Conservation Techniques-Integrated urban water planning.

UNIT IV   URBAN WASTE WATER MANAGEMENT   9

Sewage generation - storm drainage estimation-industry contribution-wastewater collection system-separate and combined system - hydraulic design of sewer and storm drain – waste water treatment-disposal methods-concept of decentralization- 3Rconcepts.

UNIT V   MUNICIPAL SOLID WASTE MANAGEMENT   9

Sources of solid waste - characteristics - rate of generation - segregation at source - collection of solid waste-methods of collection-route analysis-transfer and transfer stations - processing and disposal of solid waste. Case Studies-Environmental economics- Social and Physiological aspects of pollution -Successful Urban Management- models-Urban Management-Case studies from Developed Nations -Software

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1 Explain planning of a city and identify various urban environmental issues
CO2 Prepare Project Plans to integrate urban water resource
CO3 Explain water resource management using available water resources
CO4 Develop sustainable wastewater management concepts comparing with successful
      models followed in developed nation
CO5 Apply the principles of solid waste management

REFERENCES:

1. George Tchobanoglous, Hilary Theisen and Samuel A Vigil" Integrated Solid Waste Management", McGraw HillPublishers,NewYork,1993.
2. McGheeJ.,"Watersupply and sewerage",McGrawHill Publishers,1991
3. MartinP.WanelistaandYousef."StormWaterManagementandOperations",John   Wiley   and Sons,1993.
4. Nei IS.Grigg.,"Urban Water Infrastructure Planning- Management and Operations ",John Wiley andSons,1986.

IM4008   **LIFE CYCLE ANALYSIS AND DESIGN FORTHE ENVIRONMENT**   **L T P C**
                                                         3 0 0 3

OBJECTIVES:

To impart knowledge and skills on the concept and methodology of Life Cycle Assessment as per international standards and its potential applications to develop sustainable products and promote sustainable consumption.

UNIT I   LIFE CYCLE THINKING AND LIFECYCLE MANAGEMENT   9

Introduction to Life Cycle Thinking – Industrial ecology – Life cycle management (LCM) and Stakeholder Expectations - LCM drivers and issues - materials flow analysis - Life cycle of Products and services- International organizations and networks - History and definition of LCA - analytical tools for product and service systems ——-Value creation along the life cycle–technical characteristics – applications -limitations

UNIT II   LCA GOAL, SCOPEAND INVENTORY   9

ISO 14040 framework for LCA - Life cycle goal and scope definition - function, functional unit and reference flow System boundaries, data categories, inputs and outputs, data quality, critical review and other procedural aspects - Inventory Analysis: Raw Material Extraction and Processing , Manufacturing and Production , Product Use and Consumption , End-of-life Management , Transportation and Distribution - Dealing with Allocation Issues - Solutions to the multi functionality problem - Flow diagram - Format and data categories - Attributional versus consequential LCI – LCA soft wares and database - Data quality - Data collection and relating data to unit processes – Data validation - Cut-off and data estimation –

UNIT III   LIFE CYCLE IMPACT ANALYSIS AND INTERPRETATION   9

Characterization factors and principle of characterization - Selection of impact categories, category indicators and characterization models – Classification -Characterization - Optional elements - normalization , grouping, weighting ,data quality analysis - Characterization models – Impact assessment Case studies -Simplified/streamlined Life Cycle Assessments - procedural approaches, numerical approaches - Examples of numerical approaches - contribution analysis, perturbation analysis, uncertainty - analysis, comparative analysis, key issue analysis - Treatment of uncertainties - Elements in uncertainty handling - Sensitivity of LCA results - Sustainability analysis - Extending LCA - economic dimension, social dimension - Life cycle costing - Eco- efficiency - Combining LCA and LCC – Case studies

UNIT IV   DESIGN FOR ENVIRONMENTAND ECOLABELLING   9

Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – Design for Environment Strategies, Practices, Guidelines, Methods, And Tools. Eco-design strategies –Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling – Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian Eco mark scheme - Environmental product declarations – Environmental marketing

UNIT V   LCA SOFTWARES ANDCASE STUDIES   9

LCA Soft wares - LCA Software Demo: SimaPro, GREET, BEES, CMU EIO,GABI - Advances in LCA: Hybrid LCA, Thermodynamic LCA - LCA case studies on Product Design, Product Improvement, Product Comparison and Policy development.

TOTAL: 45 PERIODS

OUTCOMES:
CO1   Explain the various functional elements of Life Cycle Analysis and Design for Environment
CO2   apply the knowledge of science and engineering fundamentals to characterize the environmental interactions of products and services
CO3   design of engineering systems taking into account the material flow and pollutant interactions between engineering decisions and the environment
CO4   select appropriate LCA tools to support product/process design and decision making, taking into account the impact of the solutions in a sustainability context
CO5   conduct research pertinent to Life Cycle Management and communicate effectively to different stakeholders in terms of eco labels as well as engage in independent life-long learning

REFERENCES:
1.   ISO 14040-2016-Environmental management - Life cycle assessment - Principles and framework, International Organization for Standardization,2016
2.   T. E. Graedel, Braden R. Allenby, Industrial Ecology and Sustainable Engineering, Prentice Hall, 2010
3.   Ralph Horne, Tim Grant, KarliVerghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing,2009

4. ISO/TR 14047:2003, Environmental management - Life cycle impact assessment - Examples of application of ISO 14042, International Organization for Standardization,2007
5. International Organization for Standardization: ISOTR14062 Environmental management - Integrating environmental aspects into product design and development, 2002.
6. European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Luxembourg. European Union;2010
7. Catherine Benoît, UQAM/CIRAIG, and Bernard Mazijn, Guidelines for Social Life Cycle Assessment of Products, United Nations EnvironmentProgramme,2009

IM4009   **SUSTAINABLE DEVELOPMENT AND URBAN PLANNING**   **L T P C**
                                                                     3 0 0 3

OBJECTIVES:
- To Understand and Explain Sustainable Development, Environmental sustainability, Empowerment, Urban planning and Built in Environment

UNIT I   INTRODUCTION TOSUSTAINABLEDEVELOPMENT: 9
Definitions and principles of Sustainable Development - History and emergence of the concept of Sustainable Development - Environment and Development linkages- Globalization and environment – Millennium Development Goals: Status (global and Indian) Impacts on approach to development policy and practice in India, future directions.

UNIT II   ENVIRONMENTALSUSTAINABILITY: 9
Land, Water and Food production - Moving towards sustainability: Energy powering Sustainable Development - Financing the environment and Sustainable Development.

UNIT III   EMPOWERMENT: 9
Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities, Business and Industry - Sustainability indicators – Hurdles to Sustainability-Operational Guidelines-Interconnected   prerequisites for sustainable development - Science and Technology for sustainable development - Performance indicators of sustainability and Assessment mechanism – Constraints and barriers for sustainable development.

UNIT IV   URBAN PLANNING AND ENVIRONMENT: 9
Environment and Resources, Sustainability Assessment, Future Scenarios, Form of Urban Region, Managing the change, Integrated Planning, Sustainable Development

UNIT V   THE BUILTIN ENVIRONMENT: 9
Urban Form, Land Use, Compact Development, Principles of street design- complete streets, Transport Integrated Urban land use Planning, Guidelines for Environmentally Sound Transportation
                                                                 TOTAL: 45 PERIODS
COURSE OUTCOMES
CO1   Describe the concept and socio-economic policies of Sustainable
      Development
CO2   Identify the strategies for implementing eco development programmes
CO3   Identify different approaches for resource conservation and management
CO4   Suggest action plans for implementation of sustainable development CO5 Explain Urban
      Planning environment
 C05   Understand the built in environment principles

REFERENCES
1. GilgAWandYarwoodR," Rural Change and Sustainability-Agriculture, the Environment and Communities",CABI Edited by SJEssex,September2005.
2. Ganesha Somayaji and Sakarama Somayaji, "Environmental Concerns and Sustainable development: Some perspectives from India", Editors: publisher TERI Press, ISBN 8179932249.
3. James H. Weaver, Michael T. Rock, Kenneth Kustere, "Achieving Broad-Based Sustainable Development: Governance, Environment, and Growth with Equity", Kumarian Press, West Hartford, CT. Publication Year,1997.
4. Kirkby. J, O'Keefe P. and Timberlake, "Sustainable development" Earth Scan Publication, London,1996.
5. Kerry Turner. R, "Sustainable Environmental Management", Principles and Practice Publisher: Belhaven Press,ISBN:1852930039.
6. Munier N, "Introduction to Sustainability", Springer2005

IM4010	INFRASTRUCTURE FOR SMART CITY PLANNING	L T P C
		3 0 0 3

OBJECTIVES:
- To learn about the state-of-the-art strategies for effectively managing the transition from legacy infrastructure to smart urban systems.
- To understand the management of smart urban transportation systems as well as smart urban energy systems.
- To gain a deep understanding of the nature of disruptive innovations in smart infrastructure systems.

UNIT I   SMART CITIES – STATE OF THE ART   9
Urbanization and developing countries – Sustainable Development and cities – Urban prosperity – Evolution of smart cities – Smart city components and categories – Policy framework for smart cities - India 100 smart cities policy and mission – Common flaws in planning smart cities.

UNIT II   SMART URBAN MOBILITY   9
Objectives and components of urban mobility – Emerging concepts and strategies – Land use, urban form, and mobility – Transit oriented development – use of non-motorized transport – smart mobility – Major ICT supported smart mobility systems – RTIS, Automated fare collection systems, car/bike sharing systems, Intelligent signalling systems, RTMS, Parking information system, Automated vehicle location systems – Smart Mobility: Comprehensive model proposal.

UNIT III   SMART ENERGY   9
Overview – Ways and means to be energy smart – Influence of urbanization and climate change – urban density and energy use – elements of smart energy management system – strategies in making a city energy smart – making of a smart grid – use of electric vehicles(EVs) – Smart energy transformation – Challenges in making cities energy smart.

UNIT IV   SMART WATER AND WASTE MANAGEMENT   9
Smart water management – water resources and cycles – Implementing smart water management – Policy Challenges and Road Ahead – Waste Management Changing Approaches – Approach vs implementation – Smart Waste Management Strategies – Innovation in Conventional process, IoT and ICT based waste collection and management, automated waste collection systems – Smart Waste Management Challenges and Policies & Road ahead.

UNIT V   E- GOVERNANCEAND IOT   9
The power of ICT to integrate urban services – Taxonomy of layers of ICT Architecture, Access layer, Application layer, Data Layer, Communication layer, instrumentation layer, IoT/M2M layer – Major

Technology areas – Network, storage, computing, sensor, Information Security Technologies – ICT Major Components, Data Storage and Management, Network Infrastructure – Network Infrastructure for smart cities – Benefits of employing ICT – Emerging Technologies – IoT, Big Data Analytics and Cloud Computing, Artificial Intelligences, Machine and Deep Learning, Fifth Generation (5G) Network services – ICT Challenges, concerns and road ahead.

TOTAL: 45 PERIODS

COURSE OUTCOME
CO1   Explore and understand the fundamental concepts of smart and sustainable cities.
CO2   Explain the component of smart cities and dwell into their technological advancement.
CO3   Appreciate the involvement of stake holders in the design and implementation of responsive smart cities.
CO4   Explain the importance of different linkages and their roles including government, urban planners, universities, city developers and communities.
CO5   Identify and recognize the role of ICT and data analytics in addressing the urban challenges and key issues

REFERENCES:
1. Sharma, "Sustainable Smart Cities In India: Challenges And Future Perspectives", SPRINGER, 2022.
2. Anilkumar, Introduction to Smart Cities, Pearson India Education Services, 2020.
3. Jonathan Reichenta, Smart Cities for Dummies, 2020
4. Kassim Rehana Dr, Big Data for a Sustainable Smart City, Partridge Publishing Singapore, 2020
5. Mani.N, Smart Cities and Urban Development in India, New Century Publications , 2016
6. Stan Geertman, Joseph Ferreira, Jr., Robert Goodspeed, John Stillwell, "Planning Support Systems and Smart Cities", Lecture Notes in Geoinformation and Cartography, Springer, 2015
7. Anthony M Townsend, Smart Cities – Big Data, Civic Hackers, and the Quest for a New Utopia, W. W. Norton & Company, 2013

IM4011	PAVEMENT MANAGEMENT SYSTEM	L T P C
		3 0 0 3

OBJECTIVE:
- To introduce the concepts of design, evaluation and performance of existing and new flexible and rigid pavements with due emphasis on systems approach and performance prediction models.

UNIT I   PAVEMENTMANAGEMENTPROCESS   9
Historical background – general nature and applicability of systems methodology – basic components of Pavement Management System –Network and Project level of PMS - PMS functions-planning pavement investments.

UNIT II   FUNCTIONAL EVALUATIONANDPERFORMANCE   9
General concepts – economic and functional evaluation – evaluation of pavement performance– pavement distresses – condition surveys – safety evaluation visual rating of distresses, image processing; pavement friction, texture depth and skid resistance -LCMS laser crack management system- PCI development-application of GIS in pavement evaluation- case studies.

UNIT III   PAVEMENTSTRUCTURAL EVALUATION   9
Factors affecting Structural Condition of Flexible and Rigid Pavements- Pavement Deterioration- Evaluation by Non-Destructive Tests such as FWD, Benkelman Beam Rebound Deflection, Plate Load Test, Evaluation by Destructive Test Methods, and Specimen Testing - Structural analysis of Airfield pavements

UNIT IV   PERFORMANCE PREDICTIONMODELS   9
Pavement performance prediction - concepts, Techniques for developing prediction models – ranking and optimization methodologies- AASHO, CRRI and HDM models – computer applications – ANN, MATLAB–deterioration modeling- Pavement prioritization techniques.

UNIT V   MAINTENANCEAND REHABILITATION   9
Repair of pavement defects – types of maintenance of flexible and rigid pavements - Preservation and surface treatments - fog seals, crack sealing, slurry sealing and Overlays - Design of Overlays- White topping micro surfacing, thin overlays. Use of Geo synthetics in Pavement.

TOTAL: 45 PERIODS

OUTCOME:

CO1   Apply the knowledge on methods of pavement management.
CO2   Conduct research on the functional evaluation and performance of pavements
CO3   Conduct research on the Structural performance of pavements
CO4   Apply the mathematical theories and concepts in predicting the performance of pavements.
CO5   Understand and Select various maintenance and rehabilitation methods with real time case studies.

REFERENCES:
1. Sahini   M.Y., Chapman and Hall," Pavement Management for Airports, Roads and Parking Lots", NewYork,1992.
2. SrinivasaKumar.R," Pavement Evaluation, Maintenance & Management system, Universities Press India P Ltd,2014
3. Ralph Haas, W. Ronald Hudson and John Zaniewski, Modern Pavement Management, Kreigar Publishing Company, NewYork,1994
4. Michael Sargious, Pavements and Surfacings for Highways and Airports, Applied Science Publishers Limited, London,1975

IM4012	AIRPORT SYSTEM PLANNING AND DESIGN	L T P C
		3 0 0 3

OBJECTIVE:
- Provides a basic understanding on Airport Systems Planning and Operation

UNIT I   AIRPORTPLANNING   10
Planning of airports and its impact on metropolitan city development– Accessibility – Transport Connections – Road and Rail, Expansion – Feasibility Studies – Environmental and Social Issues – Forecasting Future Traffic – Airfield Capacity and Delay - Aircraft characteristics – Airport Site Selection

UNIT II   AIRPORTCOMPONENTS   10
Airport Classification, Planning of Airfield Components – Runway, Taxiway, Apron, Hangar-Passenger Terminals- Geometric design of runway and Taxiways-Runway Pavement Design-Difference between Highway and airport pavements- Introduction to various design methods- Airport drainage.

UNIT III   AIRPORT PLANNING AND AIRLINE ECONOMICS   9
Demand driven dispatch – Airline Fleet Planning Models – Network Revenue Management – Airport Performance, Slot Issues, Hub Operation, Demand Management, Multi-airport Systems- Pricing – Privatization and Deregulation, Willingness to pay and Competitive Revenue Management

UNIT IV   PASSENGER CHOICE, SCHEDULING AND FLEET ASSIGNMENT   7
Load Factor Analysis, Airline Schedule Development, Introduction to PODS Passenger Choice Models, Decision Window Model, Fleet Assignment

UNIT V   CASE STUDIES   9
Multi airport system – location of airport with respect to urban growth- case studies.

TOTAL: 45 PERIODS

OUTCOME:
CO1   Conduct Feasibility studies and plan an airport.
CO2   Design various Airport components.
CO3   Explain Airport Management and economics.
CO4   Develop scheduling and various models for Airport management.
CO5   Explain Airport planning and Design.

REFERENCES:
1. Robert Honjeff and Francis X.Mckelvey, "Planning and Design of Airports", McGraw Hill, NewYork,1996
2. Richard De Neufille and AmedeoOdoni, "Airport Systems Planning and Design", McGraw Hill, NewYork,2003
3. Airport Planning and Systems–http://airportssystems.com/Course/index-html
4. Khanna S.K and .Arora M.G, "Airport Planning and Design", Nem Chand andBros,1999.
5. Norman.J.Ashford, Sakleh.AMumayiz and Paul.H.Wright, "Airport Engineering Planning Design and Development of 21st Century Airports, John Wiley and sons, New Jersey,2011.

IM4013   URBAN INFRASTRUCTURE AND ASSET MANAGEMENT   L T P C
                                                                         3 0 0 3

OBJECTIVE:
- The course will emphasize the use of emerging technologies, information systems, and decision making tools that support the various elements of the asset management framework.

UNIT I   ROADASSET MANAGEMENT   9
Road Asset management- designing and developing rigid (or flexible) pavement with integrated structure for underground utilities & services- Network of underground road system, need for and planning and development.

UNIT II   INNOVATIVETRANSPORTMODES   9
straddling bus concept and development (eg China)- e-rickshaws- Alternate (renewable) energy options for powering transport system- solar powered aircraft -bio-bus and its impact on solid waste management - solar-powered traffic signals and street lights- all-electric bus route with wireless charging -buses park over metal plates buried in the road.

UNIT III   TELECOMMUNICATION & ITS IMPACT ON TRANSPORT   9
Commerce- e-tailing-mobile application in trade &commerce- internet-banking- internet and mobile phone in governance-services ranging from e-billing & payment for services- EB/telephone/income tax/ municipal tax & service charges/cooking gas booking &payment- booking and payment of air, train &train tickets; booking and payment of cinema tickets- teleshopping of groceries-tele-checking at airports- obtaining birth and death certificates- booking and payment for call taxis & auto rickshaws; carpooling through net and mobile phones-global meets through teleconferencing- case studies

UNIT IV   CLOUD-COMPUTING AND ITSIMPACTON TRANSPORT   9
The contribution of transport planning & development in conceptualization of smart cities- advances in capturing and processing traffic data in real time and managing traffic congestion- role of SCOOT & SCAT in reducing and minimizing traffic congestion- establishment of a sensor-networked and monitored city communication infrastructure, efficiently phasing traffic lights, and providing real-time guidance to drivers, can aid in reducing congestion. Digitally monitored parking spaces, able to dynamically alter prices according to available spaces, help control time spent cruising for parking.

UNIT V   ROLE OF SMART CARDANDCOMMUTING   9
Electronic Road Pricing (ERP) and congestion pricing- Innovative financing- carbon credit - case studies

TOTAL: 45 PERIODS

OUTCOME:

CO1	Understanding the road assets and their management techniques.
CO2	Classify the various innovative infrastructures and technologies in transport field
CO3	Understand the impact of telecommunication in transport sectors and their applications.
CO4	Explain Cloud computing and its impact in Transportation engineering
CO5	Understand the road pricing techniques and financial viability

REFERENCES:
1. International Infrastructure Management Manual.Edition2011.
2. Asset Management for Road sector", OECD Publications Service, 2, Paris Cedex16, France2001.

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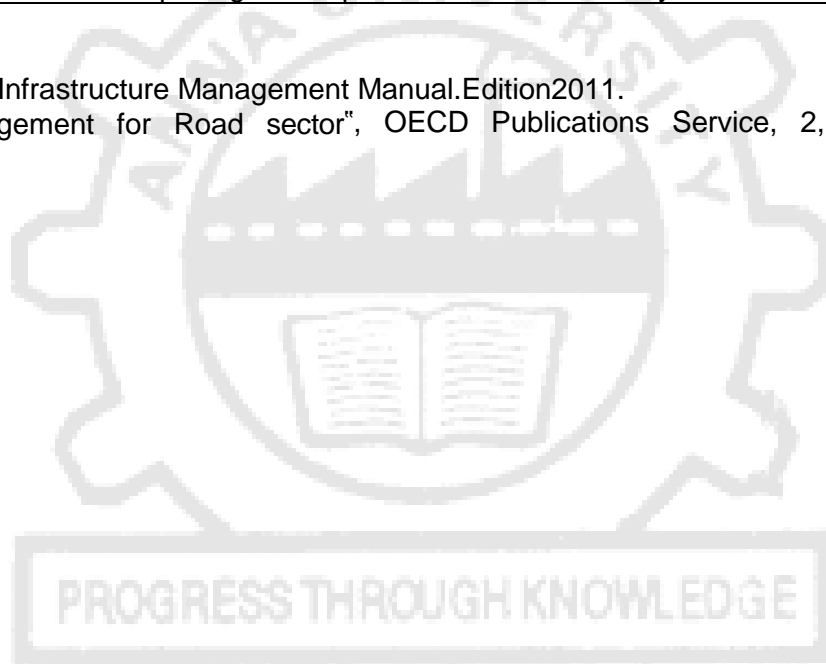
AX4091   **ENGLISH FOR RESEARCH PAPER WRITING**   **L T P C**
                                                                   2 0 0 0

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
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.

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

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. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: 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
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UNIT I **சங்க இலக்கியம்** **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
   – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரை நிறுத்திய ஔவையார்

UNIT II **அறநெறித் தமிழ்** **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
   – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை
   (தூய்மையை வலியுறுத்தும் நூல்)

UNIT III **இரட்டைக் காப்பியங்கள்** **6**

1. கண்ணகியின் புரட்சி
   - சிலப்பிதிகார வழக்குரை காதை
   சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV **அருள்நெறித் தமிழ்** **6**

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4)   - வண்டு
   நற்றிணை (11)   - நண்டு
   கலித்தொகை (11)   - யானை, புறா
   ஐந்திணை 50 (27)   - மான்
   ஆகியவை பற்றிய செய்திகள்

UNIT V   நவீன தமிழ் இலக்கியம்   **6**

  1. உரைநடைத் தமிழ்,
  - தமிழின் முதல் புதினம்,
  - தமிழின் முதல் சிறுகதை,
  - கட்டுரை இலக்கியம்,
  - பயண இலக்கியம்,
  - நாடகம்.
  2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
  3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
  4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
  5. அறிவியல் தமிழ்,
  6. இணையத்தில் தமிழ்,
  7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

  1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org
  2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia) -https://ta.wikipedia.org
  3. தர்மபுர ஆதீன வெளியீடு
  4. வாழ்வியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
  5. தமிழ்கலைக் களஞ்சியம் - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
  6. அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

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 sustainabilityperformances.
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.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
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**   **L T 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 UniversityPress, 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 Guidell, 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.