DEPARTMENT OF CIVIL ENGINEERING
GOVERNMENT COLLEGE OF TECHNOLOGY,
COIMBATORE.
(An Autonomous Institution Affiliated to Anna University, Chennai)

M.E STRUCTURAL ENGINEERING
2023 REGULATIONS
CURRICULAM & SYLLABI

VISION AND MISSION OF THE INSTITUTION

VISION

To emerge as a centre of excellence and eminence by imparting futuristic technical education in keeping with global standards, making our students technologically competent and ethically strong so that they can readily contribute to the rapid advancement of society and mankind**.**

MISSION

- To achieve academic excellence through innovative teaching and learning practices.
- To enhance employability and entrepreneurship.
- To improve the research competence to address societal needs.
- To inculcate a culture that supports and reinforces ethical, professional behaviours for a harmonious and prosperous society.

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE
DEPARTMENT OF CIVIL ENGINEERING

VISION AND MISSION OF THE DEPARTMENT

VISION

To provide quality education in Civil Engineering to the societal growth in sustainable manner on par with global standards

MISSION

- To establish the process of teaching and learning to meet the global standards for sustainable built environment
- To make Civil Engineering department a renowned high-tech consultancy centre.
- To carry out socially relevant and forward looking research for societal needs.
- Integrated with opportunities for teamwork, leadership, values, ethics and social activities.

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GOVERNMENT COLLEGE OF TECHNOLOGY
(An Autonomous Institution Affiliated to Anna University, Chennai)
Coimbatore – 641 013
DEPARTMENT OF CIVIL ENGINEERING
(Structural Engineering)
PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The following Programme Educational Objectives are designed based on the department mission:

PEO 1: To impart conceptual knowledge and develop analytical skills to design and build sustainable structural systems with an exposure to real time projects.
PEO 2: To develop research attitude in the field of Structural Engineering covering a wide spectrum of themes.
PEO 3: To excel in the profession with team work and leadership qualities having social responsibility and ethical values.

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(An Autonomous Institution Affiliated to Anna University, Chennai)
Coimbatore – 641 013
DEPARTMENT OF CIVIL ENGINEERING
(Structural Engineering)

PROGRAMME OUTCOMES (POs)

Students in the Structural Engineering Programme should be at the time of their graduation be in possession of the following:

PO 1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO 2: An ability to write and present a substantial technical report/document.

PO 3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO 4: An ability to use the advanced techniques, modern engineering skills, instrumentation and software packages necessary for structural engineering practice.

PO 5: To execute and manage the multidisciplinary projects with higher standards and sustainability.

PO 6: An ability to recognize the need for life-long learning to meet the challenging and demand driven needs of the society with a high level of enthusiasm.

CURRICULAM

GOVERNMENT COLLEGE OF TECHNOLOGY
(An Autonomous Institution Affiliated to Anna University, Chennai)
Coimbatore – 641 013
M.E. STRUCTURAL ENGINEERING
FIRST SEMESTER

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23SEFCZ1	Research Methodology and IPR *(Common to all Branches)*	FC	40	60	100	3	0	0	3
2	23SEFC02	Analytical and Numerical Methods *(Common to SE, GE)*	FC	40	60	100	3	0	0	3
3	23SEPC01	Computer Methods of Structural Analysis	PC	40	60	100	3	1	0	4
4	23SEPC02	Design of Advanced Reinforced concrete structures	PC	40	60	100	3	0	0	3
5	23SEPC03	Theory of Elasticity and Plasticity	PC	40	60	100	3	0	0	3
6	23SEPEXX	Professional Elective I	PE	40	60	100	3	0	0	3
7	23SEACXX	Audit Course-I	AC	40	60	100	2	0	0	0
PRACTICAL										
8	23SEPC04	Experimental Techniques Laboratory	PC	60	40	100	0	0	4	2
		TOTAL		**340**	**460**	**800**	**20**	**1**	**4**	**21**

SEMESTER II

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23SEPC05	Finite Element Analysis for Structural Engineers	PC	40	60	100	3	0	0	3
2	23SEPC06	Structural Dynamics	PC	40	60	100	3	0	0	3
3	23SEPC07	Advanced Steel Structures	PC	40	60	100	3	0	0	3
4	23SEPEXX	Professional Elective II	PE	40	60	100	3	0	0	3
5	23SEPEXX	Professional Elective III	PE	40	60	100	3	0	0	3
6	23SEACXX	Audit Course-II	AC	40	60	100	2	0	0	0
PRACTICAL										
7	23SEPC08	Finite Element analysis and Applications Laboratory	PC	60	40	100	0	0	4	2
8	23SEEE01	Mini Project	EEC	60	40	100	0	0	4	2
		TOTAL		**360**	**440**	**800**	**17**	**0**	**8**	**19**

SEMESTER III

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23SEPEXX	Professional Elective IV	PE	40	60	100	3	0	0	3
2	23$$OEXX	Open Elective - I	OE	40	60	100	3	0	0	3
PRACTICAL										
3	23SEEE02	Internship/Industrial Training	EEC	100	-	100	-	-	**	2
4	23SEEE03	Project - I	EEC	60	40	100	0	0	24	12
		TOTAL		**240**	**160**	**400**	**6**	**0**	**24**	**20**

**4 weeks Internship / Industrial Training

SEMESTER IV

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
PRACTICAL										
1	23SEEE04	Project - II	EEC	60	40	100	0	0	48	24
		TOTAL		**60**	**40**	**100**	**0**	**0**	**48**	**24**

Total Credits - 84

Summary of Credit Distribution

S. No	Course Work Subject Area	No of Credits					Percentage
		I	II	III	IV	Total	
1.	Foundation Course	6	-	-	-	6	7.14 %
2.	Professional Cores	12	11	-	-	23	27.38 %
3.	Professional Electives	3	6	3	-	12	14.29 %
4.	Employability Enhancement Courses	-	2	14	24	40	47.62 %
5.	Open Elective Courses	-	-	3	-	3	3.57 %
Total Credits		**21**	**19**	**20**	**24**	**84**	**100**

FOUNDATION COURSES (FC)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23SEFCZ1	Research Methodology and IPR *(Common to all Branches)*	FC	40	60	100	3	0	0	3
2	23SEFC02	Analytical and Numerical Methods *(Common to SE, GE)*	FC	40	60	100	3	0	0	3
TOTAL				**80**	**120**	**200**	**6**	**0**	**0**	**6**

PROFESSIONAL CORES (PC)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23SEPC01	Computer Methods of Structural Analysis	PC	40	60	100	3	1	0	4
2	23SEPC02	Design of Advanced Reinforced concrete structures	PC	40	60	100	3	0	0	3
3	23SEPC03	Theory of Elasticity and Plasticity	PC	40	60	100	3	0	0	3
4	23SEPC04	Experimental Techniques Laboratory	PC	60	40	100	0	0	4	2
5	23SEPC05	Finite Element Analysis for Structural Engineers	PC	40	60	100	3	0	0	3
6	23SEPC06	Structural Dynamics	PC	40	60	100	3	0	0	3
7	23SEPC07	Advanced Steel Structures	PC	40	60	100	3	0	0	3
8	23SEPC08	Finite Element analysis and Applications Laboratory	PC	60	40	100	0	0	4	2
TOTAL				**360**	**440**	**800**	**18**	**1**	**8**	**23**

PROFESSIONAL ELECTIVES (PE)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23SEPE01	Stability of Structures	PE	40	60	100	3	0	0	3
2	23SEPE02	Theory and Applications of Cement Composites	PE	40	60	100	3	0	0	3
3	23SEPE03	Structural Health Monitoring	PE	40	60	100	3	0	0	3
4	23SEPE04	Design of Formwork	PE	40	60	100	3	0	0	3
5	23SEPE05	Analysis of Laminated Composite Plates	PE	40	60	100	3	0	0	3
6	23SEPE06	Design of Concrete Bridges	PE	40	60	100	3	0	0	3
7	23SEPE07	Prestressed Concrete Structures	PE	40	60	100	3	0	0	3
8	23SEPE08	Experimental Techniques and Instrumentation	PE	40	60	100	3	0	0	3
9	23SEPE09	Structural Optimization	PE	40	60	100	3	0	0	3
10	23SEPE10	Advanced Concrete Technology	PE	40	60	100	3	0	0	3
11	23SEPE11	Plates and Shells	PE	40	60	100	3	0	0	3
12	23SEPE12	Fracture Mechanics	PE	40	60	100	3	0	0	3
13	23SEPE13	Design of Steel Concrete Composite Structures	PE	40	60	100	3	0	0	3
14	23SEPE14	Maintenance and Rehabilitation of Structures	PE	40	60	100	3	0	0	3
15	23SEPE15	Prefabricated Structures	PE	40	60	100	3	0	0	3
16	23SEPE16	Corrosion in Reinforced Concrete Elements	PE	40	60	100	3	0	0	3
17	23SEPE17	Offshore Structures	PE	40	60	100	3	0	0	3
18	23SEPE18	Earthquake Resistant Design of Structures	PE	40	60	100	3	0	0	3
19	23SEPE19	Substructure Design	PE	40	60	100	3	0	0	3
20	23SEPE20	Design of Structures for Dynamic Loads	PE	40	60	100	3	0	0	3
21	23SEPE21	Design of Tall Buildings	PE	40	60	100	3	0	0	3
22	23SEPE22	Cold Formed Steel Structures	PE	40	60	100	3	0	0	3
23	23SEPE23	Smart Materials and Smart Structures	PE	40	60	100	3	0	0	3
24	23SEPE24	Soil Structure Interaction (Common with ME Geotechnical Engineering)	PE	40	60	100	3	0	0	3
25	23SEPE25	Fundamentals of Concrete 3D Printing	PE	40	60	100	3	0	0	3
26	23SEPE26	Nano Technology	PE	40	60	100	3	0	0	3

OPEN ELECTIVES (OE)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23SEOE01	Building Bye-Laws and Codes of Practice	OE	40	60	100	3	0	0	3
2	23SEOE02	Planning of Smart Cities	OE	40	60	100	3	0	0	3
3	23SEOE03	Green Building	OE	40	60	100	3	0	0	3
4	23EEOE04	Environment Health and Safety Management	OE	40	60	100	3	0	0	3
5	23EEOE05	Climate Change and Adaptation	OE	40	60	100	3	0	0	3
6	23EEOE06	Waste to Energy	OE	40	60	100	3	0	0	3
7	23GEOE07	Energy in Built Environment	OE	40	60	100	3	0	0	3
8	23GEOE08	Earth and Its Environment	OE	40	60	100	3	0	0	3
9	23GEOE09	Natural Hazards and Mitigation	OE	40	60	100	3	0	0	3
10	23EDOE10	Business Analytics	OE	40	60	100	3	0	0	3
11	23EDOE11	Introduction to Industrial safety	OE	40	60	100	3	0	0	3
12	23EDOE12	Operations Research	OE	40	60	100	3	0	0	3
13	23MFOE13	Occupational Health and Safety	OE	40	60	100	3	0	0	3
14	23MFOE14	Cost Management of Engineering Projects	OE	40	60	100	3	0	0	3
15	23MFOE15	Composite Materials	OE	40	60	100	3	0	0	3
16	23TEOE16	Global Warming Science	OE	40	60	100	3	0	0	3
17	23TEOE17	Introduction to Nano Electronics	OE	40	60	100	3	0	0	3
18	23TEOE18	Green Supply Chain Management	OE	40	60	100	3	0	0	3
19	23PSOE19	Distribution Automation System	OE	40	60	100	3	0	0	3
20	23PSOE20	Electricity Trading & Electricity Acts	OE	40	60	100	3	0	0	3
21	23PSOE21	Modern Automotive Systems	OE	40	60	100	3	0	0	3
22	23PEOE22	Virtual Instrumentation	OE	40	60	100	3	0	0	3
23	23PEOE23	Energy Management Systems	OE	40	60	100	3	0	0	3
24	23PEOE24	Advanced Energy Storage Technology	OE	40	60	100	3	0	0	3
25	23AEOE25	Design of Digital Systems	OE	40	60	100	3	0	0	3
26	23AEOE26	Basics of Nano Electronics	OE	40	60	100	3	0	0	3
27	23AEOE27	Advanced Processor	OE	40	60	100	3	0	0	3
28	23VLOE28	HDL Programming Languages	OE	40	60	100	3	0	0	3
29	23VLOE29	CMOS VLSI Design	OE	40	60	100	3	0	0	3
30	23VLOE30	High Level Synthesis	OE	40	60	100	3	0	0	3
31	23CSOE31	Artificial Intelligence	OE	40	60	100	3	0	0	3

32	23CSOE32	Computer Network Management	OE	40	60	100	3	0	0	3
33	23CSOE33	Block Chain Technologies	OE	40	60	100	3	0	0	3

AUDIT COURSES (AC)

(Common to all branches)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23SEACZ1	English for Research Paper writing	AC	40	60	100	2	0	0	0
2	23SEACZ2	Disaster Management	AC	40	60	100	2	0	0	0
3	23SEACZ3	Value Education	AC	40	60	100	2	0	0	0
4	23SEACZ4	Constitution of India	AC	40	60	100	2	0	0	0
5	23SEACZ5	Pedagogy Studies	AC	40	60	100	2	0	0	0
6	23SEACZ6	Stress Management by Yoga	AC	40	60	100	2	0	0	0
7	23SEACZ7	Personality Development through life enlightenment skills	AC	40	60	100	2	0	0	0
8	23SEACZ8	Sanskrit for Technical Knowledge	AC	40	60	100	2	0	0	0

EMPLOYABILTY ENHANCEMENT COURSES (EEC)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23SEEE01	Mini Project	EEC	60	40	100	0	0	4	2
2	23SEEE02	Internship / Industrial Training	EEC	100	-	100	-	-	**	2
3	23SEEE03	Project - I	EEC	60	40	100	0	0	24	12
4	23SEEE04	Project - II	EEC	60	40	100	0	0	48	24
TOTAL				**280**	**120**	**400**	**0**	**0**	**76**	**40**

**4 weeks Internship / Industrial Training

L : Credits for Lecture Hours P : Credits for Practical Hours

T : Credits for Tutorial Hours C : Total Number of Credits

SYLLABI

23SEFCZ1	RESEARCH METHODOLOGY AND IPR (Common to all Branches)	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	FC	3	0	0	3

Course Objectives	• To impart knowledge on research methodology, Quantitative methods for problem solving, data interpretation and report writing. • To know the importance of IPR and patent rights.

UNIT – I	**INTRODUCTION**	**9 Periods**

Definition and objectives of Research – Types of research, Various Steps in Research process, Mathematical tools for analysis, Developing a research question-Choice of a problem Literature review, Surveying, synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.

UNIT – II	**QUANTITATIVE METHODS FOR PROBLEM SOLVING**	**9 Periods**

Statistical Modeling and Analysis, Time Series Analysis Probability Distributions, Fundamentals of Statistical Analysis and Inference, Multivariate methods, Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Spectral Analysis, Error Analysis, Applications of Spectral Analysis.

UNIT – III	**DATA DESCRIPTION AND REPORT WRITING**	**9 Periods**

Tabular and graphical description of data: Tables and graphs of frequency data of one variable, Tables and graphs that show the relationship between two variables , Relation between frequency distributions and other graphs, preparing data for analysis.

Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, referencing in academic writing.

UNIT – IV	**INTELLECTUAL PROPERTY**	**9 Periods**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development.

International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT – V	**PATENT RIGHTS**	**9 Periods**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES:

1	*Stuart Melville and Wayne Goddard, "**Research methodology: an introduction**", Juta Academic, 2nd edition, 2014.*
2	*Donald H.McBurney and Theresa White, "**Research Methods**", 9th Edition, CengageLearning, 2013.*
3	*RanjitKumar, "**Research Methodology: A Step by Step Guide for Beginners**", 5th Edition, 2019.*
4	*Dr. C. R. Kothari and GauravGarg, "**Research Methodology: Methods and Trends**", New age international publishers, 4th Edition, 2018.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate research question for conducting research.	K3
CO2	Analyze qualitative and quantitative data.	K4
CO3	Interpret research findings and give appropriate conclusions.	K2
CO4	Develop a structured content to write technical report.	K3

CO5	Summarize the importance of IPR and protect their research work through intellectual property.	K2

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	2	1	1
CO2	2	1	1	2	1	-
CO3	2	1	1	2	1	-
CO4	-	3	1	1	1	-
CO5	1	1	2	1	-	1
23SEFCZ1	2	3	2	2	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	50	30	20	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	50	30	20	-	-	100
ESE	30	30	20	20	-	-	100

23SEFC02	ANALYTICAL AND NUMERICAL METHODS (Common with ME Geotechnical Engineering)				SEMESTER I
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**FC**	**3**	**0**	**0**	**3**

Course Objectives	To familiarise the foundations of numerical methods and analysis techniques mostly used in various applications in engineering and technology.

UNIT – I	**SOLUTIONS OF EQUATIONS AND EIGEN VALUE PROBLEMS**	**9 Periods**

Error Analysis: Sources of Error in Numerical Computations, Absolute and Relative Errors, Round off and Truncation Errors. Solutions of nonlinear algebraic and transcendental equations by fixed point iteration method and Newton Raphson method. Solutions of linear system of equations by Gauss Elimination, Gauss Jordan and Gauss Seidel method. Eigen value of Matrix by Power method and Jacobi method.

UNIT – II	**CURVE FITTING AND INTERPOLATION**	**9 Periods**

Curve fitting: Fitting a straight line and parabola by method of least squares. Curves reducible to linear form. Newton's divided difference formula, Lagrange's interpolation-Newton's Forward and backward difference formula.

UNIT – III	**NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION**	**9 Periods**

Numerical approximation of derivatives using interpolation polynomials - Numerical integration by Trapezoidal, Simpson's one third rule and simpson's three eight rule- Two point and three point Gaussian quadrature formula - Double integration using Trapezoidal and Simpson one third rule.

UNIT – IV	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**9 Periods**

Taylor series method - Euler method - Modified Euler method - Fourth order Runge - Kuttamethod for solving first order equations – Predictor and corrector methods: Milne's and Adam Bashforth methods.

UNIT – V	**NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS**	**9 Periods**

Finite difference solutions for the second order ordinary differential equations – Finite difference solutions for one dimensional Heat Equation (Both Explicit and Implicit Methods) One dimensional wave equation - Laplace and Poisson equation.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCE BOOKS:

1	Steven C. Chapra, Raymond P., Canale, ***"Numerical Methods for Engineers"***, McGraw Hill Education Pvt Ltd 8th Edition 2021.
2	Srimanthapal ***"Numerical Methods, Principles, Analyses and Algorithm"***, Oxford University Press, New Delhi, 1st Edition, 2009.
3	Veerarajan T and Ramachandran T ***"Numerical Methods with Programming in C"*** McGraw Hill Education Pvt Ltd, New Delhi, 1st Edition, Reprint, 2016.
4	S.S.Sastry, **"*Introduction to Methods of Numerical Analysis*"**, Prentice Hall of India, Delhi, 5th Edition, 2015.
5	Dr. J.S Chitode **"*Numerical Methods*"** Technical Publications, Pune, 2010.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the numerical solutions to algebraic, exponential, logarithmic, transcendental and linear system of simultaneous equations.	K3
CO2	Appreciate the numerical techniques of interpolation and error approximations in various intervals in real life situations.	K3
CO3	Apply the numerical techniques of finite differences to numerical differentiation and numerical integration in engineering problems.	K3
CO4	Understand the numerical solution to first order ordinary differential equations by different methods like single step and multistep.	K3
CO5	Solve second order partial differential equations with initial and boundary conditions by using certain techniques with engineering applications.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	-	2	2
CO2	3	2	3	-	2	3
CO3	3	2	3	-	2	2
CO4	3	2	2	-	2	2
CO5	3	2	3	-	2	2
23SEFC02	3	2	3	-	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	20	40	40	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	20	40	40	-	-	-	100

23SEPC01	COMPUTER METHODS OF STRUCTURAL ANALYSIS	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	To Understand force and displacement measurements, energy concepts, applying Flexibility and Stiffness Matrix methods, and sub structuring techniques.	
UNIT – I	**FUNDAMENTAL CONCEPTS**	**12 Periods**
Force and displacement measurement – Generalized measurement – Constrained measurements – Principle of superposition – Stiffness and flexibility matrices in constrained measurements – Stiffness and flexibility of systems and elements – computing stiffness and flexibility coefficients.		
UNIT – II	**ENERGY CONCEPTS AND TRANSFORMATION OF INFORMATION**	**12 Periods**
Strain energy in terms of stiffness & flexibility matrices – Betti's law – Application of Betti's law - Computing displacements and forces from virtual work – other energy theorems - Transformation of forces and displacements in general – Stiffness and flexibility in general - Normal coordinates and orthogonal transformation – Principle of contragradience.		
UNIT – III	**FLEXIBILITY METHOD**	**12 Periods**
Statically determinate structures – Indeterminate structures – Choice of redundants leading to ill and well conditioned matrices Transformation to one set of redundants to another – Internal forces due to thermal expansion and lack of fit – Reducing the size of flexibility matrix – Application to pin - jointed plane truss – continuous beams – Frames – Grids (Concept only).		
UNIT – IV	**STIFFNESS METHOD**	**12 Periods**
Introduction – Development of the stiffness method – Analogy between flexibility and stiffness –Application of stiffness approach to pin jointed plane truss – Continuous beams – Frames - lack of fit – Grids (Concept only) – Space frames introduction only – Static condensation technique - Direct stiffness approach.		
UNIT – V	**ANALYSIS BY SUBSTRUCTURING AND ITERATION**	**12 Periods**
Analysis by substructuring technique using the stiffness and the flexibility method with tridiagonalisation. Iteration method for continuous beams and frames.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

REFERENCES:

1	*William McGuire, Richard H. Gallagher, Ronald D. Ziemian,* ***"Matrix structural Analysis"****, Wiley, 2015.*
2	*Pandit G.S, Gupta S.P,* ***"Structural Analysis-A matrix Approach"****, Tata McGraw Hill Publishing Company Ltd, 2008.*
3	*Manicka Selvam V.K,* ***"Elements of Matrix Stability Analysis of structures"****, Khanna Publishers, 2006.*
4	*Natarajan C. And Revathi P.,* ***"Matrix Methods of Structural Analysis: Theory and Problems"****, PHI Learning Pvt. Ltd, 2014.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Apply fundamental principles to evaluate the characteristics of structures.	K3
CO2	Compute the forces and displacements using energy concepts.	K3
CO3	Apply the flexibility matrix method for the analysis of beams, trusses and frames.	K3
CO4	Analyze the continuous beams, frames and trusses using stiffness matrix methods.	K3
CO5	Perform complex analytical procedures such as sub structuring and iteration techniques.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	2	-	1
CO2	1	-	2	2	-	1
CO3	3	-	3	3	1	1
CO4	3	-	3	3	1	1
CO5	2	-	3	2	1	1
23SEPC01	3	-	3	3	1	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	60				100
CAT2	20	20	60				100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	25	25	50				100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	25	25	50				100
ESE	20	20	60				100

23SEPC02	DESIGN OF ADVANCED REINFORCED CONCRETE STRUCTURES	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To familiarize with the design of structural elements using limit state of design concept and understand the inelastic behaviour of concrete elements.	
UNIT – I	**DESIGN OF BEAMS**	**9 Periods**
Review of basic concepts - Design of beams circular in plan and Spandrel beams-Design of Corbels - Design of Deep beams – Short-term and long-term deflection of reinforced concrete beams and slabs – Estimation of crack width in reinforced concrete members.		
UNIT – II	**DESIGN OF SLABS**	**9 Periods**
Yield line theory of slabs - Hillerberg's strip method of design of slabs- Design of flat slabs and flat plates according to BIS method- Design of grid floors.		
UNIT – III	**DESIGN OF SPECIAL RC ELEMENTS**	**9 Periods**
Design of slender columns - Design of shearwalls - Design of pile caps.		
UNIT – IV	**INELASTIC BEHAVIOUR OF CONCRETE BEAMS AND FRAMES**	**9 Periods**
Inelastic behaviour of concrete beams- Moment-rotation curves- Plastic hinge formation- Moment redistribution - Bakers method of analysis and design- Design of cast-in-situ joints in frames		
UNIT – V	**DETAILING AND FIELD PRACTICE**	**9 Periods**
Detailing requirements for various concrete elements in ductility, durability and fire resistance aspects - Codal requirements- Quality control of concrete		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Varghese P.C.,* ***"Advanced Reinforced Concrete"****, Prentice Hall of India, New Delhi, 2009*
2	*Varghese P.C.,* ***"Limit state design of Reinforced Concrete"****, Prentice Hall of India, New Delhi, 2008*
3	*Krishna Raju, N.,* ***"Advanced Reinforced Concrete Design"****, CBS Publishers and Distributers, 2008*
4	*Unnikrishnan Pillai S and Menon D.,* ***" Reinforced concrete Design"****, Tata McGraw Hill Book Co., New Delhi, 2003.*
5	*N.C.Sinha and S. K.Roy,* ***"Fundamentals of Reinforced concrete"****, S.Chand& Co Ltd., 2007*
6	*Pankaj Agarwal and Manish Shaikande,* ***"Earthquake Resistant Design of structures"****, Prentice Hall of India Pvt. Ltd, New Delhi, 2006*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyse and design the circular beam, spandrel beam, deep beams and its serviceability criteria	K3
CO2	Apply the concepts of yield line theory of slabs as per codal provisions	K3
CO3	Design the slender columns , pile caps and shear walls	K3
CO4	Implement the concept of inelastic behaviour of concrete elements and in joints	K3
CO5	Execute the detailing of concrete elements with respect to durability, ductility and fire resistance	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	1	1	2
CO2	3	2	3	1	1	2
CO3	3	2	3	1	1	2
CO4	3	2	3	1	1	2
CO5	3	2	3	3	1	2
23SEPC02	3	2	3	3	1	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	60				100
CAT2	20	20	60				100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	25	25	50				100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	25	25	50				100
ESE	20	20	60				100

23SEPC03	THEORY OF ELASTICITY AND PLASTICITY	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To import knowledge on the stress and strain fields of materials in elastic and plastic state, torsion behavior of non-circular and thin-walled sections and energy principles for elastic medium.	
UNIT – I	**ANALYSIS OF STRESS AND STRAIN**	**9 Periods**
Analysis of stress and strain – Stress-strain relationship- Generalised Hooke's Law – Compatibility equations –Two and three dimensional problems in Cartesian and Polar coordinates.		
UNIT – II	**TWO DIMENSIONAL PROBLEMS IN CARTESIAN AND POLAR COORDINATES**	**9 Periods**
Plane stress and plane strain – Airy's stress function – Bending of beams by uniform load – Thick cylinder under uniform pressure-Shrink and Force fits- Stress concentration- Flat plate subjected to in plane traction and shear with Circular hole – Boussinesque's Equation-Wedge problem subjected to inclined loading.		
UNIT – III	**TORSION**	**9 Periods**
Torsion of Non circular and Prismatic bars – St. Venant's approach – Prandtl approach- Hollow section-Membrane analogy of torsion- Torsion of thin walled open and closed cell – Multi-celled sections		
UNIT – IV	**ENERGY THEOREMS**	**9 Periods**
Strain energy for 2D and 3D- principle of complementary energy- Principle of virtual work – Reciprocal theorem- Engesser Theorem – Raleigh Ritz method.		
UNIT – V	**PLASTICITY**	**9 Periods**
Physical assumptions – Yield criteria for metals- Plastic stress and strain relations – Strain hardening-Application to simple problems in tension, bending and torsion.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Timeshenko.S.P and Goodier.J.N,* ***"Theory of Elasticity"****, McGraw hill international edition, 2017.*
2	*Alexander Mendelson,* ***"Plasticity: Theory and Application",*** *Krieger Publishing Company, 1983.*
3	*Sadhu Singh,* ***"Theory of Elasticity and metal forming processes"****, Khanna publishers, 2005.*
4	*Hill.R,* ***"Mathematical theory of plasticity",*** *Oxford Publishers 1998.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Illustrate the equilibrium and compatibility conditions in Cartesian and Polar coordinate systems and Compute principal stresses in Cartesian system.	K3
CO2	Investigate the 2D stress system using Airy's stress function in Cartesian and Polar Coordinates	K3
CO3	Calculate the torsional capacity of non-circular sections both solid and tubular sections	K3
CO4	To solve elastic problems using energy principles	K3
CO5	To apply the concepts of plasticity in plastic problems	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	3		1
CO2	1	-	2	3	1	1
CO3	1	-	2	3	1	1
CO4	1	-	2	3	1	1
CO5	1	-	2	3	1	1
23SEPC03	1	-	2	3	1	1
1 - Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	40	-	-	-	100
CAT2	30	30	40	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	40	40	20	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	40	40	20	-	-	100
ESE	30	30	40	-	-	-	100

23SEPC04	EXPERIMENTAL TECHNIQUES LABORATORY	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	4	2

Course Objectives	To have exposure on instruments and to conduct experiments on various structural elements to identify its behaviour.

LAB EXPERIMENTS / PROGRAMS

1. Introduction to instrumentation (LVDT, Load cell, Hydraulic jack, Strain gauges)
2. Casting and Testing of Reinforced Concrete beams for deflection
3. Casting and Testing of Reinforced Concrete beams for flexure
4. Casting and Testing of Reinforced Concrete beams for shear
5. Casting and Testing of Reinforced Concrete columns
6. Casting and Testing of Reinforced Concrete columns beam – column joint and Frames
7. Fabrication and testing of elements for steel structures
8. Use of Non destructive testing (NDT) equipment – Rebound hammer
9. Use of Non destructive testing (NDT) equipment – Ultra sonic pulse velocity meter
10. Use of Non destructive testing (NDT) equipment – Corrosion Analyzer and Rebar locator.

Contact Periods:

Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 60 Periods** **Total: 60 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Familiarize with the various instruments used for testing structural elements.	K3
CO2	Execute the test on reinforced concrete beams.	K3
CO3	Conduct the experiments on reinforced concrete columns, joints and frames.	K3
CO4	Fabricate and conduct test on various steel elements.	K3
CO5	Employ Non destructive testing equipments for testing of structures.	K3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	2	1
CO2	3	-	2	2	2	2
CO3	3	-	2	2	2	2
CO4	3	-	3	2	2	1
CO5	3	-	2	3	2	3
23SEPC04	3	-	3	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

23SEPC05	FINITE ELEMENT ANALYSIS FOR STRUCTURAL ENGINEERS	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To learn the fundamental concepts of finite element analysis, familiarize with the element properties and isoparametric elements, and get exposure to axisymmetric stress analysis and non linear analysis.

UNIT – I	**INTRODUCTION**	**9 Periods**

Engineering Problems – Numerical Methods – Brief History of the Finite Element Method – Basics steps in the Finite Element Method – Minimum Total Potential Energy Formulations - Weighted Residual Formulations - Direct method – Element stiffness matrix – Global stiffness matrix – Boundary conditions- Problems on bars, simple beams, Trusses and frames.

UNIT – II	**ELEMENT PROPERTIES**	**9 Periods**

Discretization – Displacement model – Element properties – convergence and compatibility requirements – Node Numbering procedure – Natural coordinate system - Generalized Coordinates – Shape function – Lagrange elements – stiffness matrix – Nodal load vector - elements in plane stress and plane strain– Static condensation – Simple problems only.

UNIT – III	**ISOPARAMETRIC ELEMENTS**	**9 Periods**

Basic principles of Shape Functions - Mapping – Uniqueness of mapping - Sub – Iso – Super parametric elements – Numerical integration using Gaussian Quadrature - Examples in one dimension and two dimension.

UNIT – IV	**AXISYMMETRIC STRESS ANALYSIS**	**9 Periods**

Analysis of solids of revolution under axisymmetric loading – Formulation of axisymmetric solid element – Simple examples.

UNIT – V	**NONLINEAR ANALYSIS**	**9 Periods**

Types of nonlinearities – Geometric nonlinearity – Material nonlinearity – Introduction to nonlinear solution techniques – Newton Raphson and Modified Newton Raphson methods

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES:

1	*Krishnamurthy C.S,* ***"Finite Element Analysis – Theory and programming"****, Second edition, Tata McGraw Hill Publishing Co. 2004*
2	*Reddy J. N.,* ***"Introduction to Finite Element Method"****, Tata McGraw Hill Publishing Co. 2020.*
3	*Rajasekaran S .,* ***"Finite Element Analysis in Engineering Design"****, Wheeler publishing,2008*
4	*Chandrapatla Tirupathi.R and Belegundu, Ashok. D.,* ***"Introduction to Finite Elements in Engineering"****, Second edition, Prentice Hall of India, 2014*
5	*S.S.Rao,* ***"The Finite Element Method in Engineering"****, Buttersworth - Heinemann publishing, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Practice the basics FEM for the solution of bars, beams, trusses and frame problems.	K4
CO2	Solve the structural mechanics problems using FEM element approach.	K4
CO3	Identify solutions for problems involving isoparametric elements.	K4
CO4	Analyze axisymmetric solid elements.	K4

CO5	Identify the different types of non linearities and its solution techniques.	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	2	-	1
CO2	1	-	3	2	-	1
CO3	2	-	3	3	1	2
CO4	1	-	2	3	1	2
CO5	2	-	3	3	-	1
23SEPC05	2	-	3	3	1	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	60	-	-	-	100
CAT2	20	20	60	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	25	25	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	25	25	50	-	-	-	100
ESE	20	20	60	-	-	-	100

23SEPC06	STRUCTURAL DYNAMICS	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To impart knowledge on analysis of SDOF, MDOF, Continuous system subjected to dynamic loading and also solve by numerical methods and give an exposure on advance topics of structural dynamics.

UNIT – I	**SINGLE DEGREE OF FREEDOM SYSTEMS**	**9 Periods**
Formulation of equation of motion, Free and forced vibrations, Effect of damping, Response to periodic loading – Fourier series and analysis, Response to impulse loading – Duhamel's integral		
UNIT – II	**MULTI DEGREE OF FREEDOM SYSTEMS**	**9 Periods**
Free and forced vibration of undamped and damped MDOF systems. Equation of motions, Evaluation of natural frequencies and mode shapes – Eigen value problem, Modal analysis – mode superposition method.		
UNIT – III	**CONTINUOUS SYSTEMS**	**9 Periods**
Dynamics of distributed parameter systems, Free and forced vibration of flexural beams, shear beams and columns, Modal analysis.		
UNIT – IV	**NUMERICAL METHODS IN STRUCTURAL DYNAMICS**	**9 Periods**
MDOF system - Matrix Iteration method - Rayleigh Method – Holzer Method – Dunkerleys method – Stodola method.		
UNIT – V	**SPECIAL TOPICS IN STRUCTURAL DYNAMICS**	**9 Periods**
Response spectrum analysis – Time history analysis. Dynamic Effects of Wind Loading , Vibrations caused by Traffic, Blasting and Pile Driving , machine foundation, Dynamic analysis of water tank. Vibration isolation - Tuned mass damper - vibration absorber		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Anil K. Chopra , **"Dynamics of Structures",** fifth Edition, pearson publishers, 2017*
2	*Mario Paz, **"Structural Dynamics – Theory and Computations"**, Third Edition, CBS publishers, 2012.*
3	*Clough R.W, and Penzien J, **"Dynamics of Structures"**, Second Edition, CBS publishers, 2015*
4	*Manickaselvam,V.K., **"Elementary Structural Dynamics",** Dhanpat Rai & Sons, 2001*
5	*Madhujit Mukhopadhyay, **"Structural Dynamics: Vibrations & Systems",** Ane Books Pvt. Ltd, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyze and evaluate the response of SDOF systems under dynamic loading	K3
CO2	Analyze and evaluate the response of MDOF systems under dynamic loading.	K3
CO3	Analyze and evaluate the response of continuous systems under dynamic loading.	K3
CO4	Apply the concepts of numerical methods to solve structural dynamics problems.	K3
CO5	Analyze and apply advance techniques to the structures subjected to dynamic loading.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	2	1	2
CO2	3	2	3	2	1	2
CO3	3	2	3	2	1	2
CO4	3	2	3	2	1	2
CO5	3	2	3	3	1	2
23SEPC06	3	2	3	3	1	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	20	40	40	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	-	50	50	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	-	50	50	-	-	100
ESE	20	40	40	-	-	-	100

23SEPC07	ADVANCED STEEL STRUCTURES	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To gain knowledge on design philosophies, special requirements on design and constructions and understand the design of industrial buildings, connections and cold formed steel structures.

UNIT – I	**REVIEW OF DESIGN PHILOSOPHIES**	**9 Periods**

Philosophies of Limits State Design, WSD and LRFD Concepts of Plastic design – Local Buckling of thin plate elements – Section Classification – Limit State Design – Comparison of BIS and other International codes– Behaviour and Limit state design of beam-columns.

UNIT – II	**BEHAVIOUR AND DESIGN OF CONNECTIONS**	**9 Periods**

Connection behavior - Bolted and welded connections - unstiffened and stiffened seat connections –framed connections- Connections for force and moment transmission-tee stub and End plate connections-Column stiffeners and other reinforcement-principles of semi rigid connections

UNIT – III	**ANALYSIS AND DESIGN OF INDUSTRIAL BUILDINGS**	**9 Periods**

Review of loads on structures-Dead, Live, wind and Seismic loads as per National standards-Analysis and Design of Industrial buildings and bents-Sway and non-sway frames- Design of Purlins-Analysis and Design of Gable frames.

UNIT – IV	**ANALYSIS AND DESIGN OF COLD-FORMED STEEL STRUCTURES**	**9 Periods**

Types of cross sections-concepts of local buckling, and Effective width-Design of compression and tension members-concepts of lateral buckling–Design of Beams, deflections of beams and design of beam webs-Combined stresses and connections-Empirical design of Z-purlins with lips and wall studs.

UNIT – V	**SPECIAL REQUIREMENTS OF DESIGN AND CONSTRUCTION**	**9 Periods**

Fire resisting properties of steel – Principles of Fire-resistant Design - Fatigue failures of steel structures – Principle of Fatigue-resistant Design As per IS code- Seismic Behaviour and ad vantages of steel – Principles of Earthquake resistant design of Steel Structures.

Contact Periods:
Lecture: 45 Periods Tutorial: 0Periods Practical: 0 Periods Total: 45 Periods

REFERENCES

1	*Salmon.C.G. and Johnson.J.E.* ***"Steel Structure-Design and Behaviour",*** *Harper and Row,1980.*
2	*Wie-WenYu.,* ***"Cold-formed Steel Structures",*** *McGraw Hill Book Company, 1973.*
3	*William McGuire,* ***"Steel Structures",*** *Prentice Hall,Inc., Englewood Cliffs, N.J.1986.*
4	*Subramanian.N,* ***"Design of Steel Structures",****Oxford University press,2008*
5	*DuggalS.K,* ***"Limit State Design of Steel Structures",*** *Tata McGraw Hill,2010.*
6	*GregoryJ. Hancock, Thomas Murray, DuaneS. Ellifrit****, "Cold-Formed Steel Structures to the AISI Specification",*** *CRC Press, 2001.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Know the various design philosophies as per various international codes.	K3
CO2	Design different types of eccentric bolted and welded connections.	K3
CO3	Analyse and design the components of industrial buildings.	K3
CO4	Perform design of cold formed steel structures.	K3

CO5	Design of steel structures for fire, fatigue and understand the principles of earthquake resistant design.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	2	1	-	-
CO2	1	-	-	1	1	-
CO3	2	-	1	3	2	1
CO4	2	-	-	2	1	2
CO5	2	-	2	2	2	3
23SEPC07	2	-	2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	50	-	-	-	100
CAT2	20	30	50	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20	30	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20	30	50	-	-	-	100
ESE	20	30	50	-	-	-	100

23SEPC08	FINITE ELEMENT ANALYSIS AND APPLICATIONS LABORATORY	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	4	2

Course Objectives	To provide exposure on commercial software package to solve problems in mechanics of materials and in structural engineering.

LAB EXPERIMENTS / PROGRAMS

1. Introduction to ANSYS/ABAQUS
2. Finite element analysis of simple beams
3. Finite element analysis of trusses
4. Finite element analysis of frames
5. Finite element analysis of element subjected to combined axial load and bending.
6. Finite element analysis of complex elements.
7. Introduction to MATLAB
8. Structural analysis of beams using MATLAB
9. Structural analysis of Frames and Trusses using MATLAB
10. Finite element programming using MATLAB

Contact Periods:

Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 60 Periods** **Total: 60 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Perform finite element formulations for simple engineering problems.	K1
CO2	Develop the various structural models using commercially available software.	K3
CO3	Use MATLAB and commercial finite element software for analyzing the structural elements.	K3
CO4	Use finite element method to solve engineering problems.	K3
CO5	Develop and validate the numerical model of structural elements.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	2	-	1
CO2	1	-	3	2	-	1
CO3	2	-	3	3	1	2
CO4	1	-	2	3	1	2
CO5	2	-	3	3	-	1
23SEPC08	2	-	3	3	1	2
1 – Slight, 2 – Moderate, 3 – Substantial						

23SEEE01	MINI PROJECT	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	4	2

Course Objectives	To develop skill competencies in design and detailing of structures.

MODULE

1. Design Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the design problem based on the recent trends and analyse the structural system using various techniques.
2. End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted, analysis, design and detailing of the entire structural system.

* Continuous assessment of Design Project will be monitored by the departmental committee.

Contact Periods:

Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 60 Periods** **Total: 60 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify structural engineering problems based on the current scenario.	K3
CO2	Familiarize with the various loads and load combinations as per IS codes.	K3
CO3	Apply different techniques to analyze complex structural systems.	K3
CO4	Acquire hands on experience in the analysis and design of entire structure.	K4
CO5	Prepare the structural drawings for concrete/steel structures.	K3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	-	2	2
CO2	1	2	-	1	-	-
CO3	3	1	2	2	3	3
CO4	-	-	1	-	-	-
CO5	-	2	3	3	2	2
23SEEE01	3	3	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

23SEEE02	INTERNSHIP / INDUSTRIAL TRAINING	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	-	-	-	-

Course Objectives	• To acquire entrepreneurship skills in the field of Structural Engineering. • To develop communication, interpersonal and critical skills and a record of work experience.

MODULE

- End semester presentation should be done along with the report on internship training.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Relate theoretical knowledge and skills to real world situation.	K4
CO2	Integrate knowledge from diverse disciplines in Construction Industry.	K3
CO3	Apply higher order thinking skills in making decisions in complex situations.	K3
CO4	Express ideas clearly with clients and in the preparation of technical documents.	K3
CO5	Conduct collaborative research and preparation of technical document.	K4

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	3	3	2
CO2	2	1	2	3	2	3
CO3	3	1	3	1	2	2
CO4	-	3	2	1		2
CO5	2	3	1	1	3	2
23SEEE02	3	3	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

23SEEE03	PROJECT - I	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	24	12

Course Objectives	To carry out the independent research work on the chosen topic and submit a thesis for evaluation.

MODULE

1. The project work is defined based on the interest of the students to specialize in a particular Structural Engineering area. Students are expected to carry out independent research work on the chosen topic and submit a thesis for evaluation.
2. The work at this stage may involve extensive review of literature in the chosen area of interest. Based on the literature review, the project may be carried out by numerical simulation using software packages and/or experimental work.
3. The students will give three periodical review seminars.
4. After completion of the thesis work, the student shall prepare and submit a report. The work will be evaluated by the panel of examiners.

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 360 Periods Total: 360 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Collect the literatures relevant to their area of research.	K2
CO2	Identify the research problems based on current scenario.	K4
CO3	Perform analytical investigation.	K3
CO4	Conduct experimental work.	K3
CO5	Interpret the results and prepare the report.	K4

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	-	-	-	-
CO2	3	2	2	1	2	3
CO3	3	1	2	3	2	2
CO4	3	1	1	2	1	1
CO5	3	2	2	1	-	1
23SEEE03	3	2	2	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

23SEEE04	PROJECT - II	SEMESTER IV				
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**EEC**	**0**	**0**	**48**	**24**
Course Objectives	To develop the skills to formulate the methodology for the chosen topic, carry out the extensive research work and submit a thesis for evaluation.					

MODULE

1. Students are expected to carry out research work on the chosen topic and submit a thesis for evaluation. The work at this stage may involve review of literature, extensive experimental work and/or Numerical simulation using software packages, development of analytical model, case study, field data collection and analysis etc. The students will give a periodical review seminar on each stage.
2. Student shall prepare a report on the project work outlining a review of literature published in the relevant area, need, objective and scope of work, methodology, and discusses about the results and come out with appropriate conclusions.
3. After completion of the thesis, the student shall prepare and publish a paper related to the thesis work in a Journal/Conference. The student shall have to appear for a Viva-voce examination for the thesis.

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 720 Periods Total: 720 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Collect the literatures relevant to their area of research.	K2
CO2	Identify the research problems based on current scenario.	K3
CO3	Perform analytical investigation.	K3
CO4	Conduct experimental work. Critically assess and propose solutions to Structural Engineering problems.	K4
CO5	Demonstrate the research findings and present the solutions of the thesis work.	K4

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	2	-	-	-
CO2	3	2	2	-	2	2
CO3	3	2	2	2	3	2
CO4	3	1	3	3	2	1
CO5	3	2	2	2	3	3
23SEEE04	3	2	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

23SEPE01	STABILITY OF STRUCTURES					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To learn the concepts of stability, beam-columns, inelastic and torsional buckling characteristics of various members and buckling behavior of plates.					
UNIT – I	**CONCEPT OF STABILITY**					**9 Periods**
Concept of stability - states of equilibrium – Euler column – Linear column theory, an eigen value problem for various end conditions – Large deformation theory – Imperfect columns.						
UNIT – II	**INELASTIC BUCKLING AND METHODS OF ANALYSIS**					**9 Periods**
Inelastic buckling, double modulus and tangent modulus theory-Approximate Methods- conservation of Energy principle, principle of stationery and potential energy, Rayleigh Ritz method, Finite Difference methods and Matrix methods.						
UNIT – III	**BEAM-COLUMNS**					**9 Periods**
Beam-Column subjected to concentrated lateral loads, distributed lateral loads – Effect of Axial Load on Bending Stiffness - Failure of beam columns- Buckling of frames – Modes of buckling– Calculation of critical loading in frames– Stability of a frame.						
UNIT – IV	**TORSIONAL BUCKLING**					**9 Periods**
Torsional Load-Deformation characteristics of Structural members–Strain energy of Torsion– Combined torsional and flexural buckling - Lateral buckling of beams – Pure bending of simply supported beam and cantilever beam–Design simplifications for lateral buckling.						
UNIT – V	**BUCKLING OF PLATES**					**9 Periods**
Governing differential equation – Buckling of thin plates with various edge conditions – Strain energy of bending in a plate – Calculation of critical load of plates – Inelastic buckling – Post buckling behavior of axially compressed plates – Ultimate strength of axially compressed plates.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	*Chajes.A,* ***"Principles of Structural Stability Theory",*** *Prentice Hall, 1974.*
2	*AshwiniKumar,* ***"Stability Theory of Structures",*** *Tata McGraw Hill Publishing, Company Ltd, N.Delhi, 1998.*
3	*Iyengar NGR,* ***"Elastic Stability of Structural Elements",*** *Macmillan, 2007.*
4	*Allen H.G and Bulson.P.S,* ***"Background to buckling",*** *McGraw Hill Publishing Company Ltd, 1980.*
5	*Smites,* ***"Elastic Stability of Structures"****, Prentice Hall, 1974.*
6	*Timoshenko.S, and Gere,* ***"Theory of Elastic Stability",*** *McGraw Hill Publishing Company Ltd, 2012.*

COURSE OUTCOMES:	**Bloom's Taxonomy Mapped**
Upon completion of the course, the students will be able to:	

CO1	Apply basic concepts and various approaches of stability of columns	K3
CO2	Execute and workout the inelastic buckling using various methodologies	K3
CO3	Examine the buckling behavior of beam columns and frames.	K3
CO4	Examine the lateral buckling, torsional buckling and flexural torsional buckling of various beams.	K3
CO5	Do stability analysis of buckling of thin plates.	K3

COURSE ARTICULATION MATRIX						
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	1	1	1
CO2	1	-	2	2	1	1
CO3	1	-	3	1	2	1
CO4	1	-	2	1	1	1
CO5	1	-	2	1	2	1
23SEPE01	1	-	2	2	2	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	30	-	-	-	100
CAT2	30	40	30	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	30	40	30	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	30	40	30	-	-	-	100
ESE	30	40	30	-	-	-	100

23SEPE02	THEORY AND APPLICATIONS OF CEMENT COMPOSITES				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To enhance the knowledge in the behaviour of composite materials and to investigate the failure and fracture characteristics.

UNIT – I	**INTRODUCTION**	**9 Periods**

Introduction to Composites, Classifying composite materials, Types of Cement Composites, Terminology, Constituent Materials and their Properties - Commonly used fiber and matrix constituents -Engineered Cementitious composites -Advantages.

UNIT – II	**PROPERTIES OF COMPOSITES**	**9 Periods**

Stress-Strain Relations - Orthotropic and Anisotropic Materials, Engineering Constants for Orthotropic Materials, Restrictions on Elastic Constants, Plane Stress Problem, Biaxial Strength, Theories for an Orthotropic Lamina.

UNIT – III	**BEHAVIOUR OF COMPOSITES**	**9 Periods**

Mechanics of Materials Approach to Stiffness - Determination of Relations between Elastic Constants, Elasticity Approach to Stiffness - Bounding Techniques of Elasticity, Exact Solutions - Elasticity Solutions with Continuity, Halpin, Tsai Equations, Comparison of approaches to Stiffness-Behavior of Ferrocement and Fiber Reinforced Concrete in Tension, Compression, Flexure, Shear, Fatigue and Impact - Durability and Corrosion of cement composites.

UNIT – IV	**CONSTRUCTION TECHNIQUES**	**9 Periods**

Construction Techniques - Fibre Reinforced Concrete, Ferrocement, SIFCON, Polymer Concretes, Preparation of Reinforcement, Casting and Curing- Composite Construction.

UNIT – V	**STRUCTURAL AND NON-STRUCTURAL APPLICATIONS**	**9 Periods**

FRC and Ferrocement - Housing, Water Storage, Boats and miscellaneous applications - Composite Materials - Introduction to Analysis and Design of Cement Composite Structural Elements - Ferrocement, SIFCON and Fibre Reinforced Concrete.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES:

1	*Arnon Bentur, Sidney Mindess,* ***"Fibre Reinforced Cementitious Composites",*** *CRC Press, 2014*
2	*Kaw, Autar K* ***"Mechanics of composite materials",*** *CRC Press, 2006.*
3	*Andrzej M. Brandt,* ***"Cement-Based Composites: Materials, Mechanical Properties and Performance",*** *Second Edition, CRC Press, 2005.*
4	*Robert M Jones,* ***"Mechanics of Composite Materials",*** *Taylor and Francis/BSP Books, 1998.*
5	*Mallick P. K. - Fiber Reinforced Composite Materials Manufacturing and Design (2007)*
6	***"New Concrete Materials",*** *Swamy R.N., 1st Ed., Blackie, Academic and Professional, Chapman & Hall, 1983.*
7	*Chris L. Page, M M Page,* ***"Durability of Concrete and Cement Composites",*** *Elsevier, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Detect the type of composite materials and its applications	K3
CO2	Estimate properties of composite materials.	K3
CO3	Formulate constitutive behaviour of composite materials for different loading conditions by using various theories.	K4

CO4	Recognize the techniques for appropriate composite material based on its behaviour and properties	K3
CO5	Implement cement composites as an alternative to traditional materials.	K3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	2	2
CO2	3	2	2	2	1	2
CO3	3	1	2	3	2	2
CO4	2	2	2	3	2	1
CO5	3	1	2	2	2	1
23SEPE02	3	2	2	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40	-	-	-	100
CAT2	20	40	40	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	-	50	50	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	-	50	50	-	-	100
ESE	20	40	40	-	-	-	100

23SEPE03	STRUCTURAL HEALTH MONITORING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To impart knowledge on structural health monitoring, remote structural health monitoring and to have an exposure on the various repair and rehabilitation techniques.

UNIT – I	STRUCTURAL HEALTH	9 Periods

Factors affecting Health of Structures, Causes of Distress, Regular Maintenance. Structural Health Monitoring (SHM): Definition of SHM – Classification, Types and Components of SHM – Advantages and Benefits of SHM.

UNIT – II	STATIC FIELD TESTING	9 Periods

Static field testing -Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement.

UNIT – III	DYNAMIC FIELD TESTING	9 Periods

Dynamic Field Testing -Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Data Acquisition Systems.

UNIT – IV	REMOTE STRUCTURAL HEALTH MONITORING	9 Periods

Remote Structural Health Monitoring - Importance and Advantages – Methodology – IoT applications in SHM – Applications of Machine learning Techniques in SHM.

UNIT – V	REPAIRS AND REHABILITATION TECHNIQUES	9 Periods

Repair and Rehabilitation of structures - Case Studies, piezoelectric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique.

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES

1	*Alessandro Pegoretti,* ***"Structural Health Monitoring : Current State and Future Trends"****, SAE International, 2018.*
2	*D. Hutson,* ***"Structural Sensing, Health Monitoring, and Performance Evaluation",*** *CRC Press, 2019.*
3	*Filippo Ubertini, Simon Laflamme, Jian Li,* ***"Smart Sensors for Structural Health Monitoring",*** *MDPI Books, 2019.*
4	*Maguid H.M. Hassan* ***"Advances in Structural Health Monitoring",*** *IntechOpen, 2019.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Diagnosis the distress in the structure by understanding the causes and factors.	K3
CO2	Assess the health of the structure using static field testing.	K3
CO3	Analyse the condition of structures using dynamic field-testing methods.	K3
CO4	Perform the process of remote health monitoring of structures.	K3
CO5	Suggest repairs and rehabilitation measures of the structure.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	3	2	2
CO2	3	2	3	3	2	2
CO3	3	2	3	3	2	2
CO4	1	2	3	3	2	3
CO5	2	2	3	3	2	3
23SEPE03	3	2	3	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	40	40	20	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	40	40	20	-	-	-	100
ESE	40	40	20	-	-	-	100

23SEPE04	DESIGN OF FORMWORK

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To impart knowledge on design of formwork and special structures considering formwork failure conditions and safety measures.

UNIT – I	**INTRODUCTION**	**9 Periods**

Introduction to Formwork, Requirements and Site Constraints, Selection of Formwork, Classification of Formwork. Formwork Materials: Timber, Plywood, Steel, Aluminum, Plastic, and Accessories. Horizontal and Vertical Formwork Supports.

UNIT – II	**FORMWORK DESIGN FOR STRUCTURAL ELEMENTS**	**9 Periods**

Formwork design concepts, Formwork System Design for Foundations, Walls, Columns, Slabs and Beams. Design of Decks and False works, Effects of various loads. Loading and Moment of Formwork, IS Code provisions.

UNIT – III	**FORMWORK DESIGN FOR SPECIAL STRUCTURES**	**9 Periods**

Shells, Domes, Folded Plates, Overhead Water Tanks, Bridges, Natural Draft Cooling Tower, Nuclear Reactor, Tunnel and Lift Shaft.

UNIT – IV	**FLYING FORMWORK**	**9 Periods**

Flying Formwork Accessories and Construction Sequence, Table Form, Tunnel Form, Column Mounted Shoring System, Gang Form, Slip Form, and Formwork for Precast Concrete, Applications.

UNIT – V	**FORMWORK FAILURE AND MANAGEMENT**	**9 Periods**

Formwork Failure, Causes for Formwork Failure, Case studies in Formwork Failure. Safety in use of Formwork and False work. Formwork Management Issues – Pre and Post Award, Formwork Issues in Multi-Story Building Construction.

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES:

1	*Jha, K.N., **"Formwork For Concrete Structures"**, First Edition, McGraw Hill. 2012.*
2	*Michael P. Hurst, **"Formwork"**, Construction Press, London and New York, 2003.*
3	*Robert L. Peurifoy and Garold D. Oberlender, **"Formwork For Concrete Structures"**, McGraw -Hill, 2011.*
4	*Austin, C.K., **"Formwork For Concrete, Cleaver"**, Hume Press Ltd., London, 2006.*
5	*Tudor Dinescu and Constantin Radulescu, **"Slip Form Techniques"**, Abacus Press, Turn Bridge Wells, Kent, 2004.*
6	*Indian Concrete Institute, **"Technical Monograph For Formwork"**, 2002.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the suitable type of formwork for construction activities.	K2
CO2	Carry out design of formwork system for various structural elements.	K3
CO3	Perform formwork design for special structures.	K3
CO4	Select a suitable type of flying formwork.	K3

CO5	To indicate the causes for failure of formwork.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	3	2	1	-
CO2	-	-	3	2	1	-
CO3	-	-	3	2	1	-
CO4	-	-	3	2	1	-
CO5	-	1	3	2	1	1
23SEPE04	-	1	3	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	40	-	-	-	100
CAT2	25	35	40	-	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project1	15	35	50	-	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	15	35	50	-	-	-	100
ESE	20	40	40	-	-	-	100

23SEPE05	ANALYSIS OF LAMINATED COMPOSITE PLATES					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To impart the knowledge on governing equations, analysis and various methods of composite plates.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Displacement Field Approximations for Classical Laminated Plate Theory (CLPT) and First Order Shear Deformation Theory (FSDT), Analytical Solutions for Bending of Rectangular Laminated Plates using CLPT.						
UNIT – II	**GOVERNING EQUATIONS**					**9 Periods**
Navier Solutions of Cross-Ply and Angle-Ply Laminated Simply Supported Plates, Determination of Stresses. Levy Solutions for Plates with Other Boundary Conditions, Analytical Solutions for Bending of Rectangular Laminated Plates using FSDT.						
UNIT – III	**CLASSICAL LAMINATED PLATE THEORY**					**9 Periods**
Finite Element Solutions for Bending of Rectangular Laminated Plates using CLPT .Introduction to Finite Element Method, Rectangular Elements, Formation of Stiffness Matrix, Formation of Load Vector, Numerical Integration, Post Computation of Stresses.						
UNIT – IV	**FIRST ORDER SHEAR DEFORMATION THEORY**					**9 Periods**
Finite Element Solutions for Bending of Rectangular Laminated Plates using FSDT. Finite Element Model, C0 Element Formulation, Post Computation of Stresses.						
UNIT – V	**ANALYTICAL METHODS**					**9 Periods**
Analysis of Rectangular Composite Plates using Analytical Methods.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	*J.N. Reddy,* ***"Mechanics of Laminated Composite Plates: Theory and Analysis",*** *CRC-Press, 1996.*
2	*G.J. Turvey,* ***"Buckling and Post buckling of Composite Plates",*** *I.H. Marshall Springer Science & Business Media, 1994.*
3	*Jianqiao Y,* ***"Laminated Composite Plates and Shells",*** *Springer-Verlag, London, 2003.*
4	*Yi-Ming Fu,* ***"Nonlinear Analyses of Laminated Plates and Shells with Damage",*** *WIT Press, 2013.*
5	*O.O. Ochoa, J.N. Reddy,* ***"Finite Element Analysis of Composite Laminates",*** *Springer Science & Business Media, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know the various theories behind the analysis of laminated composite plates.	K3
CO2	Apply the governing equations for laminated composite plates.	K3
CO3	Apply the Classical Laminated Plate Theory on laminated plates using FEM.	K3
CO4	Execute the FEM analysis of laminated plates using First Order Shear Deformation Theory	K3
CO5	Analyse the rectangular laminated composite plate using the analytical method.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1		2	1	1	1
CO2	1		2	2	1	1
CO3	1		3	3	2	1
CO4	1		3	3	2	1
CO5	1		2	1	2	1
23SEPE05	1	-	3	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	30	-	-	-	100
CAT2	30	40	30	-	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project1	30	40	30	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2	30	40	30	-	-	-	100
ESE	30	40	30	-	-	-	100

23SEPE06	DESIGN OF CONCRETE BRIDGES

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To possess knowledge on the analysis and design of short span, long span bridges, foundation and bearing.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Classification, investigations and planning, choice of type, I.R.C. Specifications for road bridges, standard live loads, other forces acting on bridges, general design considerations.		
UNIT – II	**SHORT SPAN BRIDGES**	**9 Periods**
Load distribution theories - Design of box culverts - Design of slab decks, tee beam and slab bridges.		
UNIT – III	**LONG SPAN BRIDGES**	**9 Periods**
Design principles of continuous bridges, arch bridges, box girder bridges, bow string girder bridges, cable stayed bridges, suspension bridges, balanced cantilever bridges		
UNIT – IV	**DESIGN OF PRESTRESSED CONCRETE BRIDGES**	**9 Periods**
Courbon's theory – Distribution co-efficient by exact analysis – Design of girder section – maximum and minimum prestressing forces – Eccentricity – Cable Zone in girder – Stresses at various sections and diagonal tension – Diaphragms – End block – short term and long term deflections		
UNIT – V	**BEARINGS, CONSTRUCTION AND MAINTENANCE OF BRIDGES**	**9 Periods**
Bearings – Steel rocker and roller bearings – Reinforced concrete rocker and roller bearings – Elastomeric bearings - Expansions joints- Design of abutments and piers – Bridge Construction and Maintenance. Types of bridge foundations – Design of foundations		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Raina V.K.* ***"Concrete Bridge Practice"****, Tata McGraw Hill Publishing Company, New Delhi, 2014.*
2	*Jagadeesh T.R and Jayaram M.A,* ***"Design Of Bridge Structures"****, PHI Learning Private Limited, 2020.*
3	*Krishnaraju, N.,* ***"Design of Bridges"*** *Oxford and IBH Publishing Co., Bombay, Calcutta, New Delhi, 2019.*
4	*Bakht, B. and Jaegar, L.G.,* ***"Bridge Analysis simplified"****, McGraw Hill, 1985.*
5	*Ponnuswamy, S.,* ***"Bridge Engineering",*** *Tata McGraw Hill, 2017*
6	*Derrick Beckett,* ***"An introduction to Structural Design of Concrete Bridges"****, Surrey University Press, Henley Thomes, Oxford Shire, 1973.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Classify the different types of bridges and calculate the loads on bridges	K2
CO2	Analyse and design short span bridges using different theories	K3
CO3	Illustrates the design principles of various long span bridges	K2
CO4	Analyse and design the Prestressed Concrete bridges	K3
CO5	Design the foundation and bearings of the bridges	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	3	1	1	2
CO2	3	2	3	3	2	3
CO3	3	2	3	1	2	3
CO4	3	2	3	1	2	3
CO5	3	2	3	1	2	3
23SEPE06	3	2	3	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Rememberin g (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	60	-	-	-	100
CAT2	20	20	60	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	25	25	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	25	25	50	-	-	-	100
ESE	20	20	60	-	-	-	100

23SEPE07	PRESTRESSED CONCRETE STRUCTURES				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To impart knowledge on the basic principles, analyze and design of prestress concrete members.

UNIT – I	**ANALYSIS OF BEAMS AND LOSSES IN PRESTRESS**	**9 Periods**

Principles of prestressing – Different systems of prestressing – Materials and Allowable stresses –Elastic Design of prismatic beams – Simple cable profile Design of beams for shear. Losses in prestress - Deflections –Short Term and Long Term deflection.

UNIT – II	**DESIGN OF TENSION AND COMPRESSION MEMBERS**	**9 Periods**

Design of compression and tension members – Design of Compression members with bending. End Block- Introduction- Stress Distribution in End Block – Anchorage Zone Stresses -Design of end block – Guyon's method, Magnel's method – I.S 1343 recommendations.

UNIT – III	**CONTINUOUS BEAMS AND COMPOSITE CONSTRUCTION**	**9 Periods**

Concept of concordancy and Linear Transformation – Elastic analysis of continuous beams– Sketching of pressure lines for continuous beams and single span single storey rigid frames – Load balancing method - Design of continuous beams. Composite construction – Types and behavior – Analysis and design for flexure and shear – Differential shrinkage.

UNIT – IV	**SPECIAL TOPICS**	**9 Periods**

One way slabs – Two way slabs – Circular prestressing – Prestressed concrete pipes – Analysis and design of liquid retaining tanks – Design of prestressed concrete sleepers and poles.

UNIT – V	**LIMIT STATE DESIGN**	**9 Periods**

Safety and Serviceability requirements – Partial safety factors – Limit state Design of beams in flexure and shear – Limit state Design of Compression members. Non prestressed reinforcements – partial prestressing.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES:

1	*Lin.T.Y. and Ned.H.Burns,* ***"Design of Prestressed concrete structures"*** *(S.I Version), John wiley & Sons Inc., New York, 2015.*
2	*Sinha.N.C. and Roy.S.K.* ***"Fundamentals of prestressed Concrete"****, S.Chand and Co., 2011*
3	*Krishnaraju N.,* ***"Prestressed Concrete"****, Tata McGraw Hill publishing Co.Ltd. New Delhi, 2018.*
4	*Leonhardt.F.* ***"Prestressed Concrete Design and Construction",*** *Wiley Ernst and Sons, 1964.*
5	*N.Rajagopalan,* ***"Prestressed Concrete",*** *Narosana Publications, 2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze and design the prestressed concrete beam sections.	K3
CO2	Design the prestressed concrete tension, compression members and end block.	K3
CO3	Analyse the statically indeterminate structure and design the continuous beams and composite beams.	K3

CO4	Design the prestressed concrete pipes, sleepers, tanks, poles and slabs.	K3
CO5	Design the PSC beam and compression member by limit state method	K3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	1	2
CO2	2	2	1	2	2	2
CO3	2	2	2	1	2	1
CO4	3	2	2	3	3	2
CO5	2	2	1	2	1	2
23SEPE07	3	2	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40	-	-	-	100
CAT2	20	40	40	-	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project1	-	-	50	50	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	-	50	50	-	-	100
ESE	20	40	40	-	-	-	100

23SEPE08	EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To learn various experimental techniques and instrumentation procedure for testing structural elements.	
UNIT – I	**FORCE AND STRAIN MEASUREMENT**	**9 Periods**
Strain Gauges, principle, types, performance and uses - Photo elasticity, principle and applications - Moiré fringes hydraulic jacks and pressure gauges - Electrical load cells - proving rings - calibration of testing machines.		
UNIT – II	**VIBRATION MEASUREMENTS**	**9 Periods**
Characteristics of structural vibration - linear variable differential transformer (LVDT) - Transducers for Velocity and acceleration measurements- vibration meterseismographs - vibration analyzer - display of recording of signals - cathode ray oscilloscope - XY plotter - chart plotters - Digital data acquisition systems.		
UNIT – III	**ACOUSTICS AND WIND FLOW MEASURES**	**9 Periods**
Principles of pressure and flow measurements- pressure transducer- sound level meter - venturimeter and flow meters - Wind tunnel and its use in structural analysis- structural modeling- direct and indirect model analysis.		
UNIT – IV	**DISTRESS MEASUREMENTS**	**9 Periods**
Diagnosis of distress in structures- crack observation and measurement- Corrosion of reinforcement in concrete- Half cell, construction and use- damage assessment - controlled blasting for demolition.		
UNIT – V	**NON DESTRUCTIVE TESTING METHODS**	**9 Periods**
Load testing on structures, buildings, bridges and towers - Rebound hammer Acoustic emission- Ultrasonic testing, Principles and applications - Holography - Use of laser for structural testing- Brittle coatings.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Sadhu Singh, **"Experimental Stress Analysis"**, Khanna publishers, New Delhi, 1996.*
2	*Dalley and Riley, **"Experimental Stress Analysis"-** McGraw Hill Book Company, New York 1991.*
3	*L.S.Srinath. **"Experimental Stress Analysis",** Tata McGraw Hill company Book Ltd., NewDelhi. 1984*
4	*Bray and Stanley, **"Non Destructive Evaluation"**, McGraw Hill Publishing co., New York,1989*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply concepts of measurements and related instruments in the real time application areas.	K2
CO2	Use the various vibration measuring instruments and analyze the structures using digital display units.	K2

CO3	Perform model analysis for wind flow measurements.	K3
CO4	Diagnose the distressed structures using advanced damage assessing techniques	K2
CO5	Perform NDT methods on the existing structures.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	3	2	3
CO2	3	-	-	2	-	-
CO3	3	-	2	1	1	2
CO4	3	-	1	2	1	2
CO5	3	-	1	3	1	2
23SEPE08	3	-	2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	40	10				100
CAT2	50	40	10				100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	30	50	20				100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	30	50	20				100
ESE	50	40	10				100

23SEPE09	STRUCTURAL OPTIMIZATION

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To learn the optimization techniques in structural engineering.

UNIT – I	OPTIMIZATION FUNDAMENTALS	9 Periods

Optimization methods - Introduction, Problem formulation, Mathematical principles in optimization - Mathematical models - Activity – Design methodology- Civil engineering case study - Unconstrained functions – single variable - several variable - equality constraints – inequality constraints- optimization - design space - Feasible and Infeasible - Convex and concave – Active constraints - Local and Global optima – differential Calculus - Optimality criteria - Lagrange multiplier method - Kuhn- tucker Criteria.

UNIT – II	LINEAR PROGRAMMING	9 Periods

Linear Programming – Formulation of problems - graphical solution - plastic design of frames - analytical methods- Simplex method – Basic ideas and steps- Duality sensitivity analysis – simple LP problems – Transportation Problem – Assignment Method.

UNIT – III	NON-LINEAR PROGRAMMING	9 Periods

Introduction to non - linear problems - One dimensional minimization methods – unimodal function - Exhaustive and unrestricted search – Dichotomous search – Fibonacci method- Golden section method - Interpolation methods.

Unconstrained multivariable function - univariate method - Cauchy's steepest descent method - conjugate gradient method (Fletcher Reeves) – Variable metric methods (Davison-Fletcher-Powell) - Direct and indirect methods - cutting plane method - Methods of feasible direction - Interior Penality function – External Penalty function method.

UNIT – IV	GEOMETRIC PROGRAMMING AND DYNAMIC PROGRAMMING	9 Periods

Geometric Programming- Polynomial – Degree of difficulty- Reducing G.P.P. to a set of simultaneous equations – Concepts of solving problems with zero difficulty and one degree of difficulty.

Dynamic Programming - Bellman's principle of optimality – Representation of a multi stage decision problem - Concept of sub - Optimisation problems – Truss optimization.

UNIT – V	NON-TRADITIONAL METHODS (concepts only)	9 Periods

Genetic Algorithm – Terminology – Natural Law of Evolutions – Genetic operators – steps for solution of problems. Simulated Annealing – Algorithm – Boltzman's equation.

ANT Colony optimization – Algorithm -Travelling salesman problem.

Introduction to TABU search – sample problem. Artificial Neural Network - Basic concepts – Biological systems –Application characteristics – overview of learning methods.

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES:

1	*Kirsch.U,* ***"Structural Optimisation: Fundamentals and Applications",*** *Springer-Verlog, 2012.*
2	*K.Deb,* ***"Optimisation for Engineering Design : Algorithms and examples",*** *Prentice Hall, New Delhi, 2012*
3	*J.S.Arora,* ***"Introduction to Optimum Design",*** *McGraw –Hill Book Compan , 2011.*
4	*Belegundu, A.D.and Chandrapatla,T.R.,* ***"Optimisation Concepts and Applications in Engineering",*** *Pearson Education, 2011.*
5	*Rao.S.S* ***,"OptimisationTheory and Applications",*** *New Age International Private Limited Publisher, New Delhi, 2002*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Apply fundamental concepts and principles in Optimization.	K2
CO2	Implement the linear programming technique for simple problems.	K3
CO3	Utilize various non-linear programming methods in structural engineering.	K3
CO4	Analyze the Optimization methods by using Geometric and Dynamic programming.	K3
CO5	Attain basic concepts of Non-traditional methods.	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2	3	2	2
CO2	2	2	1	2	2	2
CO3	2	2	2	1	2	1
CO4	3	2	2	3	3	2
CO5	2	2	1	2	1	2
23SEPE09	3	2	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	20	40	40	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1/ Project1	-	-	50	50	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2	-	-	50	50	-	-	100
ESE	20	40	40	-	-	-	100

23SEPE10	ADVANCED CONCRETE TECHNOLOGY

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To acquire knowledge on the properties of concrete and get exposed to special concretes in order to impart the concepts of sustainability in the field of concrete

UNIT – I	**INTRODUCTION**	**9 Periods**

Concrete - Understanding the quassi-brittle nature of concrete - Failure of concrete under low stress - Micro-cracking, crack propagation - stress concentration at openings –Destructive, semi-destructive & Non-destructive testing methodology - Rebound hammer test - Ultrasonic Pulse Velocity (UPV) Test - Penetration resistance test - Pull-out Test - Pull-off Method - Break-off test - Cover Measurement - Core Sampling and Testing - Half-cell electrical potential method - Resistivity Mapping Problems faced during Non-destructive evaluation - Microscopic Analysis – XRD, SEM, TEM Analysis.

UNIT – II	**ADMIXTURES AND POLYMERS**	**9 Periods**

Chemical Admixtures- Mechanism of chemical admixture – Test for determining optimum dosage -Effect on concrete property in fresh and hardened state, Mineral Admixture- Effect on concrete property in fresh state and hardened state. Polymers in Civil Engineering-Structural Plastics And Composites- Polymer Membranes Coatings.

UNIT – III	**DURABILITY PROPERTIES**	**9 Periods**

Permeability – chemical attack – Sulphate attack – Carbonation - Quality of water – marine conditions – Thermal properties of concrete – fire resistance – methods of making durable concrete

UNIT – IV	**SPECIAL CONCRETE**	**9 Periods**

Light weight concrete, Fiber and Hybrid Fiber reinforced concrete, Polymer Concrete, Super plasticized concrete, Epoxy resins and screeds for rehabilitation Fly ash and High volume flyash concrete, -High performance concrete - Self compacting concrete - Self curing concrete – Recycled aggregate concrete - Bacterial concrete – Nanoconcrete

UNIT – V	**SUSTAINABILITY**	**9 Periods**

Introduction - Need for sustainability - Concept of sustainability - social, environmental and economic sustainability concepts. Sustainable development - Engineering for sustainable development - Threats for sustainability - Low Impact development techniques-Green materials -Material selection for sustainable design

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES:

1	*Neville, A.M., **"Properties of Concrete"**, Pitman Publishing Limited, London, 2012.*
2	*Shetty M.S., **"Concrete Technology"**, S.Chand and Company Ltd. Delhi, 2019.*
3	*Gambhir.M.L., **"Concrete Technology"**, Tata McGraw Hill, Publishing Co. Ltd New Delhi, 2013.*
4	*Santhakumar .A.R., **"Concrete Technology"**, Oxford University Press, NewDelhi,2018*
5	*Metha P.K. and Montreio P.J.M., "**Concrete Structure Properties and Materials"**, 2nd edition, Prentice Hall ,203*
6	*A. M. Neville & J. J. Brooks, **"Concrete Technology"**, 4th Impression, Pearsons Education Ltd, 2010*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Apply the various testing methods of concrete to assess its properties	K2
CO2	Identify and explain the role of admixture and polymers of concrete and their effects on concrete properties	K2
CO3	Produce durable concrete	K2
CO4	Identify a suitable concrete for different structures considering the prevailing conditions	K2
CO5	Implement the concepts and need for sustainability	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	2	2
CO2	3	3	2	3	2	3
CO3	3	3	2	3	2	2
CO4	3	3	3	3	2	3
CO5	3	3	3	3	3	3
23SEPE10	3	3	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	50	-	-	-	-	100
CAT2	50	50	-	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1/ Project1	50	50	-	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2	50	50	-	-	-	-	100
ESE	50	50	-	-	-	-	100

23SEPE11	PLATES AND SHELLS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To impart knowledge on structural behaviour of plates under different boundary conditions and the membrane theory concept for the analysis of shells.

UNIT – I	**LATERALLY LOADED PLATES**	**9 Periods**

Thin Plates with Small Defection - Laterally Loaded Thin Plates - Governing Differential Equation - Boundary Conditions. Rectangular Plates- Simply Supported Rectangular Plates - Navier Solution and Levy's Method - Plates with Various Edge Conditions. Symmetrical Bending of Circular Plates - Plates on Elastic Foundation.

UNIT – II	**NUMERICAL METHODS**	**9 Periods**

Finite Difference Method – Isotropic Rectangular plates – Boundary Conditions – All-round simply supported square plate, clamped square plate and fixed square plate subjected to uniformly distributed load.

UNIT – III	**ANISOTROPIC PLATES AND THICK PLATES**	**9 Periods**

Orthotropic Plates and Grids, Moderately Thick Plates

UNIT – IV	**MEMBRANE THEORY OF SHELLS**	**9 Periods**

Classification of Shells - Types of Shells - Structural Action - Membrane Theory - Shells of Revolution and Shells of Translation - Examples - Limitations of Membrane Theory.

UNIT – V	**FOLDED PLATES**	**9 Periods**

Folded Plate structures - structural behavior and analysis - Types - Design by ACI - ASCE Task Committee method.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES:

1	*Szilard, R.,* ***"Theories and Applications of Plate Analysis",*** *Wiley India Pvt. Ltd., 2014.*
2	*Timoshenko, S. and Krieger S.W.* ***"Theory of Plates and Shells"****, McGraw Hill Book Company, 1990.*
3	*Wilhelm Fluegge,* ***"Stresses in shells"****, Springer – Verlag, 1988.*
4	*Ramasamy, G.S.,* ***"Design and Construction of Concrete Shells Roofs"****, CBS Publishers, 2005.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyse the plates subjected to lateral load.	K2
CO2	Carry out numerical analysis on plates with various boundary conditions.	K2
CO3	Evaluate the behaviour of the anisotropic plates and thick plates.	K2
CO4	Perform analysis of shells using membrane theory.	K2
CO5	Carry out analysis and design of folded plates.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	2	3	1	1
CO2	2	-	2	3	1	1
CO3	2	-	2	3	1	1
CO4	2	-	2	3	1	1
CO5	2	-	2	3	1	1
23SEPE11	2	-	2	3	1	1
1 - Slight, 2 – Moderate, 3 - Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	40	40	20	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	40	40	20	-	-	100
ESE	40	40	20	-	-	-	100

23SEPE12	FRACTURE MECHANICS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To learn about the development of fatigue crack and crack growth under elastic & elasto plastic conditions and to familiarize the principle of crack arrest along with the methods to determine fracture parameters.

UNIT – I	**INTRODUCTION TO FRACTURE MECHANICS**	**9 Periods**

Modes of fracture failure, The Griffith energy Balance Approach – Crack tip Plasticity – Fracture toughness

UNIT – II	**LINEAR ELASTIC FRACTURE MECHANICS**	**9 Periods**

Elastic crack tip stress field - Stress and displacement fields in isotropic elastic materials – Westergaard's approach– Plane Strain Fracture toughness (KIC) testing – Feddersen approach, R curve, Energy released rate of DCB specimen – An elastic deformation at crack tip – K_{1c} Test technique, Various test specimens – critical energy rate

UNIT – III	**ELASTIC PLASTIC FRACTURE MECHANICS**	**9 Periods**

Limitation of K approach- Approximate shape and size of plastic zone- Effective crack length- Effect of plate thickness - Elastic plastic fracture concept – Crack tip opening displacement – Dugdale approach – Path independence, critical J integral – Evaluation of CTOD- relationship between CTOD, K_1 and G_1 for small scale yielding

UNIT – IV	**FATIGUE CRACK GROWTH**	**9 Periods**

Fatigue crack growth, SN Curve –J_{1c} Mechanism of Fatigue, Fatigue crack propagation- Paris Law- Crack closure mechanism- Residual stresses at crack tip – Retardation effect fatigue crack growth test, stress intensity factor, factors affecting stress intensity factor

UNIT – V	**CRACK ARREST & NUMERICAL METHODS**	**9 Periods**

Principles of crack arrest, crack arrest in practice-R curves, Crack resistance curve, Numerical Methods in fracture Mechanics, Direct methods to determine fracture parameters - Indirect methods to determine fracture parameters

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES:

1	*Stanley T. Rolfe and John M. Barsom &* ***"Fracture and Fatigue Control in Structures: Applications of Fracture Mechanics"****, Prentice Hall Inc, USA, 1987.*
2	*David Broek,* ***"Elementary Engineering Fracture Mechanics"****, Springer Publishers, 2011.*
3	*Knott J.F.,* ***"Fundamental of Fracture Mechanics"****, Butterworth & Co Publishers Ltd,1976.*
4	*Suresh S.,* ***"Fatigue of materials"****, Cambridge India, 2015.*
5	*B, Karihaloo,* ***"Fracture Mechanics and Structural Concrete"****, Longman Scientific Publishers, 1995.*
6	*Simha K.R.Y.,* ***"Fracture Mechanics for Modern Engineering design"****, University Press (India) Ltd, Hyderabad, 2001.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the modes of fracture and suitable theories of failures for structural materials with pre existing cracks	K2
CO2	Measure crack tip stress and displacement fields using the principles of Linear Elastic Fracture Mechanics	K3
CO3	Implement the Elastic Plastic Fracture Mechanics approach to determine the parameters of crack development	K3
CO4	Predict the rate of Fatigue Crack Growth and influencing factors in crack propagation.	K3

CO5	Choose the methods to Crack Arrest and Numerical methods to determine fracture parameters	K3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	1	2	1
CO2	3	-	2	1	2	1
CO3	3	-	2	1	2	1
CO4	3	-	2	1	2	1
CO5	3	-	2	1	2	1
23SEPE12	3	-	2	1	2	1
1 - Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	40	30	-	-	-	100
CAT2	30	40	30	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	30	30	40	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	30	30	40	-	-	100
ESE	30	40	30	-	-	-	100

23SEPE13	DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To impart the knowledge on the design principles and steps of composite beams, floors, columns, truss and its connections and to learn the concept of composite action between structural steel and concrete in composite structures.

UNIT – I	**INTRODUCTION**	**9 Periods**

Theory of Composite Structures – Modular Ratio and Transformed section – Composite Action – No interaction & Partial Interaction – Full interaction – Effect of Slip on stress & deflection– Stress Block – Ultimate moment Capacity.

Codal Provisions for Steel Concrete Composite Design

UNIT – II	**COMPOSITE BEAMS**	**9 Periods**

Introduction to Composite beams – Ultimate Moment behaviour – Shear connectors types and load transferring mechanism – Profiled decking – Design consideration for simply supported and continuous composite beams with and without profile deck – Design examples

UNIT – III	**COMPOSITE FLOORS**	**9 Periods**

Introduction to composite floors – Shear transferring mechanism in profile deck system – Bending resistance of Composite floor slabs - – Design consideration of composite floors – Design examples

UNIT – IV	**COMPOSITE COLUMNS**	**9 Periods**

Introduction to composite columns– Resistance to axial compression of encased composite column cross section and infilled composite column cross section– Design consideration of both encased and infilled composite column under axial compression, uniaxial bending and biaxial bending- Design examples.

UNIT – V	**COMPOSITE TRUSSES AND CONNECTIONS**	**9 Periods**

Introduction of Composite Truss –Design consideration – Stud Specifications – Load Calculations – Design of composite truss. Composite connections- Complexities of Composite Connections and its design Philosophies – Force flow in the joint. Case studies on steel concrete composite constructions.

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES:

1	*Johnson R.P.,* ***"Composite Structures of Steel and Concrete: Beams, Slabs, Columns, and Frames for Buildings"****, Wiley-Blackwell Publishers, 2004.*
2	*Deric Oehlers, Mark A. Bradford.,* ***"Elementary Behaviour of Composite Steel and Concrete Structural Members"****, CRC Publishers, 1999.*
3	*Workshop on* ***"Steel –Concrete Composite Structures"****, conducted at Anna University, Chennai, 2000*
4	*IS 11384 -1985,* ***"Code of Practice for Composite Construction in Structural Steel and Concrete".***
5	*Euro Code 4,* ***"Design of composite steel and concrete structures"***
6	*BS 5950-3.1,* ***"Structural use of steelwork in building - Part 3: Design in composite construction".***

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Determine the ultimate load carrying capacity of composite structures	K2
CO2	Perform analysis and design a composite beams with or without profile decking sheet	K3
CO3	Design a composite slab with the provision of profile decking	K3
CO4	Assess the load carrying capacity and perform design of composite columns subjected to axial compression and bending	K3
CO5	Carry out design of composite truss and its connections	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	1	2	1
CO2	2	-	3	1	2	1
CO3	2	-	3	1	2	1
CO4	2	-	3	1	2	1
CO5	2	-	3	1	2	1
23SEPE13	2	-	3	1	2	1
1 - Slight, 2 – Moderate, 3 - Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	20	40	40	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	-	50	50	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	-	50	50	-	-	100
ESE	20	40	40	-	-	-	100

23SEPE14	MAINTENANCE AND REHABILITATION OF STRUCTURES				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To induce an exposure on repair, rehabilitation and strengthening techniques for damaged and existing structures.	
UNIT – I	**MAINTENANCE AND REPAIR STRATEGIES**	**9 Periods**
Maintenance – Repair and Rehabilitation – Retrofit and Strengthening – Facets of Maintenance – Importance of Maintenance – Various aspects Inspection – Assessment procedure for evaluating a damaged structure – Structural Audit – Causes of deterioration – Diagnosis of Causes and Preventive measures.		
UNIT – II	**SERVICEABILITY AND DURABILITY OF CONCRETE**	**9 Periods**
Quality assurance for concrete construction – Factors affecting concrete properties – Strength, permeability, thermal properties – Effects due to climate, temperature, chemicals, aggressive environment, wear and erosion – Types of cracks – Causes and effects of cracks – Corrosion mechanism – Causes and effects of corrosion – Cover thickness requirements.		
UNIT – III	**REPAIR MATERIALS AND SPECIAL CONCRETE**	**9 Periods**
Repair materials – Strategy and Selection – Special Mortars and Concretes – Polymer Concrete and Mortar – Concrete Chemicals – Quick setting compounds – Grouting Materials – Bonding Agents – Protective coatings – FRP Sheets.		
UNIT – IV	**REPAIR TECHNIQUES AND DEMOLITION**	**9 Periods**
Rust eliminators – Methods of corrosion protection: Corrosion inhibitors and cathodic protection – Crack repair techniques – Vacuum concreting – Guniting and Shotcreting – Epoxy injection – Shoring and underpinning – Engineered demolition techniques for dilapidated structures – Case studies.		
UNIT – V	**REHABILITATION AND STRENGTHENING TECHNIQUES**	**9 Periods**
Repairs to overcome deflection, cracking, chemical disruption, weathering, wear, fire, leakage, marine exposure – Strengthening of Super Structures – Jacketing – Reinforcement addition, Plating, Conversion to composite construction – Post stressing – Strengthening of substructures – Case studies.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Bhattacharjee J* ***"Concrete Structures Repair, Rehabilitation and Retrofitting"****, CBS Publishers and Distributors, 2020.*
2	*CPWD* ***"Handbook on Repair and Rehabilitation of RCC Buildings"****, CPWD, Govt. of India, New Delhi, 2014.*
3	*Peter H. Emmons* ***"Concrete Repair And Maintenance Illustrated"****, RS Means, 1994.*
4	*R.T.Allen and S.C.Edwards,* ***"Repair Of Concrete Structures"****, CRC Press, 2019.*
5	*P.C Varghese* ***"Maintenance, Repair & Rehabilitation & Minor Works of Buildings"****, PHI Learning Private Limited, Delhi, 2014.*
6	*Denison Campbell, Allen and Harold Roper,* ***"Concrete Structures, Materials, Maintenance And Repair"****, Longman Scientific and Technical UK, 1991.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Inspect the condition of the damages structures to perform structural audit.	K2
CO2	Identify issues addressed in structures due to lack of durability.	K2
CO3	Select a suitable repair material & retrofit technique for damaged structures.	K3
CO4	Apply the appropriate demolition technique for damaged structure.	K3
CO5	Choose an appropriate strengthening technique for deteriorated structures.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	3	1	-	1
CO2	2	1	3	2	-	1
CO3	2	-	3	2	-	1
CO4	2	-	3	2	-	1
CO5	2	-	3	2	-	1
23SEPE14	2	1	3	2	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	40	-	-	-	100
CAT2	20	40	40	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	10	40	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	10	40	50	-	-	-	100
ESE	20	40	40	-	-	-	100

23SEPE15	PREFABRICATED STRUCTURES				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To impart knowledge on elements of prefabricated structures and its construction.	
UNIT – I	**INTRODUCTION AND DESIGN PRINCIPLES**	**9 Periods**
Comparison with monolithic construction – Types of prefabrication – site and plant prefabrication - specific requirements for planning and layout of prefabrication plant-IS Code specifications. Modular co-ordination – Components - Prefabrication systems and structural schemes - Design considerations - Economy of prefabrication- assessment of handling and erection spaces.		
UNIT – II	**PREECAST CONCRETE FLOOR AND BEAMS**	**9 Periods**
Types of composites - non composite - reinforced beam - pre stressed beam - design-detailing. Precast flooring options-flooring arrangements-design of individual units-design of composite floors - Roof panels.		
UNIT – III	**PRECAST CONCRETE COLUMN AND WALLS**	**9 Periods**
Precast column design, Types of wall panels - Blocks and large panels- Curtain- Partition -load bearing walls - precast shear walls - footings.		
UNIT – IV	**JOINTS AND CONNECTIONS**	**9 Periods**
Basic mechanism-compression joint-shear joint - tension joint. Pin jointed connection-moment resisting connections- beam to column- column to foundation connections- wall to wall panel connection - Effective sealing of joints for water proofing – Provisions for non-structural fastenings – Expansion joints in pre-cast construction.		
UNIT – V	**PRODUCTION AND HOISTING TECHNOLOGY**	**9 Periods**
Choice of production setup – Manufacturing methods – Stationary and mobile production – Planning of production setup– Storage of precast elements – Dimensional tolerances – Acceleration of concrete hardening. Equipments for hoisting and erection – Techniques for erection of different types of members like Beams, Slabs, Wall panels and Columns – Vacuum lifting pads.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES:

1	*L. Mokk,* ***"Prefabricated Concrete for Industrial and Public Structures"****, Publishing House of the Hungarian Academy of Sciences, Budapest, 2007.*
2	*K.M. Elliott,* ***"Precast concrete structures"****, Butterworth Heinmann, 2002.*
3	*Structural Design Manual,* ***"Precast Concrete Connection Details"****, Society for the Studies in the use of Precast Concrete, Netherland Betor Verlag, 2009.*
4	*Ganesan and Latha,* ***"Prefabricated structures"****, Sree Kamalamani Publications, Chennai, 2014.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the principle of fabrication in the design of structures.	K2
CO2	Plan, analyze and design the prefabricated floor and beam element.	K3
CO3	Plan, analyze and design the prefabricated concrete column and wall.	K3
CO4	Design the joints of prefabricated structures..	K3
CO5	Perform the production and erection process in the design of prefabricated elements.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2	3	2	2
CO2	3	2	1	2	2	2
CO3	3	2	2	1	2	1
CO4	3	2	2	3	3	2
CO5	3	2	1	2	1	2
23SEPE15	3	2	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	20	40	40	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	-	50	50	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	-	50	50	-	-	100
ESE	20	40	40	-	-	-	100

23SEPE16	CORROSION IN REINFORCED CONCRETE ELEMENTS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To understand the basics of corrosion mechanism, corrosion losses due to various external factors, the testing methods of corrosion in concrete and the methods of corrosion prevention in reinforced concrete

UNIT – I	**CORROSION FUNDAMENTALS**	**9 Periods**

General, Corrosion Mechanisms in concrete, Types – Carbonation, Chlorination, stray current induced, Hydrogen embrittlement, Stress corrosion, Oxidation, Electrochemical aspects, corrosion kinetics, corrosion induced degradation in concrete, Environmental Exposures.

UNIT – II	**CORROSION PROCESS**	**9 Periods**

Diffusion, Permeation, Migration and Porosity, Concrete Resistivity, Corrosion Thermodynamics, Initiation and Propagation of Corrosion**,** Passivation and Re-passivation of Steel, Electrochemical Polarization, Tafel Extrapolation, EMF series, Corrosion Products

UNIT – III	**CORROSION DIAGNOSIS & TESTING**	**9 Periods**

Importance, Inspection and Condition Assessment, Classification materials and specimens, surface preparation, exposure techniques, duration, planned interval tests, Electrochemical Inspection Techniques, Half Cell Potential Mapping, Resistivity Measurements, Corrosion Monitoring Techniques, NACE Methods, Service Life Prediction, NDTs.

UNIT – IV	**CORROSION PROTECTION FOR CONCRETE**	**9 Periods**

Material selection, concrete manufacturing, design and curing, Special Concretes, cathodic and anodic protection, Coatings (metallic, inorganic, non-metallic and organic), Surface treatments, Corrosion resistant reinforcement, Admixtures.

UNIT – V	**CORROSION IN SELECTED ENVIRONMENTS**	**9 Periods**

Atmospheric Corrosion, Corrosion in Soils, Corrosion of Steel in Concrete, Corrosion in Water, Microbiologically Induced Corrosion - Case studies.

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES:

1	*Mars G. Fontana**, "Corrosion Engineering",** Third Edition, Thirteenth Reprint, Tata Mc-Graw Hill Education Private Limited, New Delhi, 2012.*
2	*Amir Poursaee, **"Corrosion of Steel in Concrete Structures"**, WoodHead Publishing series in Civil and Structural Engineering, 2016.*
3	*Jones, D.A. **"Principles and Prevention of Corrosion"**, 2nd Edition, Macmillan Publishing Co., 1995.*
4	*Balasubramanian, M.R., Krishnamoorthy, S. and Murugesan, V., **"Engineering Chemistry",** Allied Publisher Limited., Chennai, 1993.*
5	*Sadasivam, V. **"Modern Engineering Chemistry - A Simplified Approach"**, Kamakya Publications, Chennai, 1999*
6	*Kuriakose, J.C. and Rajaram J. **"Chemistry in Engineering and Technology"**, Vol. I and II, Tata McGraw-Hill Publications Co. Ltd., New Delhi, 1996.*

COURSE OUTCOMES:		Bloom's Taxonomy Mapped
Upon completion of the course, the students will be able to:		
CO1	Apply the fundamental science involved in the corrosion process	K2
CO2	Identify the causes and mechanism of corrosion in concrete	K2
CO3	Diagnose the extent of deterioration due to corrosion	K2

CO4	Implement the prevention techniques available for reinforcement corrosion	K2
CO5	Examine the influence of environment on corrosion process	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	3	2
CO2	3	3	3	3	3	2
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	2
23SEPE16	3	3	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	50					100
CAT2	50	50					100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	50	50					100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	50	50					100
ESE	50	50					100

23SEPE17	OFFSHORE STRUCTURES					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To impart knowledge on analysis and design of offshore structures under various environmental conditions.					
UNIT – I	**WAVE THEORIES**					**9 Periods**
Wave generation process, small and finite amplitude wave theories.						
UNIT – II	**FORCES OF OFFSHORE STRUCTURES**					**9 Periods**
Wind forces, wave forces on vertical, inclined cylinders, structures - current forces and use of Morison equation						
UNIT – III	**OFFSHORE SOIL AND STRUCTURE MODELING**					**9 Periods**
Different types of offshore structures, foundation modeling, structural modeling.						
UNIT – IV	**ANALYSIS OF OFFSHORE STRUCTURES**					**9 Periods**
Static method of analysis, foundation analysis and dynamics of offshore structures.						
UNIT – V	**DESIGN OF OFFSHORE STRUCTURES**					**9 Periods**
Design of platforms, helipads, Jacket tower and mooring cables and pipe lines.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*Chakrabarti, S.K. "**Hydrodynamics of Offshore Structures**", Computational Mechanics Publications, 1987.*
2	*Thomas H. Dawson, "**Offshore Structural Engineering**", Prentice Hall Inc Englewood Cliffs, N.J. 1983*
3	*API, Recommended Practice for Planning, "**Designing And Constructing Fixed Offshore Plat-Forms**", American Petroleum Institute Publication, RP2A, Dalls, Tex.*
4	*Reddy, D.V. and Arockiasamy, M., "**Offshore Structures**", Vol.1, Krieger Publishing Company, Malabar, Florida, 1991.*
5	*Brebia, C.A.Walker, S., "**Dynamic Analysis Of Offshore Structures**" , Newnes Butterworths, U.K. 1979.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Choose appropriate wave theory for small and finite amplitude waves	K2
CO2	Calculate member forces acting on off shore structures.	K3
CO3	Formulate the structural and foundation modeling of offshore structures.	K3
CO4	Perform different analysis of Offshore platform.	K3
CO5	Design various components of offshore structures.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	2	2	2	3
CO2	2	-	-	2	-	2
CO3	2	-	2	3	1	2
CO4	2	-	1	2	2	3
CO5	2	-	1	3	2	3
23SEPE17	2	-	2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20				100
CAT2	30	50	20				100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20	40	40				100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20	40	40				100
ESE	40	40	20				100

23SEPE18	EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To get exposure in to effect of earthquakes, analysis and design of earthquake resistant Structures

UNIT – I	INTRODUCTION	9 Periods

Elements of engineering seismology – causes of earthquakes, seismic waves, magnitude, intensity and energy release – Indian seismology –Earthquake history – Seismic zone Map of India – seismographs – seismogram – accelerograph – strong motion characteristics- initiation into vibration of structures.

UNIT – II	METHODS OF SEISMIC ANALYSIS	9 Periods

Introduction to methods of seismic analysis – Equivalent static analysis IS 1893 provisions – Design horizontal seismic coefficient – design base shear – distribution – idealization of building frames - seismic analysis and modeling – determination of lateral forces – equivalent static lateral force method – response spectrum method – time history method – push over analysis - mathematical modeling of multistorey RC Building.

UNIT – III	IS CODE PROVISIONS	9 Periods

Modal response contribution – modal participation factor – response history – spectral analysis – approximate methods for lateral load analysis – IS 1893 provisions – IS 4326 provisions – behavior and design of masonry structures – discussion of codes IS 13827 and 13828. Ductile detailing of reinforcement in RC Buildings as per IS 13920

UNIT – IV	SEISMIC DESIGN CONCEPTS	9 Periods

Concept of earthquake resistant design – concept of ductility – lateral force resisting systems – strong column weak beam concept - guidelines for seismic resistant construction - beam column joints –effect of structural irregularities – cyclic load behavior of RC, steel and prestressed concrete elements – Earthquake Resistant Design for multi storey RC frames, shear wall, braced frames– capacity based design.

UNIT – V	SPECIAL PROBLEMS AND MODERN CONCEPTS	9 Periods

Soil performance - Liquefaction -Modern concepts – base isolation – adaptive system – seismic evaluation- retrofitting and strengthening of structures – seismic retrofitting strategies.

Computer Aided Analysis and Design: (For internal assessment only – not for theory examination) computer aided analysis and design of building systems for earthquake loads – response spectrum - time history analysis – capacity based design – hands on session using computer software.

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES:

1	*ChopraAK, "**Dynamics of Structure s-Theory and Applications to Earthquake Engineering",** Prentice-Hall of India Pvt. Ltd., NewDelhi, 2007.*
2	*Pankaj Agarwal and ManishShrikhande, **"Earthquake Resistant Design of Structures",** Prentice– Hall of India Pvt.Ltd., NewDelhi–110 001,2006.*
3	*CloughRW and Penzien J, **"Dynamics of Structures",** McGraw Hill, INC, 1993.*
4	*TaranathBS, **"Wind and Earthquake Resistant Buildings –structural Analysis & Design"**, Marcell Decker, NewYork, 2005.*
5	*Chen WF& Scawthorn, **"Earthquake Engineering Handbook",** CRC Press, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Value the causes of earthquake and its measurement.	K3
CO2	Analyze the structure for lateral loads.	K2
CO3	Implement the codal provisions for earthquake resistant design & detailing	K3
CO4	Apply the concepts of earthquake resistant design.	K3
CO5	Utilize the modern concepts on strengthening and retrofitting of structures affected due to earthquake.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	1	1	2
CO2	2	2	2	3	2	2
CO3	2	3	2	2	3	2
CO4	3	2	2	3	2	2
CO5	2	2	2	3	3	3
23SEPE18	3	3	2	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	20	40	40	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	-	50	50	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	-	50	50	-	-	100
ESE	20	40	40	-	-	-	100

23SEPE19	SUBSTRUCTURE DESIGN				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To discuss and evaluate the feasibility of foundation solutions to different types of soil conditions considering the time effect on soil behavior.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Design of soil investigation report for design of foundation structure –Types – Selection of foundation–Basic requirement of foundation–Computation of loads–General principle of design of reinforced concrete shallow and deep foundation.		
UNIT – II	**DESIGN OF SHALLOW FOUNDATION**	**9 Periods**
Shallow foundation – bearing capacity of footings – floating raft – Capacity of footing –Beams on Elastic foundation – Design of raft and buoyancy–Rafts and basement design.		
UNIT – III	**DESIGN OF DEEP FOUNDATION**	**9 Periods**
Deep foundation–Load carrying capacity of different types of piles and detailing of reinforcement according to IS 2911– Design of pile caps– Uplift capacity of piles–Lateral pile load test.		
UNIT – IV	**FOUNDATION FOR BRIDGES AND MACHINES**	**9 Periods**
Foundation for bridges– Well and caisson foundation– Design of pier cap - Design of pier–General principles, planning and design of machine foundation.		
UNIT – V	**TOWER FOUNDATIONS**	**9 Periods**
Introduction–Design of foundation for towers–forces on tower foundation –General design criteria–Structural design of supports for foundation excavation–Design of ground anchors.		
Contact Periods : **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES

1	*Swami Saran,* ***"Analysis and Design of Substructures"****, Oxford & IBH Publishing Company Private Limited, 2009.*
2	*Bowels J. E,* ***"Foundation Analysis and Design",*** *McGraw-Hill International Book Co,2007.*
3	*Thomlinson, M.J. and Boorman. R., "****Foundation Design and Construction",*** *ELBS Longman VI edition, 2005.*
4	*Nayak, N.V.,* ***"Foundation Design manual for Practicing Engineers",*** *Dhanpat Rai and Sons, 2009.*
5	*Winterkorn H.F., and Fang H.Y.,* ***"Foundation Engineering Hand Book",*** *Van Nostrard-Reinhold -2004.*
6	*BrajaM. Das,* ***"Principles of Foundations Engineering",*** *Thomson Asia(P) Ltd-2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret subsurface information and to identify a suitable foundation system for a structure.	K3
CO2	Design shallow foundations for various types of structures.	K3
CO3	Calculate capacity of piles and Design deep foundation.	K3
CO4	Analyse and design foundations for bridges and machines.	K3

CO5	Analyse and Design foundations for tall towers.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	1	1	1
CO2	2	-	2	2	1	1
CO3	2	-	3	2	2	1
CO4	2	-	3	2	2	1
CO5	2	-	3	2	2	1
23SEPE19	2	-	3	2	2	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	50	-	-	-	100
CAT2	20	30	50	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20	30	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20	30	50	-	-	-	100
ESE	20	30	50	-	-	-	100

23SEPE20	DESIGN OF STRUCTURES FOR DYNAMIC LOADS				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To impart knowledge on behaviour, analyze and design of structures subjected to dynamic loading	
UNIT – I	**GENERAL**	**9 Periods**
Design philosophy to resist earthquake, cyclone, flood, blast and impact - National and International codes of practice – Behavior of concrete, steel, masonry and soil under impact and cyclic loads- Energy absorption capacity – Ductility of material and the structure. Design Against Cyclone And Flood- Effect of cyclones on buildings and special structures – safety and precautionary steps in design.		
UNIT – II	**DESIGN AGAINST EARTH-QUAKES**	**9 Periods**
Earth-quake characterisation – Response spectrum – seismic coefficient and response spectra methods of estimating loads – Response of framed, braced frames and shear wall buildings – Design as per BIS codes practice – Ductility based design.		
UNIT – III	**DESIGN AGAINST BLAST AND IMPACT**	**9 Periods**
Characteristics of internal and external blast - Impact and impulse loads- Explosions- Threats – wave scaling law – Fire loading – restraints – Pressure distribution on buildings above ground due to external blast – underground explosion - Design of buildings for blast , fire and impact as per BIS code of practice.		
UNIT – IV	**DESIGN AGAINST WIND**	**9 Periods**
Characteristics of wind – Basic and design wind speeds Aeroelastic and Aerodynamic effect - Design as per BIS code of practice including Gust factor approach-along wind and across wind response- effect on tall buildings, towers, chimneys, roofs, window glass, Cladding and slender structures - vibration of cable supported bridges and power lines due to wind effects- tornado effects.		
UNIT – V	**SPECIAL CONSIDERATIONS**	**9 Periods**
Detailing for ductility – Passive and active control of vibrations – New and favorable materials - Response of dams, bridges, buildings- strengthening measures-safety analysis- methods of strengthening for different disasters - Maintenance and modifications to improve hazard resistance.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Raiker.R.N.* ***"Learning from failure Deficiencies in Design",*** *Construction and Service, R & D Centre(SDCPL) Raiker Bhavan, Bombay , 1987*
2	*Bela Goschy,* ***"Design of Buildings to withstand abnormal loading"****, Butterworhts, 1990.*
3	*Paulay.T and Priestly. M.N.J,* ***"A seismic Design of Reinforced Concrete and Masonry Buildings"****, John Wiley and Sons, 1991*
4	*Dowling. C.H,* ***"Blast Vibration – Monitoring and Control"****, Prentice Hall Inc, Englewoods Cliffs, 1985.*
5	*Alan G. Daven Port, "****Wind Effects on Buildings and Structures", Proceedings of the Jubileum Conference on Wind effects on Structures"****, Port Alegne, Brazil, pp 25- 29, May 1998, Balkema A.A. Publishers, 1998.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the effects of dynamic loads like earthquake, blast and impact on structures.	K2
CO2	Perform seismic resistant design as per IS	K2
CO3	Design the structures against blast and impact.	K3
CO4	Calculate effect of wind on structures and design against wind load.	K3

CO5	Implement detailing of structure considering ductility and apply different strengthening techniques	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2	3	2	2
CO2	3	2	1	2	2	2
CO3	3	2	2	1	2	1
CO4	3	2	2	3	3	2
CO5	3	2	1	2	1	2
23SEPE20	3	2	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	20	40	40	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	-	50	50	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	-	50	50	-	-	100
ESE	20	40	40	-	-	-	100

23SEPE21	DESIGN OF TALL BUILDINGS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To acquire knowledge in the behaviour, analysis and design of tall buildings.

UNIT – I	DESIGN CRITERIA	9 Periods

Design philosophy, Loading, Sequential loading, materials - Special Concrete for Tall buildings - Design mixes.

UNIT – II	LOADS AND MOVEMENT	9 Periods

Gravity Loading : Dead and live load, methods of live load reduction, Impact and construction loads. Wind load : Static and dynamic approach, Analytical and wind tunnel experimental method. Seismic load: Equivalent lateral force, modal analysis, combinations of loading.

UNIT – III	BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS	9 Periods

Factors affecting growth, Height and Structural form. High rise behaviour, Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, outrigger - braced and hybrid mega system.

UNIT – IV	ANALYSIS AND DESIGN	9 Periods

Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of building as total structural system considering overall integrity and major subsystem interaction, Analysis for member forces, drift and twist, computerized general three dimensional analysis. Structural elements: Sectional shapes, properties and resisting capacity, design, deflection, cracking, prestressing, shear flow. Design for differential movement, creep, shrinkage effects, temperature effects, fire resistance.

UNIT – V	STABILITY OF TALL BUILDINGS	9 Periods

Overall buckling analysis of frames, wall -frames, Approximate methods, second order effects of gravity loading, P-Delta analysis, simultaneous first-order and P -Delta analysis, Translational, Torsional instability, out of plum effects, stiffness of member in stability, effect of foundation rotation.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES:

1	*Bungale S. Taranath .,* ***"Structural Analysis and Design of Tall Buildings"****, McGraw Hill, 2011*
2	*Taranath B.S,* ***"Tall Building Design: Steel, Concrete, and Composite Systems"****, McGraw Hill, 2016*
3	*Bryan stafford Smith, Alexcoull,* ***"Tall Building Structures", Analysis and Design"****, John Wiley and Sons, Inc., 1991*
4	*Wolfgang Schueller,* ***"High Rise Building Structures"****, John Wiley and Sons, 1977.*
5	*Lynn S.Beedle,* ***"Advances in Tall Buildings"****, CBS Publishers and Distributors, Delhi, 1986*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Classify different types of loads acting on tall buildings.	K3
CO2	Recognize various structural loads and movements in tall structures	K4
CO3	Differentiate the behaviour of different types of tall structures and its components.	K4
CO4	Analyze and design structural elements of tall buildings	K3
CO5	Evaluate stability analysis of frames for various secondary effects such as creep, shrinkage and temperature	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	2	1	2
CO2	2	2	3	3	2	2
CO3	2	1	2	2	2	1
CO4	3	2	3	2	3	2
CO5	3	2	2	3	2	3
23SEPE21	3	2	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	20	40	40	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	-	50	50	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	-	50	50	-	-	100
ESE	20	40	40	-	-	-	100

23SEPE22	COLD FORMED STEEL STRUCTURES				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To impart knowledge on design of various cold formed steel structural elements and its connections.	
UNIT – I	**INTRODUCTION**	**9 Periods**
General – Types of Cold Formed Steel Sections and their applications – Methods of Forming – Materials used in Cold Formed Steel Construction – Yield Point – Tensile Strength – Stress Strain Curve – Modulus of Elasticity and Tangent Modulus – Ductility – Weldability – Fatigue Strength and Toughness. Connections – Types of Connections – Welded Connections – Bolted Connections – Other Fasteners.		
UNIT – II	**STRENGTH OF THIN ELEMENTS AND DESIGN CRITERIA**	**9 Periods**
General – Definitions of General Terms – Basic Design Stress – Wind, Earthquake and Combined forces – Structural Behavior of Compression Elements and Design Criteria – Stiffeners for Compression Elements – Structural Behavior of Perforated Elements – Plate buckling of Columns – Behavior of Webs of Beams and Cylindrical Tubular Elements.		
UNIT – III	**DESIGN OF FLEXURAL MEMBERS**	**9 Periods**
General – Beam Strength and Deflection – Design of Webs of beams – Lateral Buckling of Beams – Bracing Requirements of Beams – Unusually Wide Beam Flanges and Unusually Short Span beams.		
UNIT – IV	**DESIGN OF COMPRESSION MEMBERS**	**9 Periods**
General – Yielding – Flexural Column Buckling – Effect of Cold Work on Column Buckling – Effect of Local Buckling on Column Strength – AISI Design Formula for Flexural Buckling – Effective Length factor K – Torsional Buckling and Torsional-Flexural Buckling – Bracing and Secondary Members – Maximum Slenderness Ratio – Wall Studs – Testing of Wall Material for Lateral Bracing Value.		
UNIT – V	**DESIGN OF BEAM COLUMNS**	**9 Periods**
General – doubly symmetric shapes and shapes not subjected to torsional or torsional-flexural buckling – thin walled open Sections which may be subjected to Torsional-Flexural Buckling – Singly Symmetric Open Shapes – Unsymmetrical Shapes. Light Gauge Steel Shear Diaphragms and shell Roof Structures - light Gauge Steel Shear Diaphragms – Columns and Beams braced by Steel Diaphragms – Shell Roof Structures.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Wie-Wen Yu, "**Cold Formed Steel Structures**", Mcgraw Hill Book Company, 1973.*
2	*Horne M.R. and Morris L.J., "**Plastic Design Of Low Rise Frames**", Granada Publishing Ltd., 1981.*
3	*Salmon C.G. and Johnson J.E., "**Steel Structures-Design And Behaviour**", Harper and Row, 1980. Dayaratnam P. "Design of Steel Structures", A.H. Wheeler, 1980. L T P C 3 0 0 3 89*
4	*Kuzamanovic B.O. and Willems N., "**Steel Design For Structural Engineers**", Prentice Hall, 1977.*
5	*William McGuire, "**Steel Structures**", Prentice Hall Inc., Englewood Cliffs, N.J., 1986.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Indicate the properties of Cold formed steel structures.	K2
CO2	Apply the knowledge of thin elements in the design of cold formed steel.	K3
CO3	Perform design of cold formed steel flexural members as per codal provisions.	K3

CO4	Design the compression members as per codal provisions.	K3
CO5	Check the adequacy of cold formed steel beam columns as per codal provisions	K3

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	1	1	1
CO2	2	-	1	2	2	1
CO3	2	-	2	3	2	2
CO4	2	-	1	2	2	2
CO5	2	-	1	3	2	2
23SEPE22	2	-	2	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20				100
CAT2	30	50	20				100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20	40	40				100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20	40	40				100
ESE	40	40	20				100

23SEPE23	SMART MATERIALS AND SMART STRUCTURES				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To give an exposure of various smart materials for measuring techniques, signal processing and control systems and structural health monitoring systems.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Properties of smart materials - mechanisms – instrumented structures functions and response sensing system – self-diagnosis – signal processing consideration – actuation systems and effectors		
UNIT – II	**MEASURING TECHNIQUES**	**9 Periods**
Strain measuring techniques using electrical strain gauges, types – resistance-capacitance –inductance- wheat stone bridges-pressure transducers-load cells- temperature compensation – strain rosettes		
UNIT – III	**SENSORS AND ACTUATORS**	**9 Periods**
Sensing technology – types of sensors – physical measurement using piezo electric strain measurement – inductively read transducers – LVDT – fiber techniques - fiber optic strain sensors - Actuator techniques – Actuator and Actuator materials - piezo electric and electro resistive material – magneto structure material – shape memory alloys – electro ortheological fluids– electro magnetic actuation – role of actuators and actuator materials		
UNIT – IV	**SIGNAL PROCESSING AND CONTROL SYSTEMS**	**9 Periods**
DataAcquisitionandprocessing–signalprocessingandcontrolforsmartstructures–sensors as geometrical processors– signal processing–control system– linear and nonlinear.		
UNIT – V	**INTRODUCTION TO STRUCTURAL HEALTH MONITORING (SHM)**	**9 Periods**
Definition & motivation for SHM, SHM – a way for smart materials and structures – SHM and bio mimetic – analog between the nervous system of a man and a structure with SHM,SHM as a part of system management, Passive and Active SHM, NDE, SHM and NDECS –basic components of SHM – Applications – SHM of a bridge – applications for external post tensioned cables, monitoring historical buildings.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Brain Culshaw,* ***"Smart structures and materials Artech–Borton",*** *London.*
2	*L.S.Srinath,* ***"Experimental stress analysis",*** *Tata McGraw Hill, 1998.*
3	*J.W.Dally & W.F.****"Riley, Experimental stress analysis",****Tata McGrawHill,1998.*
4	*Daniel Balageas, Claus-Peter FritzenamI Alfredo Guemes,* ***"Structural Health Monitoring",*** *Published by ISTE Ltd., U.K. 2006*
5	*Hand book on* ***"Repair and Rehabilitation of RCC Buildings",*** *Published by Director General, CPWD, Govt. of India, 2002.*
6	***Hand Book on Seismic Retro fitting of Buildings****, Published by CPWD & Indian Building Congress in Association with IIT, Madras, Narosa Publishing House,2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Gain knowledge on smart materials , function and response sensing systems	K1
CO2	Apply the various strain measuring techniques	K2
CO3	Know the working mechanism of sensors and actuators.	K2
CO4	Use data acquisition signal processing and control systems effectively.	K3

CO5	Familiarize about Structural Health Monitoring system and its application in civil Engineering field.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	1	1	-
CO2	2	-	2	1	1	-
CO3	2	-	2	3	2	1
CO4	2	-	3	3	3	2
CO5	3	-	3	3	3	3
23SEPE23	3	-	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	30	-	-	-	100
CAT2	30	40	30	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	30	40	30	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	30	40	30	-	-	-	100
ESE	30	40	30	-	-	-	100

23SEPE24	SOIL STRUCTURE INTERACTION (Common with M.E. Geotechnical Engineering)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To inculcate the knowledge on soil foundation interaction, soil models and elastic analysis of piles and piled raft.	
UNIT – I	**SOIL - FOUNDATION INTERACTION**	**9 Periods**
Introduction to soil – Foundation interaction problems – Soil behaviour – Foundation behaviour – Interface behaviour – Scope of soil-foundation interaction analysis – Soil response models – Winkler, Elastic continuum, Two parameter elastic models, Elastic – Plastic behaviour – Time dependent behaviour.		
UNIT – II	**BEAMS ON ELASTIC FOUNDATION - SOIL MODELS**	**9 Periods**
Infinite beam – Two parameters – Isotropic elastic half space – Analysis of beams of finite length – Classification of finite beams in relation to their stiffness – Analysis through application packages		
UNIT – III	**PLATE ON ELASTIC MEDIUM**	**9 Periods**
Infinite plate – Winkler, Two parameters, Isotropic elastic medium, Thin and thick plates – Analysis of finite plates – Rectangular and circular plates – Numerical analysis of finite plates – Simple solutions – Analysis of braced cuts – Application packages.		
UNIT – IV	**ELASTIC ANALYSIS OF PILE**	**9 Periods**
Elastic analysis of single pile – Theoretical solutions for settlement and load distribution – Analysis of pile group – Interaction analysis – Load distribution in groups with rigid cap – Pile raft – Application packages.		
UNIT – V	**LATERALLY LOADED PILE**	**9 Periods**
Load deflection prediction for laterally loaded piles – Subgrade reaction and elastic analysis – Interaction analysis – Pile raft system – Solutions through influence charts –Application packages		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Saran, S., "**Analysis and design of substructures"**, Taylor & Francis Publishers, 2006.*
2	*Hemsley, J.A., **"Elastic Analysis of Raft Foundations",** Thomas Telford, 1998*
3	*Poulos, H.G., and Davis, E.H., **"Pile Foundation Analysis and Design"**, John Wiley, 2008*
4	*Murthy, V.N.S., **"Advanced Foundation Engineering",** CBS Publishers, New Delhi, 2007*
5	*McCarthy, R.N., **"Essentials of Soil Mechanics and Foundations: Basic Geotechnics"**, Sixth Edition, Prentice Hall, 2002*
6	*Selvadurai, A.P.S., **"Elastic Analysis of Soil Foundation Interaction"**, Elsevier, 1979.*
7	*Scott, R.F., **"Foundation Analysis"**, Prentice Hall, 1981*
8	*Structure Soil Interaction – State of Art Report, Institution of structural Engineers, 1978.ACI 336, Suggested Analysis and Design Procedures for Combined Footings and Mats, American Concrete Institute, Delhi, 1988*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand various soil response models applicable to soil-foundation interaction analysis.	**K2**
CO2	Come up with elastic solutions for problems of pile, pile-raft system	K3
CO3	Use software packages to analyze soil-foundation system including laterally loaded piles.	K3
CO4	Acquire knowledge on elastic analysis of pile and pile group	K3
CO5	Acquire knowledge on analysis of laterally loaded piles	K3

COURSE ARTICULATION MATRIX						
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	1	2	1
CO2	3	-	2	1	2	1
CO3	3	-	2	1	2	1
CO4	3	-	2	1	2	1
CO5	3	-	2	1	2	1
22SEPE24	3	-	2	1	2	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	30				100
CAT2	30	40	30				100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1		50	50				100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2		50	50				100
ESE	30	40	30				100

23SEPE25	FUNDAMENTALS OF CONCRETE 3D PRINTING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To possess knowledge on materials, mix design approaches, testing, equipments, stages, various printing technologies, applications and impact of concrete 3D printing.	
UNIT – I	**INTRODUCTION**	**9 Periods**
General considerations for 3D printing and additive fabrication - main concepts of 3D printing- Towards the 3D printing of cement-based materials - Classification of 3D printing methods for concrete - Advantages – Limitations - Gantry printers - Delta Printers - Robotic arm printers - Crawler boom printers - Polar printer - Optimal selection of printers.		
UNIT – II	**MATERIALS, TESTING AND EQUIPMENTS**	**9 Periods**
Raw materials – supplementary cementitious materials, admixtures, cement and aggregates, mix design approaches – performance requirement of 3DPC - Pumping - Extrusion - Bulidability - Printability - Other problems occurring during concrete extrusion printing - Shrinkage and cracking during drying - Components - Concrete pump and mixing unit - Production Unit- Control Unit - Types of extruder - Ram Extruder - Pneumatic Extruder - Types of nozzle - Effect of nozzle shape, size, and orientation.		
UNIT – III	**MECHANICAL BEHAVIOR OF 3D PRINTED MATERIAL**	**9 Periods**
Mechanical performance of the cement material printing using extrusion - Mechanical behaviour of 3D printed cement materials - Effect of extrusion on the mechanical characteristics of cement-based composites - Effects of the additive fabrication method on the mechanical behaviour of cement-based materials - anisotropic stratified materials: possible causes - Effects of the time intervals between successive deposits.		
UNIT – IV	**EXTRUSION AND CASTING**	**9 Periods**
Stages of 3D printing process - criteria for pumping material in a fresh state - effect of time intervals between successive deposits and effect of water content - change of rheology: physico- chemical activity over time – pumping – extrusion - other problems occurring during concrete extrusion printing – effect of bond between layers - shrinkage and cracking during drying of concrete.		
UNIT – V	**APPLICATIONS AND IMPACT OF CONCRETE 3D PRINTING**	**9 Periods**
Application of 3D printing in construction industry and concrete product development – Industrial adoption of 3D printing - Impact of 3D printing on the construction and economy - Impact of emerging printing technology on society - cost benefits of 3D printing in construction – recent advancements - Future of concrete 3D printing.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Jay G. Sanjayan, Ali Nazari, and BehzadNematollahi,* ***"3D Concrete Printing Technology"*** *, Elsevier; 2019 (ISBN - 978-0-12-815481-6).*
2	*Arnaud Perrot,* ***"3D Printing of Concrete: State of the Art and Challenges of the Digital Construction Revolution"*** *, Wiley; 2019, (ISBN: 978-1-786-30341-7)*
3	*Bakker R,* ***"Smart Buildings: Technology and the design of the Built Environment"****, RIBA Publications, 2020.*
4	*Wangler R and R.J Flatt,* ***"Concrete and Digital fabrication: Digital Concrete 2018"****, Conference Proceedings RILEM Book series, 2019.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Illustrate the genereal considerations, concepts and classifications of concrete 3D printing	K2
CO2	Identify materials, testing and equipments for concrete 3D printing	K2
CO3	Evaluate the Mechanical behaviour of 3D printed material	K2
CO4	To analyse the extrusion and casting process involved in 3D printing process	K2
CO5	Utilize 3D printing technologies based on its applications and impact	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	3	3	3
CO2	3	2	3	3	3	3
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3
CO5	3	2	3	3	3	3
23SEPE25	3	2	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	50	10	-	-	-	100
CAT2	40	50	10	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	30	50	20	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	30	50	20	-	-	-	100
ESE	40	50	10	-	-	-	100

23SEPE26	NANO TECHNOLOGY

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course objectives	To know the fundamentals of Nanomaterials and applications of Nanotechnology in Civil Engineering.	
UNIT – I	**INTRODUCTION TO NANOMATERIALS**	**9 Periods**
Fundamentals of materials science and Structure: Introduction - microstructure, and nanostructure; Importance and examples for Nanomaterials, ceramic and glass materials, composite materials, polymeric materials, metals and alloys- rheological fluids, metallic glasses, advanced ceramics - Applications of modern engineering materials.		
UNIT – II	**NANOTECHNOLOGY IN CEMENT AND CONCRETE**	**9 Periods**
Introduction to Nanomaterials in Cement and Concrete, different Nanomaterials used in concrete, Development of Nano concrete, Application of Nanomaterials in UHPC, Nano silica, densification of cement using Nano silica, Nano alumina, Carbon Nanotube (CNT), the Effect of Single walled Carbon Nanotube (SWCNT) and Other Nanomaterials on Cement Hydration and Reinforcement.		
UNIT – III	**APPLICATIONS OF NANOMATERIALS IN SMART AND GREEN BUILDINGS**	**9 Periods**
Nanomaterials-based self-healing concrete and its Sustainability – Application areas of Nanomaterials for green buildings -safety and security- indoor quality-material surface advancement- energy generation and storage- environmental impact control -Sustainable building assessment systems.		
UNIT – IV	**NANOTECHNOLOGY IN STRUCTURAL STEEL**	**9 Periods**
Nanotechnology and Steel- Applications in steel structures for strength and corrosion resistance, effect of copper Nanoparticles on strength of steel- Applications in welds and joints, weld ability, delayed fracture, strengthening of steel bolts, vanadium and molybdenum Nanoparticles to improve delayed fracture.		
UNIT – V	**ADVANCES IN NANO TECHNOLOGY**	**9 Periods**
Next-Generation Nano -based Concrete and Steel Construction Products: Optimization of Nano-modified Cement Materials- Functional Nanomaterials and their applications.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Dinesh C Agrawal, "**Introduction to Nanoscience And Nanomaterials"** World Scientific Publishing Company; 1st edition, 2013.*
2	*Fernando Pacheco-Torgal,Maria Vittoria Diamanti,Ali Nazari,Claes Goran Granqvist,Alina Pruna,Serji Amirkhanian, **"Nanotechnology in eco-efficient construction"**, Woodhead Publishing, second edition, 2019*
3	*Kaushik Pal **"Green Nanomaterials: Sustainable Technologies and Applications"** Apple Academic Press, 1st edition ,2022.*
4	*Małgorzata Krystek, Leszek Szojda, Marcin Górski **"Nanomaterials in Structural Engineering"** Intech Open, 2018.*
5	*M.S. Ramachandra Rao, Shubra Singh, **"Nanoscience and Nanotechnology: fundamentals to Frontiers"**, Wiley, 2013*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Acquire the knowledge on Nanomaterials and its properties.	K2
CO2	Utilize the Nano materials in Concrete construction.	K3
CO3	Implement the Nanomaterials in Smart and Green Buildings.	K3
CO4	Utilize the nanoparticles in Structural Steel.	K3
CO5	Implement the advancement in Nanotechnology.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	2	1	2
CO2	2	1	2	2	2	2
CO3	3	2	2	2	3	3
CO4	3	2	2	2	3	2
CO5	2	2	2	3	3	3
23SEPE26	3	2	2	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	40	40	20	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	40	40	20	-	-	100
ESE	40	40	20	-	-	-	100

23SEOE01	BUILDING BYE-LAWS AND CODES OF PRACTICE (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To impart knowledge on the building bye –laws and to emphasize the significance of codes of practice in construction sector.					
UNIT – I	**INTRODUCTION TO BUILDING BYE-LAWS**					**9 Periods**
Introduction to Building Bye Laws and regulation, their need and relevance, General definitions such as building height, building line, FAR, Ground Coverage, set back line. Introduction to Master Plan and understanding various land uses like institutional, residential etc. - Terminologies of Building bye-laws.						
UNIT – II	**ROLE OF STATUTORY BODIES**					**9 Periods**
Role of various statutory bodies governing building works like development authorities, municipal corporations etc. Local Planning Authority, Town and Country planning organisation, Ministry of urban development.						
UNIT – III	**APPLICATION OF BUILDING BYE-LAWS**					**9 Periods**
Interpretation of information given in bye laws including ongoing changes as shown in various annexure and appendices. Application of Bye-laws like structural safety, fire safety, earthquake safety, basement, electricity, water, and communication lines in various building types.						
UNIT – IV	**INTRODUCTION TO CODES OF PRACTICE**					**9 Periods**
Introduction to various building codes in professional practice - Codes, regulations to protect public health, safety and welfare - Codes, regulations to ensure compliance with the local authority.						
UNIT – V	**APPLICATION OF CODES OF PRACTICE**					**9 Periods**
Applications of various codes as per various building types. Bureau of Indian Standards, Eurocode – Introduction to other international codes.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES :

1	***"National Building Code of India 2016 – SP 7",*** *NBC 2016, Bureau of Indian Standards.*
2	***"Model Building Bye-Laws (MBBL) – 2016",*** *Town and Country Planning Organization, Ministry of Housing and Urban Affairs, Government of India.*
3	***"Unified Building Bye-laws for Delhi 2016",*** *Nabhi Publications, 2017.*
4	Mukesh *Mittal,* ***"Building Bye Laws",*** *Graphicart publishers, Jaipur, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the building bye-laws in planning, design and construction works.	K3
CO2	Familiarize with the role of various statutory bodies.	K2
CO3	Execute safety related work practices in the construction sector.	K3
CO4	Ensure compliance with the rules and regulations in design and construction practices.	K3
CO5	Perform design and construction practices based on national and international codal provisions.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	3	1	1	2	3
CO2	1	3	1	1	2	3
CO3	1	3	1	1	2	3
CO4	2	3	1	1	2	3
CO5	2	3	1	1	2	3
23SEOE01	2	3	1	1	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	40	40	20	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	40	40	20	-	-	-	100
ESE	40	40	20	-	-	-	100

23SEOE02	PLANNING OF SMART CITIES (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To have an exposure on planning of smart cities with consideration of the recent challenges and to address the importance of sustainable development of urban area.					
UNIT – I	**SMART CITIES DEVELOPMENT POTENTIALS AND CHALLENGES**					**9 Periods**
Perspectives of Smart Cities: Introduction and Overview - Implementation Challenges - Methodological issues - Spatial distribution of startup cities – Re imagining postindustrial cities - Implementation Challenges for Establishing Smart Urban Information and Knowledge Management System.						
UNIT – II	**SUSTAINABLE URBAN PLANNING**					**9 Periods**
Optimising Green Spaces for Sustainable Urban Planning - 3D City Models for Extracting Urban Environmental Quality Indicators - Assessing the Rainwater Harvesting Potential - The Strategic Role of Green Spaces - Monitoring Urban Expansion.						
UNIT – III	**ENERGY MANAGEMENT AND SUSTAINABLE DEVELOPMENT**					**9 Periods**
Alternatives for Energy Stressed Cities - Social Acceptability of Energy - Efficient Lighting - Energy Management - Urban Dynamics and Resource Consumption - Issues and Challenges of Sustainable Tourism - Green Buildings: Eco-friendly Technique for Modern Cities.						
UNIT – IV	**MULTIFARIOUS MANAGEMENT FOR SMART CITIES**					**9 Periods**
Assessment of Domestic Water Use Practices - Issue of Governance in Urban Water Supply - Assessment of Water Consumption at Urban Household Level - Water Sustainability - Socio-economic Determinants and Reproductive Healthcare System - Problems and Development of Slums.						
UNIT – V	**INTELLIGENT TRANSPORT SYSTEM**					**9 Periods**
Introduction to Intelligent Transport Systems (ITS) - The Range of ITS Applications -Network Optimization - Sensing Traffic using Virtual Detectors - Vehicle Routing and Personal route information - The Smart Car - Commercial Routing and Delivery - Electronic Toll Collection - The Smart Card - Dynamic Assignment - Traffic Enforcement. Urban Mobility and Economic Development.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*Poonam Sharma, Swati Rajput,* ***"Sustainable Smart Cities In India Challenges And Future Perspectives"****, Springer 2017 Co.(P) Ltd. 2013.*
2	*Ivan Nunes Da Silva,* ***"Rogerio Andrade Flauzino-Smart Cities Technologies-Exli4eva"****, 2016.*
3	*Stan McClellan, Jesus A. Jimenez, George Koutitas* ***"Smart Cities_ Applications, Technologies, Standards"****, and Driving Factors-Springer International Publishing, 2018.*
4	*Stan Geertman, Joseph Ferreira, Jr., Robert Goodspeed, John Stillwell,* ***"Planning Support Systems And Smart Cities"****, Springer, 2015.*
5	*Pradip Kumar Sarkar and Amit Kumar Jain* ***"Intelligent Transport Systems"****, PHI Learning, 2018.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Indicate the potential challenges in smart city development.	K2
CO2	Select the different tools for sustainable urban planning.	K3
CO3	Choose appropriate energy conservation system for smart cities.	K3
CO4	Identify the proper method of water management system.	K3

CO5	Apply Intelligent Transport System concepts in planning of smart city.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	3	1	1
CO2	1	1	1	3	2	1
CO3	1	1	-	2	2	1
CO4	1	-	1	2	1	1
CO5	1	-	1	3	1	-
23SEOE02	1	1	2	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	45	30	-	-	-	100
CAT2	25	45	30	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	15	40	45	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	10	45	45	-	-	-	100
ESE	20	40	40	-	-	-	100

23SEOE03	GREEN BUILDING (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To introduce the different concepts of energy efficient buildings, indoor environmental quality management, green buildings and its design.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Life cycle impacts of materials and products – sustainable design concepts – strategies of design for the Environment -The sun-earth relationship and the energy balance on the earth's surface, climate, wind – Solar radiation and solar temperature – Sun shading and solar radiation on surfaces – Energy impact on the shape and orientation of buildings – Thermal properties of building materials.		
UNIT – II	**ENERGY EFFICIENT BUILDINGS**	**9 Periods**
Passive cooling and day lighting – Active solar and photovoltaic- Building energy analysis methods- Building energy simulation- Building energy efficiency standards-Lighting system design- Lighting economics and aesthetics- Impacts of lighting efficiency – Energy audit and energy targeting- Technological options for energy management.		
UNIT – III	**INDOOR ENVIRONMENTAL QUALITY MANAGEMENT**	**9 Periods**
Psychrometry- Comfort conditions- Thermal comfort- Ventilation and air quality-Air conditioning requirement- Visual perception- Illumination requirement- Auditory requirement- Energy management options- Air conditioning systems- Energy conservation in pumps- Fans and blowers- Refrigerating machines- Heat rejection equipment- Energy efficient motors- Insulation.		
UNIT – IV	**GREEN BUILDING CONCEPTS**	**9 Periods**
Green building concept- Green building rating tools- Leeds and IGBC codes. – Material selection Embodied energy- Operating energy- Façade systems- Ventilation systems-Transportation- Water treatment systems- Water efficiency- Building economics		
UNIT – V	**GREEN BUILDING DESIGN - CASE STUDY**	**9 Periods**
Case studies - Building form, orientation and site considerations; conservation measures; energy modeling; heating system and fuel choices; renewable energy systems; material choices - construction budget		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES :

1	*Sam Kubba* ***"Handbook of Green Building Design and Construction: LEED, BREEAM, and Green Globes",*** *, Elsevier Science, 2012.*
2	*Yudelson, Jerry, McGraw-Hill,* ***"Greening existing buildings",*** *New York, 2010*
3	*Charles J. Kibert, John Wiley & Sons,* ***"Sustainable Construction: Green Building Design and Delivery****", 3rd Edition, 2012*
4	*R.S. Means, John Wiley & Sons,* ***"Green Building: Project Planning & Cost Estimating",*** *2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the concepts of sustainable design in building construction.	K3
CO2	Execute green building techniques including energy efficiency management in the building design.	K3
CO3	Establish indoor environmental quality in green building.	K3
CO4	Perform the green building rating using various tools.	K3
CO5	Create drawings and models of green buildings.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	3	3
CO2	3	3	2	3	3	3
CO3	2	2	2	2	3	3
CO4	2	3	1	3	3	3
CO5	3	3	1	3	3	3
23SEOE03	3	3	2	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	40	40	20	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	40	40	20	-	-	-	100
ESE	40	40	20	-	-	-	100

23EEOE04	ENVIRONMENT HEALTH AND SAFETY MANAGEMENT (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To impart knowledge on occupational health hazards, safety measures at work place, accident prevention, safety management and safety measures in industries.

UNIT – I	**OCCUPATIONAL HEALTH HAZARDS**	**9 Periods**

Occupation, Health and Hazards - Safety Health and Management: Occupational Health Hazards - Ergonomics - Importance of Industrial Safety - Radiation and Industrial Hazards: Types and effects - Vibration - Industrial Hygiene - Different air pollutants in industries and their effects - Electrical, fire and Other Hazards.

UNIT – II	**SAFETY AT WORKPLACE**	**9 Periods**

Safety at Workplace - Safe use of Machines and Tools: Safety in use of different types of unit operations - Ergonomics of Machine guarding - working in different workplaces - Operation, Inspection and maintenance - Housekeeping, Industrial lighting, Vibration and Noise.

UNIT – III	**ACCIDENT PREVENTION**	**9 Periods**

Accident Prevention Techniques - Principles of accident prevention - Hazard identification and analysis, Event tree analysis, Hazop studies, Job safety analysis - Theories and Principles of Accident causation - First Aid: Body structure and functions - Fracture and Dislocation, Injuries to various body parts.

UNIT – IV	**SAFETY MANAGEMENT**	**9 Periods**

Safety Management System and Law - Legislative measures in Industrial Safety - Occupational safety, Health and Environment Management, Bureau of Indian Standards on Health and Safety, IS 14489 standards - OSHA, Process safety management (PSM) and its principles - EPA standards

UNIT – V	**GENERAL SAFETY MEASURES**	**9 Periods**

Plant Layout for Safety - design and location, distance between hazardous units, lighting, colour coding, pilot plant studies, Housekeeping - Accidents Related with Maintenance of Machines - Work Permit System - Significance of Documentation - Case studies involving implementation of health and safety measures in Industries.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES:

1	***"Physical Hazards of the Workplace"**, Barry Spurlock, CRC Press, 2017.*
2	***"Handbook of Occupational Safety and Health",** S. Z. Mansdorf, Wiley Publications,2019*
3	***"Safety, Health, and Environment"**, NAPTA, 2nd Edition, Pearson Publications, 2019.*
4	*"**Occupational Health and Hygiene in Industries**", Raja Sekhar Mamillapalli, Visweswara Rao , PharmaMed Press, 1st edition, 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the occupational health hazards.	K3
CO2	Execute various safety measures at workplace.	K3
CO3	Analyze and execute accident prevention techniques.	K3
CO4	Implement safety management as per various standards.	K3
CO5	Develop awareness on safety measures in Industries.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	2	2	3	2
CO2	2	2	2	1	2	2
CO3	2	3	2	1	2	2
CO4	1	1	1	2	2	2
CO5	1	1	1	1	1	2
23EEOE04	1	2	2	1	2	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	20	10	5	5	100
CAT2	25	35	20	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	30	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	25	35	20	10	5	5	100

23EEOE05	CLIMATE CHANGE AND ADAPTATION (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To understand the Earth's climate system, changes and their effects on the earth, identifying the impacts, adaptation, mitigation of climate change and for gaining knowledge on clean technology, carbon trading and alternate energy sources.

UNIT – I	**EARTH'S CLIMATE SYSTEM**	**9 Periods**

Introduction-Climate in the spotlight - The Earth's Climate Machine – Climate Classification- Global Wind Systems – Trade Winds and the Hadley Cell – The Westerlies – Cloud Formation and Monsoon Rains – Storms and Hurricanes - The Hydrological Cycle – Global Ocean Circulation – El Nino and its Effect - Solar Radiation – The Earth's Natural Green House Effect – Green House Gases and Global Warming – Carbon Cycle.

UNIT – II	**OBSERVED CHANGES AND ITS CAUSES**	**9 Periods**

Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large-Scale Variability –Drivers of Climate Change – Climate Sensitivity and Feedbacks – The Montreal Protocol –UNFCCC – IPCC – Evidences of Changes in Climate and Environment – on a Global Scale and in India – climate change modeling.

UNIT – III	**IMPACTS OF CLIMATE CHANGE**	**9 Periods**

Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society – Methods and Scenarios –Projected Impacts for Different Regions – Uncertainties in the Projected Impacts of Climate Change – Risk of Irreversible Changes.

UNIT – IV	**CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES**	**9 Periods**

Adaptation Strategy/Options in various sectors – Water – Agriculture –- Infrastructure and Settlement including coastal zones – Human Health – Tourism – Transport – Energy – Key Mitigation Technologies and Practices – Energy Supply – Transport – Buildings – Industry –Agriculture – Forestry - Carbon sequestration – Carbon capture and storage (CCS) – Waste (MSW & Bio waste, Biomedical, Industrial waste – International and Regional cooperation.

UNIT – V	**CLEAN TECHNOLOGY AND ENERGY**	**9 Periods**

Clean Development Mechanism – Carbon Trading - examples of future Clean Technology –Biodiesel – Natural Compost – Eco- Friendly Plastic – Alternate Energy – Hydrogen – Biofuels– Solar Energy – Wind – Hydroelectric Power – Mitigation Efforts in India and Adaptation funding.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0Periods** **Practical: 0 Periods** **Total:45 Periods**

REFERENCES

1	***"Impacts of Climate Change and Climate Variability on Hydrological Regimes",*** *Jan C. Van Dam, Cambridge University Press, 2003.*
2	*IPCC fourth assessment report - The AR4 synthesis report, 2007*
3	*IPCC fourth assessment report –Working Group I Report****, "The physical sciencebasis",****2007*
4	*IPCC fourth assessment report - Working Group II Report,* ***"Impacts, Adaptation and Vulnerability",*** *2007*
5	*IPCC fourth assessment report – Working Group III Report"* ***Mitigation of Climate Change",*** *2007*
6	***"Climate Change and Water". Technical Paper of the Intergovernmental Panel on Climate Change,*** *Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., IPCC Secretariat, Geneva, 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Classify the Earths climatic system and factors causing climate change and global warming.	K2
CO2	Relate the Changes in patterns of temperature, precipitation and sea level rise and Observed effects of Climate Changes	K2
CO3	Illustrate the uncertainty and impact of climate change and risk of reversible changes.	K3
CO4	Articulate the strategies for adaptation and mitigation of climatic changes.	K3
CO5	Discover clean technologies and alternate energy source for sustainable growth.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	2	3	1
CO2	3	2	2	2	3	2
CO3	2	2	2	2	3	2
CO4	3	2	2	2	2	2
CO5	3	3	2	3	3	3
23EEOE05	3	3	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	30	35	10	-	-	100
CAT2	25	30	35	10	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	30	40	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	30	40	10	-	-	100
ESE	25	30	35	10	-	-	100

23EEOE06	WASTE TO ENERGY (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To classify waste as fuel, introduce conversion devices, gain knowledge about Biomass Pyrolysis, demonstrate methods, factors for biomass gasification, and acquire knowledge about biogas and its development in India.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, Gasifiers, Digestors.						
UNIT – II	**BIOMASS PYROLYSIS**					**9 Periods**
Biomass Pyrolysis: Pyrolysis -Types, Slow Pyrolysis, Fast Pyrolysis – Manufacture of charcoal – Methods – Yields and Applications – Manufacture of Pyrolytic oils and gases, Yields and Applications.						
UNIT – III	**BIOMASS GASIFICATION**					**9 Periods**
Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, Construction and Operation – Gasifier burner arrangement for thermal heating – Gasifier Engine arrangement and electrical power – Equilibrium and Kinetic Considerations in gasifier operation.						
UNIT – IV	**BIOMASS COMBUSTION**					**9 Periods**
Biomass Combustion – Biomass Stoves – Improved Chullahs, types, some exotic designs, Fixed bed combustors, types – Inclined grate combustors – Fluidized bed combustors, design, construction and operation of all the above biomass combustors.						
UNIT – V	**BIOENERGY SYSTEM**					**9 Periods**
Biogas: Properties of biogas (Calorific value and composition) – Biogas plant technology and status – Bio energy system – Design and constructional features – Biomass resources and their classification - Biomass conversion processes – Thermo chemical conversion – Direct combustion – biomass gasification – pyrolysis and liquefaction – biochemical conversion – anaerobic digestion – Types of biogas plants – Applications – Alcohol production from biomass – Bio diesel production – Urban waste to energy conversion – Biomass energy programme in India.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES:

1	***"Energy Recovery from Municipal Solid Waste by Thermal Conversion Technologies",*** *P Jayaram Reddy, Taylor and Francis Publications, 2016.*
2	***"Waste – to – Energy: Technologies and project Implementations",*** *Marc J Rogoff, Francois Screve,ELSEVIER Publications, Third Edition, 2019.*
3	***"Biogas Technology and Principles"****, Brad Hill, NY RESEARCH PRESS Publications, Illustrated Edition, 2015.*
4	***"Biomass Gasification and Pyrolysis Practical Design and Theory"***,Prabir*ELSEVIER Publications, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Investigate solid waste management techniques.	K2
CO2	Get knowledge about biomass pyrolysis.	K3
CO3	Demonstrate methods and factors considered for biomass gasification.	K3
CO4	Identify the features of different facilities available for biomass combustion.	K4

CO5	Analyze the potential of different Bioenergy systems with respect to Indian condition.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	3	2	3	1
CO2	3	2	2	2	3	1
CO3	3	3	2	3	2	1
CO4	3	2	2	3	3	1
CO5	2	3	3	3	2	1
23EEOE06	3	3	3	3	3	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	20	25	15	10	100
CAT2	10	25	20	10	25	10	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	-	15	35	50	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	10	40	50	-	-	100
ESE	10	25	25	20	10	10	100

23GEOE07	ENERGY IN BUILT ENVIRONMENT (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objective	To understand constructional energy requirements of buildings, energy audit methods and conservation of energy.					
UNIT–I	**INTRODUCTION**					**9 Periods**
Indoor activities and environmental control - Internal and external factors on energy use –Characteristics of energy use and its management -Macro aspect of energy use in dwellings and its implications –Thermal comfort-Ventilation and air quality-Air-conditioning requirement-Visual perception-Illumination requirement-Auditory requirement.						
UNIT–II	**LIGHTING REQUIREMENTS IN BUILDING**					**9 Periods**
The sun-earth relationship - Climate, wind, solar radiation and temperature - Sun shading and solar radiation on surfaces-Energy impact on the shape and orientation of buildings–Lighting and day lighting : Characteristics and estimation, methods of day-lighting–Architectural considerations for day-lighting.						
UNIT–III	**ENERGY REQUIREMENTS IN BUILDING**					**9 Periods**
Steady and unsteady heat transfer through wall and glazed window-Standards for thermal performance of building envelope- Evaluation of the overall thermal transfer- Thermal gain and net heat gain-End-Use energy requirements-Status of energy use in buildings-Estimation of energy use in a building.						
UNIT–IV	**ENERGY AUDIT**					**9 Periods**
Energy audit and energy targeting-Technological options for energy management-Natural and forced ventilation–Indoor environment and air quality-Air flow and air pressure on buildings-Flow due to Stack effect.						
UNIT–V	**COOLING IN BUILT ENVIRONMENT**					**9 Periods**
Passive building architecture– Radiative cooling-Solar cooling techniques-Solar desiccant dehumidification for ventilation-Natural and active cooling with adaptive comfort–Evaporative cooling – Zero energy building concept.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*J.Krieder and A.Rabl**, "Heating and Cooling of Buildings**: **Design for Efficiency"**, McGraw-Hill, 2000.*
2	*S.M.Guinnes and Reynolds, **"Mechanical and Electrical Equipment for Buildings"**, Wiley, 1989.*
3	*A.Shaw, **"Energy Design for Architects"**, AEE Energy Books, 1991.*
4	*ASHRAE**,"Hand book of Fundamentals"**,ASHRAE,Atlanta,GA.,2001.*
5	*Reference Manuals of DOE-2 (1990), Orlando Lawrence-Berkeley Laboratory, University of California, and Blast, University of Illinoi ,USA.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand energy and its usage	K2
CO2	Know lighting to be given to a building	K1
CO3	Analyse the energy requirements in a building	K3
CO4	Apply the energy audit concepts.	K3
CO5	Study architectural specifications of a building	K1

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	1	2	1
CO2	2	-	3	1	2	1
CO3	2	-	3	1	2	1
CO4	2	-	3	1	2	1
CO5	2	-	3	1	2	1
23GEOE07	2	-	3	1	2	1
1–Slight, 2–Moderate, 3–Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Rememberin g (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluatin g (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	40	40	20	-	-	-	100
CAT 2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	50	50	-	-	-	-	100
ESE	40	40	20	-	-	-	100

23GEOE08	EARTH AND ITS ENVIRONMENT (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objective	To know about the planet earth, the geosystems and the resources like ground water and air and to learn about the Environmental Assessment and sustainability.					
UNIT–I	**EVOLUTION OF EARTH**					**9 Periods**
Evolution of earth as habitable planet-Evolution of continents-oceans and landforms-evolution of life through geological times - Exploring the earth's interior - thermal and chemical structure - origin of gravitational and magnetic fields.						
UNIT–II	**GEOSYSTEMS**					**9 Periods**
Plate tectonics - working and shaping the earth - Internal geosystems – earthquakes – volcanoes -climatic excursions through time - Basic Geological processes - igneous, sedimentation – metamorphic processes.						
UNIT–III	**GROUND WATER GEOLOGY**					**9 Periods**
Geology of ground water occurrence –recharge process-Ground water movement-Ground water discharge and catchment hydrology – Ground water as a resource - Natural ground water quality and contamination-Modelling and managing ground water systems.						
UNIT–IV	**ENVIRONMENTAL ASSESMENT AND SUSTAINABILITY**					**9 Periods**
Engineering and sustainable development - population and urbanization - toxic chemicals and finite resources - water scarcity and conflict - Environmental risk - risk assessment and characterization –hazard assessment-exposure assessment.						
UNIT–V	**AIR AND SOLIDWASTE**					**9 Periods**
Air resources engineering-introduction to atmospheric composition–behaviour-atmospheric photo chemistry-Solid waste management–characterization-management concepts.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	*John Grotzinger and Thomas H.Jordan, "**Understanding Earth",** Sixth Edition, W.H.Freeman, 2010.*
2	*Younger,P.L., "**Ground water in the Environment: An introduction"**, Blackwell Publishing,2007.*
3	*Mihelcic, J. R., Zimmerman, J. B., "**Environmental Engineering:Fundamentals, Sustainability and Design"**,Wiley,NJ, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	To know about evolution of earth and the structure of the earth.	K2
CO2	To understand the internal geosystems like earthquakes and volcanoes and the Various geological processes.	K2
CO3	To able to find the geological process of occurrence and movement of Ground water and the modeling systems.	K3
CO4	To assess the Environmental risks and the sustainability developments.	K3
CO5	To learn about the photochemistry of atmosphere and the solid waste Management concepts.	K1

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	-	2	2	-
CO2	3	-	3	3	-	3
CO3	2	-	-	-	-	-
CO4	-	2	-	-	1	-
CO5	2	2	-	1	-	-
23GEOE08	2	2	3	3	2	3
1–Slight, 2–Moderate, 3–Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	40	40	20	-	-	-	100
CAT 2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	40	40	20	-	-	-	100

23GEOE09	NATURAL HAZARDS AND MITIGATION (Common to all Branches)				
PREREQUISITES:	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objective	To get idea on the causes, effects and mitigation measures of different types of hazards with case studies.	
UNIT–I	**EARTH QUAKES**	**9 Periods**
Definitions and basic concepts-different kinds of hazards–causes-Geologic Hazards–Earthquakes-causes of earthquakes–effects-plate tectonics-seismic waves-measures of size of earthquakes-earthquake resistant design concepts.		
UNIT–II	**SLOPE STABILITY**	**9 Periods**
Slope stability and landslides-causes of landslides–principles of stability analysis-remedial and corrective measures for slope stabilization.		
UNIT–III	**FLOODS**	**9 Periods**
Climatic Hazards–Floods-causes of flooding-regional flood frequency analysis–flood control measures-flood routing-flood forecasting-warning systems.		
UNIT–IV	**DROUGHTS**	**9 Periods**
Droughts –causes - types of droughts –effects of drought -hazard assessment – decision making-Use of GIS in natural hazard assessment–mitigation-management.		
UNIT–V	**TSUNAMI**	**9 Periods**
Tsunami–causes–effects–under sea earthquakes–landslides–volcanic eruptions–impact of sea meteorite–remedial measures–precautions–case studies.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Donald Hyndman and David Hyndman,* ***"Natural Hazards and Disasters",*** *Brooks/Cole Cengage Learning, 2008.*
2	*Edward Bryant,* ***"Natural Hazards"****, Cambridge University Press,2005.*
3	*J Michael Duncan and Stephan G Wright,* ***"Soil Strength and Slope Stability"****, John Wiley & Sons, Inc,2005.*
4	*AmrS.Elnashai and Luigi Di Sarno,****"Fundamentals of Earthquake Engineering"****, John Wiley & Sons,Inc,2008*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Learn the basic concepts of earthquakes and the design concepts of earthquake Resistant buildings.	K2
CO2	Acquire knowledge on the causes and remedial measures of slope stabilization.	K3
CO3	As certain the causes and control measures of flood.	K3
CO4	Know the types, causes and mitigation of droughts.	K2
CO5	Study the causes, effects and precautionary measures of Tsunami.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	3	2	3
CO2	3	1	2	3	3	3
CO3	3	2	3	-	-	3
CO4	3	-	-	3	2	3
CO5	3	-	2	2	-	3
23GEOE09	3	1	2	3	2	3
1–Slight, 2–Moderate, 3–Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT 1	40	40	20	-	-	-	100
CAT 2	40	40	20	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	40	40	20	-	-	-	100

23EDOE10	BUSINESS ANALYTICS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	• To apprehend the fundamentals of business analytics and its life cycle. • To gain knowledge about fundamental business analytics. • To study modeling for uncertainty and statistical inference. • To apprehend analytics the usage of Hadoop and Map Reduce frameworks. • To acquire insight on other analytical frameworks.					
UNIT – I	**BUSINESS ANALYTICS AND PROCESS**					**9 Periods**
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.						
UNIT – II	**REGRESSION ANALYSIS**					**9 Periods**
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.						
UNIT – III	**STRUCTURE OF BUSINESS ANALYTICS**					**9 Periods**
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.						
UNIT – IV	**FORECASTING TECHNIQUES**					**9 Periods**
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.						
UNIT – V	**DECISION ANALYSIS AND RECENT TRENDS IN BUSINESS ANALYTICS**					**9 Periods**
Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical : 0Periods** **Total : 45 Periods**						

REFERENCES

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

5	*U. Dinesh Kumar,* ***"Business Analytics: TheScience of Data-Driven Decision Making",*** *Wiley, 2017.*
6	*Rui Miguel Forte,* ***"Mastering Predictive Analytics with R",*** *Packt Publication, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the real world business problems and model with analytical solutions.	K4
CO2	Solve analytical problem with relevant mathematics background knowledge.	K4
CO3	Convert any real world decision making problem to hypothesis and apply suitable statistical testing.	K4
CO4	Write and Demonstrate simple applications involving analytics using Hadoop and Map Reduce	K4
CO5	Use open source frameworks for modeling and storing data.	K4

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	1	2	1
CO2	1	1	1	2	1
CO3	2	2	1	1	-
CO4	2	2	1	-	-
CO5	1	2	-	-	-
23EDOE10	1	2	1	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDOE11	INTRODUCTION TO INDUSTRIAL SAFETY (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	• Summarize basics of industrial safety. • Describe fundamentals of maintenance engineering. • Explain wear and corrosion. • Illustrate fault tracing. • Identify preventive and periodic maintenance.

UNIT – I	**INTRODUCTION**	**9 Periods**

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

UNIT – II	**FUNDAMENTALS OF MAINTENANCE ENGINEERING**	**9 Periods**

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

UNIT – III	**WEAR AND CORROSION AND THEIR PREVENTION**	**9 Periods**

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

UNIT – IV	**FAULT TRACING**	**9 Periods**

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

UNIT – V	**PERIODIC AND PREVENTIVE MAINTENANCE**	**9 Periods**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical:0Periods** **Total:45 Periods**

REFERENCES

1	*Hans F. Winterkorn,* ***"Foundation Engineering Handbook",*** *Chapman & Hall London, 2013.*
2	***"Maintenance Engineering"*** *by Dr. Siddhartha Ray, New Age International (P) Ltd., Publishers, 2017*
3	***"Industrial Safety Management",*** *McGraw Hill Education; New edition (1 July 2017)*
4	***"Industrial Engineering And Production Management",*** *S. Chand Publishing; Third edition ,2018*
5	***"Industrial Safety and Maintenance Engineering",*** *Parth B. Shah, 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Ability to summarize basics of industrial safety	K4
CO2	Ability to describe fundamentals of maintenance engineering	K4
CO3	Ability to explain wear and corrosion	K4
CO4	Ability to illustrate fault tracing	K4
CO5	Ability to identify preventive and periodic maintenance	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	-	-
CO2	2	2	1	-	1
CO3	1	2	1	1	1
CO4	2	1	1	1	1
CO5	2	1	2	1	1
23EDOE11	2	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23EDOE12	OPERATIONS RESEARCH (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

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

UNIT – I	**INTRODUCTION**	**9 Periods**
Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models		
UNIT – II	**LINEAR PROGRAMMING PROBLEM**	**9 Periods**
Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming		
UNIT – III	**NON-LINEAR PROGRAMMING PROBLEM**	**9 Periods**
Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT		
UNIT – IV	**SEQUENCING AND INVENTORY MODEL**	**9 Periods**
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.		
UNIT – V	**GAME THEORY**	**9 Periods**
Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation		

Contact Periods:
Lecture: 45 Periods Tutorial : 0 Periods Practical : 0 Periods Total : 45 Periods

REFERENCES

1	*H.A. Taha **"Operations Research, An Introduction",** PHI, 2017.*
2	***"Industrial Engineering and Management",** O. P. Khanna, 2017.*
3	***"Operations Research",** S.K. Patel, 2017.*
4	***"Operation Research",**AnupGoel, RuchiAgarwal, Technical Publications, Jan 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate linear programming problem and solve using graphical method.	K4
CO2	Solve LPP using simplex method.	K4
CO3	Formulate and solve transportation, assignment problems.	K4
CO4	Solve project management problems.	K4
CO5	Solve scheduling problems	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	-	-
CO2	2	2	1	-	-
CO3	1	1	2	1	1
CO4	1	1	-	-	-
CO5	2	1	-	-	-
23EDOE12	2	1	1	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	25	25	25			100
CAT2	20	25	25	30			100
Assignment 1	25	30	25	20			100
Assignment 2	30	20	30	20			100
ESE	20	30	20	30			100

23MFOE13	OCCUPATIONAL HEALTH AND SAFETY (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	• To gain knowledge about occupational health hazard and safety measures at work place. • To learn about accident prevention and safety management. • To learn about general safety measures in industries.

UNIT – I	**OCCUPATIONAL HEALTH AND HAZARDS**	**9 Periods**

Safety- History and development, National Safety Policy- Occupational Health Hazards - Ergonomics - Importance of Industrial Safety Radiation and Industrial Hazards- Machine Guards and its types, Automation.

UNIT – II	**SAFETY AT WORKPLACE**	**9 Periods**

Safety at Workplace - Safe use of Machines and Tools: Safety in use of different types of unit operations - Ergonomics of Machine guarding - working in different workplaces - Operation, Inspection and maintenance, Plant Design and Housekeeping, Industrial lighting, Vibration and Noise Case studies.

UNIT – III	**ACCIDENT PREVENTION**	**9 Periods**

Accident Prevention Techniques - Principles of accident prevention - Definitions, Theories, Principles – Hazard identification and analysis, Event tree analysis, Hazop studies, Job safety analysis - Theories and Principles of Accident causation - First Aid : Body structure and functions - Fracture and Dislocation, Injuries to various body parts.

UNIT – IV	**SAFETY MANAGEMENT**	**9 Periods**

Safety Management System and Law - Legislative measures in Industrial Safety: Various acts involved in Detail- Occupational safety, Health and Environment Management: Bureau of Indian Standards on Health and Safety, 14489, 15001 - OSHA, Process safety management (PSM) and its principles - EPA standards- Safety Management: Organisational & Safety Committee - its structure and functions.

UNIT – V	**GENERAL SAFETY MEASURES**	**9 Periods**

Plant Layout for Safety -design and location, distance between hazardous units, lighting, colour coding, pilot plant studies, Housekeeping - Accidents Related with Maintenance of Machines - Work Permit System: Significance of Documentation Directing Safety, Leadership -Case studies involving implementation of health and safety measures in Industries.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total:45 Periods**

REFERENCES

1	*Benjamin O.Alli,* ***Fundamental Principles of Occupational Health and Safety*** *ILO 2008.*
2	*Danuta Koradecka,* ***Handbook of Occupational Health and Safety****, CRC, 2010.*
3	*Dr. Siddhartha Ray,* ***Maintenance Engineering,*** *New Age International (P) Ltd., Publishers, 2017*
4	*Deshmukh. L.M.,* ***Industrial Safety Management****, 3rd Edition, Tata McGraw Hill, NewDelhi, 2008.*
5	*https://nptel.ac.in/courses/110105094*
6	*https://archive.nptel.ac.in/courses/110/105/110105094/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Gain the knowledge about occupational health hazard and safety measures at work place.	K3
CO2	Learn about accident prevention and safety management.	K2
CO3	Understand occupational health hazards and general safety measures in industries.	K3
CO4	Know various laws, standards and legislations.	K2

CO5	Implement safety and proper management of industries.	K4

COURSE ARTICULATION MATRIX:					
Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	1	1
CO2	2	2	1	1	1
CO3	1	2	1	1	1
CO4	2	1	1	1	1
CO5	2	1	2	1	1
23MFOE13	**2**	**1**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		50	50				100
CAT2		50	30	20			100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1		50	50				100
Individual Assessment 2/ Case Study 2/ Seminar 2 / Project 2		50	30	20			100
ESE		40	40	20			100

23MFOE14	COST MANAGEMENT OF ENGINEERING PROJECTS (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	• To understand the costing concepts and their role in decision making. • To acquire the project management concepts and their various aspects in selection. • To gain the knowledge in costing concepts with project execution. • To develop knowledge of costing techniques in service sector and various budgetary control techniques. • To familiarize with quantitative techniques in cost management.

UNIT – I	**INTRODUCTION TO COSTING CONCEPTS**	**9 Periods**

Introduction and Overview of the Strategic Cost Management Process, Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision - Making.

UNIT – II	**PROJECT PLANNING ACTIVITIES**	**9 Periods**

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

UNIT – III	**COST ANALYSIS**	**9 Periods**

Cost Behaviour and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

UNIT – IV	**PRICING STRATEGIES AND BUDGETORY CONTROL**	**9 Periods**

Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing, Costing of service sector, Just-in -time approach, Material Requirement Planning, Enterprise Resource Planning. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT – V	**TQM AND OPERATIONS REASEARCH TOOLS**	**9 Periods**

Total Quality Management and Theory of constraints, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES:

1	*Charles T. Horngren and George Foster, **Advanced Management Accounting**, 2018.*
2	*John M. Nicholas,**Project Management for Engineering, Business and Technology**, Taylor &Francis, 2016*
3	*Nigel J, **Engineering Project Management**, John Wiley and Sons Ltd, Smith 2015.*
4	*Charles T. Horngren and George Foster **Cost Accounting a Managerial Emphasis**, Prentice Hall of India, New Delhi, 2011.*
5	*https://archive.nptel.ac.in/courses/110/104/110104073/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Apply the costing concepts and their role in decision making.	K3
CO2	Apply the project management concepts and analyze their various aspects in selection.	K4
CO3	Interpret costing concepts with project execution.	K4
CO4	Gain knowledge of costing techniques in service sector and various budgetary control techniques.	K2
CO5	Become familiar with quantitative techniques in cost management.	K3

COURSE ARTICULATION MATRIX:					
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	1	2	1	1
CO2	2	1	1	1	-
CO3	2	2	2	-	-
CO4	1	1	1	1	1
CO5	1	2	1	1	-
23MFOE14	1	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1			40	60			100
CAT2		30	30	40			100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1			40	60			100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2		30	30	40			100
ESE		20	40	40			100

23MFOE15	COMPOSITE MATERIALS (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	• To summarize the characteristics of composite materials and effect of reinforcement in composite materials. • To identify the various reinforcements used in composite materials. • To compare the manufacturing process of metal matrix composites. • To understand the manufacturing processes of polymer matrix composites. • To analyze the strength of composite materials.

UNIT – I	**INTRODUCTION**	**9 Periods**

Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement on overall composite performance.

UNIT – II	**REINFORCEMENT**	**9 Periods**

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

UNIT – III	**MANUFACTURING OF METAL MATRIX COMPOSITES**	**9 Periods**

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

UNIT – IV	**MANUFACTURING OF POLYMER MATRIX COMPOSITE**	**9 Periods**

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

UNIT – V	**STRENGTH ANALYSIS OF COMPOSITES**	**9 Periods**

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

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES:

1	*Chawla K.K., **Composite Materials**, Springer, 2013.*
2	*Lubin.G, **Hand Book of Composite Materials**, Springer New York, 2013.*
3	*Deborah D.L. Chung, **Composite Materials Science and Applications**, Springer, 2011.*
4	*uLektz, **Composite Materials and Mechanics**, uLektz Learning Solutions Private Limited, Lektz, 2013.*
5	*https://nptel.ac.in/courses/112104168*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know the characteristics of composite materials and effect of reinforcement in composite materials.	K2
CO2	Know the various reinforcements used in composite materials.	K2
CO3	Understand and apply the manufacturing processes of metal matrix composites	K3
CO4	Understand and apply the manufacturing processes of polymer matrix composites.	K3

CO5	Analyze the strength of composite materials.	K4

COURSE ARTICULATION MATRIX:

COs/Pos	PO1	PO2	PO3	PO4	PO5
CO1	1	2	1	1	1
CO2	2	2	1	1	2
CO3	2	1	2	1	1
CO4	1	2	2	2	1
CO5	1	2	1	1	1
23MFOE15	1	2	2	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		60	40				100
CAT2			60	40			100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1		60	40				100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2			60	40			100
ESE		40	40	20			100

23TEOE16	GLOBAL WARMING SCIENCE (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To make the students learn about the material consequences of climate change, sea level change due to increase in the emission of greenhouse gases and to examine the science behind mitigation and adaptation proposals.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Terminology relating to atmospheric particles – Aerosols - Types, characteristics, measurements – Particle mass spectrometry - Anthropogenic-sources, effects on humans.		
UNIT – II	**CLIMATE MODELS**	**9 Periods**
General climate modeling- Atmospheric general circulation model - Oceanic general circulation model, sea ice model, land model concept, paleo-climate - Weather prediction by numerical process. Impacts of climate change - Climate Sensitivity - Forcing and feedback.		
UNIT – III	**EARTH CARBON CYCLE AND FORECAST**	**9 Periods**
Carbon cycle-process, importance, advantages - Carbon on earth - Global carbon reservoirs - Interactions between human activities and carbon cycle - Geologic time scales - Fossil fuels and energy - Perturbed carbon cycle.		
UNIT – IV	**GREENHOUSE GASES**	**9 Periods**
Blackbody radiation - Layer model - Earth's atmospheric composition and Green house gases effects on weather and climate - Radioactive equilibrium - Earth's energy balance.		
UNIT – V	**GEO ENGINEERING**	**9 Periods**
Solar mitigation - Strategies – Carbon dioxide removal - Solar radiation management - Recent observed trends in global warming for sea level rise, drought, glacier extent.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Eli Tziperman,* ***"Global Warming Science: A Quantitative Introduction to Climate Change and Its Consequences"****, Princeton University Press, 1st Edition, 2022.*
2	*John Houghton,* ***"Global warming: The Complete Briefing"****, Cambridge University Press, 5th Edition, 2015.*
3	*David Archer,* ***"Global warming: Understanding the Forecast"****, Wiley, 2nd Edition, 2011.*
4	*David S.K. Ting, Jacqueline A Stagner,* ***"Climate Change Science: Causes, Effects and Solutions for Global Warming"****, Elsevier, 1st Edition, 2021.*
5	*Frances Drake,* ***"Global Warming: The Science of Climate Change"****, Routledge, 1st edition, 2000.*
6	*Dickinson,* ***"Climate Engineering-A review of aerosol approaches to changing the global energybalance"****, Springer, 1996.*
7	*Andreas Schmittner,* ***"Introduction to Climate Science"****, Oregon State University, 2018.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the global warming in relation to climate changes throughout the earth.	K2
CO2	Assess the best predictions of current climate models.	K4
CO3	Understand the importance of carbon cycle and its implication on fossil fuels.	K2
CO4	Know about current issues, including impact from society, environment, economy as well as ecology related to greenhouse gases.	K4
CO5	Know the safety measures and precautions regarding global warming.	K5

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	1	1	2
CO2	1	1	2	1	1	1
CO3	1	2	1	1	1	2
CO4	1	1	1	1	1	2
CO5	2	1	2	1	1	2
23TEOE16	1	1	1	1	1	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	35	35	10	-	-	100
CAT2	15	25	25	20	15	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	25	20	20	35	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	20	35	15	10	-	100
ESE	25	20	25	20	10	-	100

23TEOE17	INTRODUCTION TO NANO ELECTRONICS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
ENGINEERING PHYSICS		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To make the students provide strong, essential, important methods and foundations of quantum mechanics and apply quantum mechanics on engineering fields.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Particles and Waves - Operators in quantum mechanics - The Postulates of quantum mechanics - The Schrodinger equation values and wave packet Solutions - Ehrenfest's Theorem.						
UNIT – II	**ELECTRONIC STRUCTURE AND MOTION**					**9 Periods**
Atoms- The Hydrogen Atom - Many-Electron Atoms – Pseudopotentials, Nuclear Structure, Molecules, Crystals - Translational motion – Penetration through barriers – Particle in a box - Two terminal quantum dot devices - Two terminal quantum wire devices.						
UNIT – III	**SCATTERING THEORY**					**9 Periods**
The formulation of scattering events - Scattering cross section - Stationary scattering state - Partial wave stationary scattering events - multi-channel scattering - Solution for Schrodinger equation- Radial and wave equation - Greens' function.						
UNIT – IV	**CLASSICAL STATISTICS**					**9 Periods**
Probabilities and microscopic behaviours - Kinetic theory and transport processes in gases - Magnetic properties of materials - The partition function.						
UNIT – V	**QUANTUM STATISTICS**					**9 Periods**
Statistical mechanics - Basic Concepts - Statistical models applied to metals and semiconductors - The thermal properties of solids- The electrical properties of materials - Black body radiation - Low temperatures and degenerate systems.						
Contact Periods: **Lecture:45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total:45 Periods**						

REFERENCES:

1	*Vladimi V.Mitin, Viatcheslav A. Kochelap and Michael A.Stroscio,* ***"Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications",*** *Cambridge University Press, 1st Edition, 2007.*
2	*Vinod Kumar Khanna,* ***"Introductory Nanoelectronics: Physical Theory and Device Analysis",*** *Routledge, 1st Edition, 2020.*
3	*George W. Hanson,* ***"Fundamentals of Nanoelectronics"****, Pearson Publishers, United States Edition, 2007.*
4	*Marc Baldo,* ***"Introduction to Nanoelectronics"****, MIT Open Courseware Publication, 2011.*
5	*Vladimi V.Mitin,* ***"Introduction to Nanoelectronics"****, Cambridge University Press, South Asian Edition, 2009.*
6	*Peter L. Hagelstein, Stephen D. Senturia and Terry P. Orlando, "****Introductory Applied Quantum Statistical Mechanics"****, Wiley, 2004.*
7	*A. F. J. Levi,* ***"Applied Quantum Mechanics"****, 2nd Edition, Cambridge, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the postulates of quantum mechanics.	K2
CO2	Know about nano electronic systems and building blocks.	K2
CO3	Solve the Schrodinger equation in 1D, 2D and 3Ddifferent applications.	K4
CO4	Learn the concepts involved in kinetic theory of gases.	K2

CO5	Know about statistical models applies to metals and semiconductor.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	1	1	1
CO2	2	2	1	1	1	1
CO3	2	2	2	1	1	1
CO4	1	1	1	1	1	1
CO5	1	1	1	1	1	1
23TEOE17	1	1	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	30	30	20	20	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project 1	35	25	20	20	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	30	25	20	25	-	-	100
ESE	20	30	30	20	-	-	100

23TEOE18	GREEN SUPPLY CHAIN MANAGEMENT (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To make the students learn and focus on the fundamental strategies, tools and techniques required to analyze and design environmentally sustainable supply chain systems.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Intro to SCM – complexity in SCM, Facility location - Logistics – Aim, activities, importance, progress, current trends - Integrating logistics with an organization.		
UNIT – II	**ESSENTIALS OF SUPPLY CHAIN MANAGEMENT**	**9 Periods**
Basic concepts of supply chain management - Supply chain operations – Planning and sourcing - Making and delivering - Supply chain coordination and use of technology - Developing supply chain systems.		
UNIT – III	**PLANNING THE SUPPLY CHAIN**	**9 Periods**
Types of decisions – strategic, tactical, operational - Logistics strategies, implementing the strategy - Planning resources – types, capacity, schedule, controlling material flow, measuring and improving performance.		
UNIT – IV	**ACTIVITIES IN THE SUPPLY CHAIN**	**9 Periods**
Procurement – cycle, types of purchase – Framework of e-procurement - Inventory management – EOQ, uncertain demand and safety stock, stock control - Material handling – Purpose of warehouse and ownership, layout, packaging - Transport – mode, ownership, vehicle routing and scheduling models- Travelling salesman problems - Exact and heuristic methods.		
UNIT – V	**SUPPLY CHAIN MANAGEMENT STRATEGIES**	**9 Periods**
Five key configuration components - Four criteria of good supply chain strategies - Next generation strategies- New roles for end-to-end supply chain management - Evolution of supply chain organization – International issues in SCM – Regional differences in logistics.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Charisios Achillas, Dionysis D. Bochtis, Dimitrios Aidonis and Dimitris Folinas,* ***"Green Supply Chain Management"****, Routledge, 1st Edition, 2019.*
2	*Hsiao-Fan Wang and Surendra M.Gupta,* ***"Green Supply Chain Management: Product Life Cycle Approach"****, McGraw-Hill Education, 1st Edition, 2011.*
3	*Joseph Sarkis and Yijie Dou,* ***"Green Supply Chain Management"****, Routledge, 1st Edition, 2017.*
4	*Arunachalam Rajagopal,* ***"Green Supply Chain Management: A Practical Approach"****, Replica, 2021.*
5	*Mehmood Khan, Matloub Hussain and Mian M. Ajmal,* ***"Green Supply Chain Management for Sustainable Business Practice"****, IGI Global, 1st Edition, 2016.*
6	*S Emmett,* ***"Green Supply Chains: An Action Manifesto"****, John Wiley & Sons Inc, 2010.*
7	*Joseph Sarkis and Yijie Dou,* ***"Green Supply Chain Management: A Concise Introduction"****, Routledge, 1st Edition, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Integrate logistics with an organization.	K2
CO2	Evaluate complex qualitative and quantitative data to support strategic and operational decisions.	K5
CO3	Develop self-leadership strategies to enhance personal and professional effectiveness.	K3
CO4	Analyze inventory management models and dynamics of supply chain.	K4
CO5	Identify issues in international supply chain management and outsources strategies.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	1	1	3
CO2	2	2	1	1	1	1
CO3	2	1	2	1	1	1
CO4	2	2	1	1	2	2
CO5	1	1	2	1	1	3
23TEOE18	2	1	1	1	1	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	30	10	10	-	100
CAT2	30	40	20	10	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project 1	30	20	25	15	10	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	35	30	25	10	-	-	100
ESE	30	30	20	10	10	-	100

23PSOE19	DISTRIBUTION AUTOMATION SYSTEM (Common to all Branches)	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To study about the distributed automation and economic evaluation schemes of power network

UNIT – I	INTRODUCTION	9 Periods

Introduction to Distribution Automation (DA) - Control system interfaces- Control and data requirements- Centralized (vs) decentralized control- DA system-DA hardware-DAS software.

UNIT – II	DISTRIBUTION AUTOMATION FUNCTIONS	9 Periods

DA capabilities - Automation system computer facilities- Management processes- Information management- System reliability management- System efficiency management- Voltage management- Load management.

UNIT – III	COMMUNICATION SYSTEMS	9 Periods

Communication requirements - reliability- Cost effectiveness- Data requirements- Two way capability- Communication during outages and faults - Ease of operation and maintenance- Conforming to the architecture of flow. Distribution line carrier- Ripple control-Zero crossing technique- Telephone, cableTV, radio, AM broadcast, FM SCA,VHF radio, microwave satellite, fiber optics-Hybrid communication systems used in field tests.

UNIT – IV	ECONOMIC EVALUATION METHODS	9 Periods

Development and evaluation of alternate plans- select study area – Select study period- Project load growth- Develop alternatives- Calculate operating and maintenance costs-Evaluate alternatives.

UNIT – V	ECONOMIC COMPARISON	9 Periods

Economic comparison of alternate plans-Classification of expenses - capital expenditures-Comparison of revenue requirements of alternative plans-Book life and continuing plant analysis- Year by year revenue requirement analysis, Short term analysis- End of study adjustment-Break even analysis, sensitivity analysis - Computational aids.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

REFERENCES

1	*M.K. Khedkar, G.M. Dhole,* ***"A Textbook of Electric Power Distribution Automation"****, Laxmi Publications, Ltd., 2010.*
2	*Maurizio Di Paolo Emilio,* ***"Data Acquisition Systems: From Fundamentals to Applied Design"****, Springer Science & Business Media, 21-Mar-2013*
3	*IEEE Tutorial course* ***"Distribution Automation"****, IEEE Working Group on Distribution Automation, IEEE Power Engineering Society. Power Engineering Education Committee, IEEE Power Engineering Society. Transmission and Distribution Committee, Institute of Electrical and Electronics Engineers, 1988*
4	*Taub,* ***"Principles Of Communication Systems",*** *Tata McGraw-Hill Education, 07-Sep-2008*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyse the requirements of distributed automation	K1
CO2	Know the functions of distributed automation	K2
CO3	Perform detailed analysis of communication systems for distributed automation.	K3
CO4	Study the economic evaluation method	K4
CO5	Understand the comparison of alternate plans	K5

COURSE ARTICULATION MATRIX				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	2	-	1	3
CO2	3	-	3	2
CO3	3	-	3	2
CO4	3	-	3	1
CO5	2	-	1	2
23PSOE19	3	-	3	2
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	30%	20%	10%	20%	-	100%
CAT2	20%	20%	20%	20%	20%	-	100%
Individual Assessment1/ Case study1/ Seminar 1/ Project1	20%	10%	30%	20%	20%	-	100%
Individual Assessment2/ Case study2/ Seminar 2 / Project2	20%	30%	10%	20%	20%	-	100%
ESE	30%	20%	20%	20%	10%	-	100%

23PSOE20	ELECTRICITY TRADING AND ELECTRICITY ACTS (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To acquire expertise on Electric supply and demand of Indian Grid, gain exposure on energy trading in the Indian market and infer the electricity acts and regulatory authorities.	
UNIT – I	**ENERGY DEMAND**	**9 Periods**
Basic concepts in Economics - Descriptive Analysis of Energy Demand - Decomposition Analysis and Parametric Approach - Demand Side Management - Load Management - Demand Side Management - Energy Efficiency - Rebound Effect		
UNIT – II	**ENERGY SUPPLY**	**9 Periods**
Supply Behavior of a Producer - Energy Investment - Economics of Non-renewable Resources - Economics of Renewable Energy Supply Setting the context - Economics of Renewable Energy Supply - Economics of Electricity Supply		
UNIT – III	**ENERGY MARKET**	**9 Periods**
Perfect Competition as a Market Form - Why is the Energy Market not Perfectly Competitive? - Market Failure and Monopoly - Oil Market: Pre OPEC Era I - Oil Market: Pre OPEC Era II - Oil Market: OPEC		
UNIT – IV	**LAW ON ELECTRICITY**	**9 Periods**
Introduction of the Electricity Law; Constitutional Design - Evolution of Laws on Electricity Salient Features of Electricity Act, 2003 - Evolution of Laws on Electricity - Salient Features of the Electricity Act 2003		
UNIT – V	**REGULATORY COMMISSIONS FOR ELECTRICITY ACT**	**9 Periods**
Regulatory Commissions - Appellate Tribunal - Other Institutions under the Act - Electricity (Amendment) Bill 2020/2021. A Critical Comment - Renewable Energy - Role of Civil Society; Comments on Draft Renewable Energy Act, 2015		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Bhattacharyya, Subhes. C. (2011).* ***"Energy Economics: Concepts, Issues, Markets and Governance"****. Springer.London, UK*
2	*Stevens, P. (2000).* ***"An Introduction to Energy Economics. In Stevens, P.(ed.) The Economics of Energy"****, Vol.1, Edward Elgar, Cheltenham, UK.*
3	*Nausir Bharucha,* ***"Guide to the Electricity Laws"****, LexisNexis, 2018*
4	*Mohammad Naseem,* ***"Energy Laws in India"****, Kluwer Law International, 3rd Edn, The Netherlands, 2017.*
5	*Alok Kumar & Sushanta K Chaterjee,* ***"Electricity Sector in India: Policy and Regulation"****, OUP, 2012.*
6	*Benjamin K Sovacool & Michael H Dowrkin,* ***"Global Energy Justice: Problems, Principles and Practices"****, Cambridge Univesity Press, 2014.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe electric supply and demand of power grid	K1
CO2	Summarize various energy trading strategies	K2
CO3	Relate the electricity acts practically	K3
CO4	Cite the electricity regulatory authorities	K2
CO5	Analyze/check the existing power grid for its technical and economical sustainability	K4

COURSE ARTICULATION MATRIX				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	3
CO2	3	-	1	1
CO3	3	-	2	2
CO4	3	-	1	2
CO5	3	-	3	3
23PSOE20	3	-	2	2
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	30%	20%	30%	-	-	100%
CAT2	20%	20%	20%	20%	20%	-	100%
Individual Assessment1/ Case study1/ Seminar 1/ Project1	20%	30%	30%	20%	-	-	100%
Individual Assessment2/ Case study2/ Seminar 2 / Project2	20%	30%	-	20%	-	40%	100%
ESE	30%	30%	-	20%	20%	-	100%

23PSOE21	MODERN AUTOMOTIVE SYSTEMS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To expose the students with theory and applications of Automotive Electrical and Electronic Systems.					
UNIT – I	**INTRODUCTION TO MODERN AUTOMOTIVE ELECTRONICS**					**9 Periods**
Introduction to modern automotive systems and need for electronics in automobiles- Role of electronics and microcontrollers- Sensors and actuators- Possibilities and challenges in automotive industry- Enabling technologies and industry trends.						
UNIT – II	**SENSORS AND ACTUATORS**					**9 Periods**
Introduction- basic sensor arrangement- Types of sensors- Oxygen sensor, engine crankshaft angular position sensor – Engine cooling water temperature sensor- Engine oil pressure sensor- Fuel metering- vehicle speed sensor and detonation sensor- Pressure Sensor- Linear and angle sensors- Flow sensor- Temperature and humidity sensors- Gas sensor- Speed and Acceleration sensors- Knock sensor- Torque sensor- Yaw rate sensor- Tyre Pressure sensor- Actuators - Stepper motors – Relays.						
UNIT – III	**POWERTRAIN CONTROL SYSTEMS IN AUTOMOBILE**					**9 Periods**
Electronic Transmission Control - Digital engine control system: Open loop and close loop control systems- Engine cooling and warm up control- Acceleration- Detonation and idle speed control - Exhaust emission control engineering- Onboard diagnostics- Future automotive powertrain systems.						
UNIT – IV	**SAFETY, COMFORT AND CONVENIENCE SYSTEMS**					**9 Periods**
Cruise Control- Anti-lock Braking Control- Traction and Stability control- Airbag control system- Suspension control- Steering control- HVAC Control.						
UNIT – V	**ELECTRONIC CONTROL UNITS (ECU)**					**9 Periods**
Introduction to Energy Sources for ECU, Need for ECUs- Advances in ECUs for automotives - Design complexities of ECUs- V-Model for Automotive ECU's- Architecture of an advanced microcontroller (XC166 Family, 32-bit Tricore) used in the design of automobile ECUs- On chip peripherals, protocol interfaces, analog and digital interfaces.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*Enrique Acha, Manuel Madrigal,* ***"Power System Harmonics: Computer Modeling and Analysis****", John Wiley and Sons, 2001.*
2	*M. H. J. Bollen,* ***"Understanding Power Quality Problems, Voltage Sag and Interruptions",*** *IEEE Press, series on Power Engineering, 2000.*
3	*Roger C. Dugan, Mark F. McGranaghan, Surya Santoso and Wayne Beaty H.,* ***"Electrical Power SystemQuality"****, Second Edition, McGraw Hill Publication Co., 2008.*
4	*G.T.Heydt,* ***"Electric Power Quality",*** *Stars in a Circle Publications, 1994(2nd edition).*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge about conventional automotive control units and devices.	K1
CO2	Recognize the practical issues in the automotive control systems	K2
CO3	Analyze the impact of modern automotive techniques in various Engineering applications	K4
CO4	Develop modern automotive control system for electrical and electronics systems	K6
CO5	Understand the function of sensors and actuators	K2

COURSE ARTICULATION MATRIX				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	1	3
CO2	3	-	3	2
CO3	3	-	3	2
CO4	2	-	3	1
CO5	2	-	1	2
23PSOE21	3	-	2	2
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	30%	20%	30%	-	-	100%
CAT2	20%	20%	20%	20%	20%	-	100%
Individual Assessment1/ Case study1/ Seminar 1/ Project1	20%	30%	-	20%	-	30%	100%
Individual Assessment2/ Case study2/ Seminar 2 / Project2	20%	30%	-	20%	-	40%	100%
ESE	30%	30%	20%	20%	-	-	100%

23PEOE22	VIRTUAL INSTRUMENTATION (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To comprehend the Virtual instrumentation programming concepts towards measurements and control and to instill knowledge on DAQ, signal conditioning and its associated software tools	
UNIT – I	**INTRODUCTION**	**7 Periods**
Introduction - advantages - Block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - Data-flow techniques, graphical programming in data flow, comparison with conventional programming.		
UNIT – II	**GRAPHICAL PROGRAMMING AND LabVIEW**	**9 Periods**
Concepts of graphical programming - LabVIEW software - Concept of VIs and sub VI - Display types - Digital - Analog - Chart and Graphs. Loops - structures - Arrays – Clusters- Local and global variables – String - Timers and dialog controls.		
UNIT – III	**MANAGING FILES & DESIGN PATTERNS**	**11 Periods**
High-level and low-level file I/O functions available in LabVIEW – Implementing File I/O functions to read and write data to files – Binary Files – TDMS – sequential programming – State machine programming – Communication between parallel loops –Race conditions – Notifiers & Queues – Producer Consumer design patterns		
UNIT – IV	**PC BASED DATA ACQUISITION**	**9 Periods**
Introduction to data acquisition on PC, Sampling fundamentals, ADCs, DACs, Calibration, Resolution, - analog inputs and outputs - Single-ended and differential inputs - Digital I/O, counters and timers, DMA, Data acquisition interface requirements - Issues involved in selection of Data acquisition cards - Use of timer-counter and analog outputs on the universal DAQ card.		
UNIT – V	**DATA ACQUISITION AND SIGNAL CONDITIONING**	**9 Periods**
Components of a DAQ system, Bus, Signal and accuracy consideration when choosing DAQ hardware – Measurement of analog signal with Finite and continuous buffered acquisition- analog output generation – Signal conditioning systems – Synchronizing measurements in single & multiple devices – Power quality analysis using Electrical Power Measurement tool kit.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Jeffrey Travis, Jim Kring,* ***"LabVIEW for Everyone: Graphical Programming Made Easy and Fun" (3rd Edition),*** *Prentice Hall, 2006.*
2	*Jovitha Jerome,* ***"Virtual Instrumentation using LabVIEW",*** *PHI, 2010*
3	*Gary W. Johnson, Richard Jennings,* ***"LabVIEW Graphical Programming"****, McGraw Hill Professional Publishing, 2019*
4	*Robert H. Bishop,* ***"Learning with LabVIEW"****, Prentice Hall, 2013.*
5	*Kevin James, "****PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control"****, Newness, 2000*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the graphical programming techniques using LabVIEW software.	K2
CO2	Explore the basics of programming and interfacing using related hardware.	K4
CO3	Analyse the aspects and utilization of PC based data acquisition and Instrument interfaces.	K4
CO4	Create programs and Select proper instrument interface for a specific application.	K6

CO5	Familiarize and experiment with DAQ and Signal Conditioning	K3

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	3	2	1
CO2	3	-	3	2	1
CO3	3	-	2	2	2
CO4	3	1	3	3	1
CO5	3	1	3	3	2
23PEOE22	3	1	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	15	15	-	-	100
CAT2	15	10	25	30	20	-	100
Individual Assessment1/ Case study1/ Seminar 1/ Project1	10	10	20	30	20	10	100
Individual Assessment2/ Case study2/ Seminar 2 / Project2	25	40	20	15	-	-	100
ESE	30	25	15	20	5	5	100

23PEOE23	ENERGY MANAGEMENT SYSTEMS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To Comprehend energy management schemes, perform energy audit and execute economic analysis and load management in electrical systems.					
UNIT – I	**GENERAL ASPECTS OF ENERGY AUDIT AND MANAGEMENT**					**9 Periods**
Energy Conservation Act 2001 and policies – Eight National Missions - Basics of Energy and its forms (Thermal and Electrical) - Energy Management and Audit - Energy Managers and Auditors - Types and Methodology Audit Report - Material and energy balance diagrams - .Energy Monitoring and Targeting.						
UNIT – II	**STUDY OF BOILERS, FURNACES AND COGENERATION**					**9 Periods**
Boiler Systems - Types - Performance Evaluation of boilers - Energy Conservation Opportunity - Steam Distribution - Efficient Steam Utilisation - Furnaces:types and classification - Performance evaluation of a typical fuel fired furnace. Cogeneration: Need - Principle - Technical options - classification - Technical parameters and factors influencing cogeneration choice - Prime Movers - Trigeneration.						
UNIT – III	**ENERGY STUDY OF ELECTRICAL SYSTEMS**					**9 Periods**
Electricity Billing – Electricity load management - Maximum Demand Control - Power Factor improvement and its benefits - pf controllers - capacitors - Energy efficient transformers and Induction motors - rewinding and other factors influencing energy efficiency - Standards and labeling programme of distribution transformers and IM - Analysis of distribution losses - demand side management - harmonics - filters - VFD and its selection.						
UNIT – IV	**STUDY OF ELECTRICAL UTILITIES**					**9 Periods**
Compressor types - Performance - Air system components - Efficient operation of compressed air systems- Compressor capacity assessment - HVAC: psychrometrics and air-conditioning processes - Types of refrigeration system - Compressor types and applications - Performance assessment of refrigeration plants - Lighting Systems: Energy efficient lighting controls - design of interior lighting - Case study.						
UNIT – V	**PERFORMANCE ASSESSMENT FOR EQUIPMENT**					**9 Periods**
Performing Financial analysis: Fixed and variable costs – Payback period – ROI - methods – factors affecting analysis. Energy Performance Assessment: Heat exchangers - Fans and Blowers - Pumps. Energy Conservation in buildings and ECBC.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES:

1	*Murphy W.R. and G.Mckay Butter worth , "**Energy Management**", Heinemann Publications, 2007*
2	*Albert Thumann, Terry Niehus, William J. Younger, "**Handbook of Energy Audits"**, Ninth Edition, River Publishers, 2012.*
3	*Dr. Subhash Gadhave Anup Goel Siddu S. Laxmikant D. Jathar, **"Energy Audit & Management"**, Second edition, Technical Publications, 2019.*
4	*S. M. Chaudhari, S. A. Asarkar, M. A. Chaudhari, **"Energy Conservation and Audit"**, Second Edition, Nirali Prakashan Publications, 2021.*
5	www.em-ea.org/gbook1.asp

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the feature of energy audit methodology and documentation of report.	K3
CO2	Perform action plan and financial analysis	K4
CO3	Familiarize with thermal utilities.	K4
CO4	Familiarize with electrical utilities.	K4

CO5	Perform assessment of different systems.	K5

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	1	1
CO2	3	2	2	1	1
CO3	3	2	2	1	1
CO4	3	2	2	1	1
CO5	3	2	2	1	1
23PEOE23	3	2	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment1/ Case study1/ Seminar 1/ Project1	-	30	30	20	20	-	100
Individual Assessment2/ Case study2/ Seminar 2 / Project2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

23PEOE24	ADVANCED ENERGY STORAGE TECHNOLOGY (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To explore the fundamentals, technologies and applications of energy storage					
UNIT – I	**ENERGY STORAGE: HISTORICAL PERSPECTIVE, INTRODUCTION AND CHANGES**					**9 Periods**
Storage Needs- Variations in Energy Demand- Variations in Energy Supply- Interruptions in Energy Supply- Transmission Congestion - Demand for Portable Energy-Demand and scale requirements - Environmental and sustainability issues-conventional energy storage methods: battery-types.						
UNIT – II	**TECHNICAL METHODS OF STORAGE**					**9 Periods**
Introduction: Energy and Energy Transformations, Potential energy (pumped hydro, compressed air, springs)- Kinetic energy (mechanical flywheels)- Thermal energy without phase change passive (adobe) and active (water)-Thermal energy with phase change (ice, molten salts, steam)- Chemical energy (hydrogen, methane, gasoline, coal, oil)- Electrochemical energy (batteries, fuel cells)- Electrostatic energy (capacitors), Electromagnetic energy (superconducting magnets)- Different Types of Energy Storage Systems.						
UNIT – III	**PERFORMANCE FACTORS OF ENERGY STORAGE SYSTEMS**					**9 Periods**
Energy capture rate and efficiency- Discharge rate and efficiency- Dispatch ability and load flowing characteristics, scale flexibility, durability – Cycle lifetime, mass and safety – Risks of fire, explosion, toxicity- Ease of materials, recycling and recovery- Environmental consideration and recycling , Merits and demerits of different types of Storage.						
UNIT – IV	**APPLICATION CONSIDERATION**					**9 Periods**
Comparing Storage Technologies- Technology options- Performance factors and metrics- Efficiency of Energy Systems- Energy Recovery - Battery Storage System: Introduction with focus on Lead Acid and Lithium- Chemistry of Battery Operation, Power storage calculations, Reversible reactions, Charging patterns, Battery Management systems, System Performance, Areas of Application of Energy Storage: Waste heat recovery, Solar energy storage, Green house heating, Power plant applications, Drying and heating for process industries, energy storage in automotive applications in hybrid and electric vehicles.						
UNIT – V	**HYDROGEN FUEL CELLS AND FLOW BATTERIES**					**9 Periods**
Hydrogen Economy and Generation Techniques, Storage of Hydrogen, Energy generation - Super capacitors: properties, power calculations – Operation and Design methods - Hybrid Energy Storage: Managing peak and Continuous power needs, options - Level 1: (Hybrid Power generation) Bacitor "Battery + Capacitor" Combinations: need, operation and Merits; Level 2: (Hybrid Power Generation) Bacitor + Fuel Cell or Flow Battery operation-Applications: Storage for Hybrid Electric Vehicles, Regenerative Power, capturing methods.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*DetlefStolten,* ***"Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications",*** *Wiley, 2010.*
2	*Jiujun Zhang, Lei Zhang, Hansan Liu, Andy Sun, Ru-Shi Liu,* ***"Electrochemical Technologies for Energy Storage and Conversion",*** *John Wiley and Sons, 2012.*
3	*Francois Beguin and ElzbietaFrackowiak,* ***"Super capacitors",*** *Wiley, 2013.*
4	*Doughty Liaw, Narayan and Srinivasan,* ***"Batteries for Renewable Energy Storage",*** *The Electrochemical Society, New Jersy, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Recollect the historical perspective and technical methods of energy storage.	K1
CO2	Explain the basics of different storage methods.	K2
CO3	Determine the performance factors of energy storage systems.	K2
CO4	Identify applications for renewable energy systems.	K4
CO5	Outline the basics of Hydrogen cell and flow batteries.	K2

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	3	3
CO2	3	1	3	3	3
CO3	3	1	3	3	3
CO4	3	1	3	3	3
CO5	3	1	3	3	3
23PEOE24	3	1	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment1/ Case study1/ Seminar 1/ Project1	-	30	30	20	10	10	100
Individual Assessment2/ Case study2/ Seminar 2 / Project2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

23AEOE25	DESIGN OF DIGITAL SYSTEMS (Common to all Branches)

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To gain knowledge in the design and VHDL programming of synchronous and asynchronous sequential circuits, PLD's and the basic concepts of testing in VLSI circuits	
UNIT–	**I SYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN**	**9 Periods**
Analysis of Clocked Synchronous Sequential Circuits - Modeling, state table reduction, state assignment, Design of Synchronous Sequential circuits, Design of iterative circuits- ASM chart –ASM realization.		
UNIT–II	**ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN**	**9 Periods**
Analysis of Asynchronous Sequential Circuits - Races in ASC – Primitive Flow Table - Flow Table Reduction Techniques, State Assignment Problem and the Transition Table – Design of ASC – Static and Dynamic Hazards – Essential Hazards– Data Synchronizers.		
UNIT–III	**SYSTEM DESIGN USING PLDS**	**9 Periods**
Basic concepts – Programming Technologies - Programmable Logic Element (PLE) – Programmable Array Logic (PLA)-Programmable Array Logic (PAL) –Design of combinational and sequential circuits using PLDs– Complex PLDs (CPLDs).		
UNIT– IV	**INTRODUCTION TO VHDL**	**9 Periods**
Design flow -Software tools – VHDL: Data Objects-Data types – Operators –Entities and Architectures Components and Configurations – Signal Assignment – Concurrent and Sequential statements —Behavioral, Dataflow and Structural modeling– Transport and Inertial delays –Delta delays-Attributes - Generics–Packages and Libraries.		
UNIT–V	**LOGIC CIRCUIT TESTING AND TESTABLE DESIGN**	**9 Periods**
Digital logic circuit testing - Fault models - Combinational logic circuit testing - Sequential logic circuit testing-Design for Testability - Built-in Self-test, Board and System Level Boundary Scan - Case Study: Traffic Light Controller.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES:

1	*Donald G.Givone,* ***"Digital principles and Design",*** *TataMcGrawHill, 2002.*
2	*Nelson, V.P., Nagale, H.T., Carroll, B.D., and Irwin, J.D.,* ***"Digital Logic Circuit Analysis and Design",*** *Prentice Hall International, Inc., NewJersey, 1995.*
3	*VolneiA.Pedroni****,"Circuit Design withVHDL",*** *PHILearning,2011.*
4	*ParagK Lala****,"Digital Circuit Testing and Testability",*** *AcademicPress,1997.*
5	*CharlesHRoth****,"Digital Systems Design Using VHDL",*** *Cencage 2nd Edition2012.*
6	*NripendraN.Biswas****,"Logic Design Theory"*** *Prentice Hal l of India,2001.*

COURSEOUTCOMES: Upon completion of the course ,students will be able to/have:		Bloom's Taxonomy Mapped
CO1	To design synchronous sequential circuits based on specifications.	K3
CO2	To design asynchronous sequential circuits based on specifications	K3
CO3	Ability to illustrate digital design implementation using PLDs.	K2
CO4	To develop algorithm and VHDL code for design of digital circuits.	K3
CO5	Understand the different testing methods for combinational and sequential circuits.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	-	1
CO2	3	-	2	-	-	1
CO3	3	-	2	-	-	1
CO4	3	-	2	-	-	1
CO5	3	-	2	-	-	1
23AEOE25	3	-	2	-	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1		50%	50%				100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2		50%	50%				100%
ESE	20%	45%	35%				100%

23AEOE26	BASICS OF NANO ELECTRONICS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objective	The students will be able to acquire knowledge about nano device fabrication technology, nano structures, nano technology for memory devices and applications of nano electronics in data transmission.					
UNIT – I	**TECHNOLOGY AND ANALYSIS**					**9 Periods**
Fundamentals : Dielectric, Ferroelectric and Optical properties - Film Deposition Methods – Lithography Material removing techniques - Etching and Chemical Mechanical Polishing - Scanning ProbeTechniques.						
UNIT – II	**CARBON NANO STRUCTURES**					**9 Periods**
Principles and concepts of Carbon Nano tubes - Fabrication - Electrical, Mechanical and VibrationProperties - Applications of Carbon Nano tubes.						
UNIT – III	**LOGIC DEVICES**					**9 Periods**
Silicon MOSFET's: Novel materials and alternative concepts - Single electron devices for logic applications - Super conductor digital electronics - Carbon Nano tubes for data processing.						
UNIT – IV	**MEMORY DEVICES AND MASS STORAGE DEVICES**					**9 Periods**
Flash memories - Capacitor based Random Access Memories - Magnetic Random Access Memories - Information storage based on phase change materials - Resistive Random Access Memories - HolographicData storage.						
UNIT – V	**DATA TRANSMISSION AND INTERFACING DISPLAYS**					**9 Periods**
Photonic Networks - RF and Microwave Communication System - Liquid Crystal Displays - Organic Light emitting diodes.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES:

1	*Rainer Waser,* ***"Nano Electronics and Information Technology, Advanced Electronicmaterials and novel devices"****, 3rd Edition, Wiley VCH, 2012.*
2	*T. Pradeep, "****Nano: The essentials"****, Tata McGraw Hill, 2007.*
3	*Charles Poole, "****Introduction to Nano Technology"****, Wiley Interscience, 2003*
4	*Vladimir V.Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "****Introduction to Nano Electronics Science, Nanotechnology, Engineering and Applications"****, Cambridge University Press, 2011.*
5	*C.Wasshuber Simon, "****Simulation of Nano Structures Computational Single-Electronics"****,Springer, 2001.*
6	*Mark Reed and Takhee Lee, "****Molecular Nano Electronics, American Scientific Publisher,California"****, 2003.*

COURSE OUTCOMES: Upon completion of the course, students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	Explain principles of nano device fabrication technology.	K2
CO2	Describe the concept of Nano tube and Nano structure.	K2
CO3	Explain the function and application of various nano devices	K3
CO4	Reproduce the concepts of advanced memory technologies.	K2
CO5	Emphasize the need for data transmission and display systems.	K2

COURSE ARTICULATION MATRIX									
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	2	-	-	1	3	-	1
CO2	3	-	2	-	-	1	3	-	1
CO3	3	-	2	-	-	1	3	-	1
CO4	3	-	2	-	-	1	3	-	1
CO5	3	-	2	-	-	1	3	-	1
22AEOE26	3	-	2	-	-	1	3	-	1
1 – Slight, 2 – Moderate, 3 – Substantial									

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50%	25%	25%				100%
CAT2	50%	25%	25%				100%
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1	50%	25%	25%				100%
Individual Assessment 2/ Case Study 2/ Seminar 2 / Project 2	50%	25%	25%				100%
ESE	50%	25%	25%				100%

23AEOE27	ADVANCED PROCESSOR (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objective	The students will be able to acquire knowledge about the high performance RISC, CISC and special purpose processors.

UNIT – I	**MICROPROCESSOR ARCHITECTURE**	**9 Periods**

Instruction set – Data formats – Instruction formats – Addressing modes – Memory hierarchy – registerfile – Cache – Virtual memory and paging – Segmentation – Pipelining – The instruction pipeline – pipeline hazards – Instruction level parallelism – reduced instruction set – Computer principles – RISCversus CISC – RISC properties – RISC evaluation.

UNIT – II	**HIGH PERFORMANCE CISC ARCHITECTURE –PENTIUM**	**9 Periods**

The software model – functional description – CPU pin descriptions – Addressing modes – Processor flags – Instruction set – Bus operations – Super scalar architecture – Pipe lining – Branch prediction – The instruction and caches – Floating point unit– Programming the Pentium processor.

UNIT – III	**HIGH PERFORMANCE CISC ARCHITECTURE – PENTIUM INTERFACE**	**9 Periods**

Protected mode operation – Segmentation – paging – Protection – multitasking – Exception and interrupts- Input /Output – Virtual 8086 model – Interrupt processing.

UNIT – IV	**HIGH PERFORMANCE RISC ARCHITECTURE: ARM**	**9 Periods**

ARM architecture – ARM assembly language program – ARM organization and implementation – ARM instruction set - Thumb instruction set.

UNIT – V	**SPECIAL PURPOSE PROCESSORS**	**9 Periods**

Altera Cyclone Processor – Audio codec – Video codec design – Platforms – General purpose processor –Digital signal processor – Embedded processor – Media Processor – Video signal Processor – Custom Hardware – Co-Processor.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

REFERENCES:

1	*Daniel Tabak,* ***"Advanced Microprocessors",*** *McGraw Hill Inc., 2011.*
2	*James L. Antonakos,* ***"The Pentium Microprocessor",*** *Pearson Education, 1997.*
3	*Steve Furber,* ***"ARM System –On –Chip architecture"****, Addison Wesley, 2009.*
4	*Gene. H. Miller,* ***"Micro Computer Engineering"****, Pearson Education, 2003.*
5	*Barry. B. Brey,* ***"The Intel Microprocessors Architecture, Programming and Interfacing",*** *PHI, 2008.*
6	*Valvano,* ***"Embedded Microcomputer Systems"*** *Cencage Learing India Pvt Ltd, 2011.*
7	*Iain E.G. Richardson,* ***"Video codec design"****, John Wiley & sons Ltd, U.K, 2002.*

COURSE OUTCOMES: Upon completion of the course, students will be able to		**Bloom's Taxonomy Mapped**
CO1	Describe the fundamentals of various processor architecture.	K2
CO2	Interpret and understand the high performance features in CISC architecture.	K2
CO3	Describe the concepts of Exception and interrupt processing.	K2
CO4	Develop programming skill for ARM processor.	K3
CO5	Explain various special purpose processor	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	-	1
CO2	3	-	2	-	-	1
CO3	3	-	2	-	-	1
CO4	3	-	2	-	-	1
CO5	3	-	2	-	-	1
22AEOE27	3	-	2	-	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1		50%	50%				100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2		50%	50%				100%
ESE	30%	40%	30%				100%

23VLOE28	HDL PROGRAMMING LANGUAGES (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	OE	**3**	**0**	**0**	**3**

Course Objective	To code and simulate any digital function in Verilog HDL and understand the difference between synthesizable and non-synthesizable codes.	
UNIT – I	**VERILOG INTRODUCTION AND MODELING**	**9 Periods**
Introduction to Verilog HDL, Language Constructs and Conventions, Gate Level Modeling, Modeling at Dataflow Level, Behavioral Modeling, Switch Level Modeling, System Tasks, Functions and Compiler Directives.		
UNIT – II	**SEQUENTIAL MODELING AND TESTING**	**9 Periods**
Sequential Models - Feedback Model, Capacitive Model, Implicit Model, Basic Memory Components, Functional Register, Static Machine Coding, Sequential Synthesis. Test Bench - Combinational Circuits Testing, Sequential Circuit Testing, Test Bench Techniques, Design Verification, Assertion Verification.		
UNIT – III	**SYSTEM VERILOG**	**9 Periods**
Introduction, System Verilog declaration spaces, System Verilog Literal Values and Built-in Data Types, System Verilog User-Defined and Enumerated Types, system Verilog Arrays, Structures and Unions, system verilog Procedural Blocks, Tasks and Functions.		
UNIT – IV	**SYSTEM VERILOG MODELING**	**9 Periods**
System Verilog Procedural Statements, Modeling Finite State Machines with System Verilog, System Verilog Design Hierarchy.		
UNIT – V	**INTERFACES AND DESIGN MODEL**	**9 Periods**
System Verilog Interfaces, A Complete Design Modeled with System Verilog, Behavioral and Transaction Level Modeling.		
Contact Periods: **Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods**		

REFERENCES:

1	*T.R.Padmanabhan, B Bala Tripura Sundari,* ***"Design through Verilog HDL",*** *Wiley 2009.*
2	*Stuart Sutherland, Simon Davidmann, Peter Flake , Foreword by Phil Moorby,* ***"System Verilog For Design Second Edition A Guide to Using System Verilog for Hardware Design and Modelling",*** *Springer 2006.*
3	*Samir Palnitkar,* ***"Verilog HDL",*** *2nd Edition, Pearson Education, 2009.*
4	*ZainalabdienNavabi,****"Verilog Digital System Design",****TMH,2ndEdition,2005.*
5	*System Verilog 3.1a, Language Reference Manual, Accellera, 2004*
6	*Dr.SRamachandran,* ***"Digital VLSI Systems Design: A Design Manual for Implementation of Projects on FPGAs and ASICs Using Verilog",*** *Springer, 2007.*
7	*Chris Spear,* ***"System verilog for verification a guide to learning the test bench Language Features",*** *Springer 2006.*
6	*Stuart Sutherland, Simon Davidmann, Peter Flake,* ***"System Verilog For Design: A Guide to Using System Verilog for Hardware Design and Modeling"*** *1st Edition, 2003*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the verilog coding and simulate any digital function using Verilog HDL	K2
CO2	Develop sequential modeling based Verilog HDL code and develop the test bench for the modeling	K3
CO3	Explain the system verilog modeling	K2
CO4	Differentiate the synthesizable and non-synthesizable code	K3
CO5	Apply good coding techniques on system verilog interfaces and complete design model	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3		2		2
CO2	3	3		2		2
CO3	3	3		2		2
CO4	3	3		2		2
CO5	3	3		2		2
23VLOE28	3	3		2		2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	40%	20%	-	-	-	100%
CAT2	40%	40%	20%	-	-	-	100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	-	50%	50%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	-	50%	50%	-	-	-	100%
ESE	40%	40%	20%	-	-	-	100%

23VLOE29	CMOS VLSI DESIGN (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	OE	**3**	**0**	**0**	**3**

Course Objective	To gain knowledge on CMOS Circuits with its characterization and to design CMOS logic and sub-system with low power	
UNIT – I	**INTRODUCTION TO MOS CIRCUITS**	**9 Periods**
MOS Transistor Theory -Introduction MOS Device Design Equations -MOS Transistor as a Switches - Pass Transistor - CMOS Transmission Gate -Complementary CMOS Inverter - Static Load MOS Inverters - Inverters with NMOS loads - Differential Inverter - Tri State Inverter - BiCMOS Inverter.		
UNIT – II	**CIRCUIT CHARACTERIZATION AND PERFORMANCE ESTIMATION**	**9 Periods**
Delay Estimation, Logical Effort and Transistor Sizing, Power Dissipation, Sizing Routing Conductors, Charge Sharing, Design Margin and Reliability.		
UNIT – III	**CMOS CIRCUIT AND LOGIC DESIGN**	**9 Periods**
CMOS Logic Gate Design, Physical Design of CMOS Gate, Designing with Transmission Gates, CMOS Logic Structures, Clocking Strategies, I/O Structures.		
UNIT – IV	**CMOS SUBSYSTEM DESIGN**	**9 Periods**
DataPath Operations-Addition/Subtraction, Parity Generators, Comparators, Zero/One Detectors, Binary Counters, ALUs, Multipliers, Shifters, Memory Elements, Control-FSM, Control Logic Implementation.		
UNIT – V	**LOWPOWERCMOS VLSIDESIGN**	**9 Periods**
Introduction to Low Power Design, Power Dissipation in FET Devices, Power Dissipation in CMOS, Low-Power Design through Voltage Scaling – VTCMOS Circuits, MTCMOS Circuits, Architectural Level Approach – Pipelining and Parallel Processing Approaches, Low Power Basics CMOS Gate and Adder Design.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Sung Mo Kang,Yusuf Lablebici,**"CMOS Digital Integrated Circuits:Analysis & Design"**, Tata Mc-Graw Hill, 2011.*
2	*N.Weste and K.Eshranghian, **"Principles of CMOS VLSI Design"**, AddisonWesley,1998.*
3	*Neil H. E. Weste, David Harris, Ayan Banerjee, **"CMOS VLSI Design: A Circuits and Systems Perspective"**, Pearson Education 2013.*
4	*Kiat-Seng Yeo,Kaushik Roy,**"Low-Voltage, Low-Power VLSI Subsystems",** McGraw-Hill Professional, 2004.*
5	*Gary K.Yeap, **"Practical Low Power Digital VLSI Design"**, Kluwer Academic Press, 2002.*
6	*Jan M .Rabaey,**"Digital Integrated Circuits: A Design Perspective"**, Pearson Education, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the MOS circuits and Transmission gates	K2
CO2	Illustrate the CMOS Circuits with its characterization	K2
CO3	Design CMOS logic circuits	K3
CO4	Design CMOS sub-system	K3
CO5	Discuss low power CMOS VLSI Design	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	-	2	-	3
CO2	2	1	-	2	-	3
CO3	2	1	-	2	-	3
CO4	3	1	-	2	-	3
CO5	3	1	-	2	-	3
23VLOE29	**3**	**1**	**-**	**2**	**-**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	40%	20%	-	-	-	100%
CAT2	40%	40%	20%	-	-	-	100%
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project1	-	50%	50%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2	-	50%	50%	-	-	-	100%
ESE	40%	40%	20%	-	-	-	100%

23VLOE30	HIGH LEVEL SYNTHESIS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	**3**	**0**	**0**	**3**
Course Objective	To provide students with foundations in High level synthesis, verification and CAD Tools					
UNIT – I	**HIGH-LEVEL SYNTHESIS (HLS) FUNDAMENTALS**					**9 Periods**
Overview HLS flow, Scheduling Techniques, Resource sharing and Binding Techniques, Data-path and Controller Generation Techniques.						
UNIT – II	**HIGH LEVEL SYNTHESIS**					**9 Periods**
Introduction to HDL, HDL to DFG, operation scheduling: constrained and unconstrained scheduling, ASAP, ALAP, List scheduling, Force directed Scheduling, operator binding, Static Timing Analysis: Delay models, setup time, hold time, cycle time, critical paths, Topological mvs. Logical timing analysis, False paths, Arrival time (AT), Required arrival Time (RAT), Slacks.						
UNIT – III	**HIGH-LEVEL SYNTHESIS VERIFICATION**					**9 Periods**
Simulation based verification - Formal Verification of digital systems- BDD based approaches, functional equivalence, finite state automata, ω-automata, FSM verification.						
UNIT – IV	**CAD TOOLS FOR SYNTHESIS**					**9 Periods**
CAD tools for synthesis, optimization, simulation and verification of design at various levels as well as for special realizations and structures such as microprogrammes, PLAs, gate arrays etc. Technology mapping for FPGAs. Low power issues in high level synthesis and logic synthesis.						
UNIT – V	**ADVANCED TOPICS**					**9 Periods**
Relative Scheduling, IO scheduling modes - cycle fixed scheduling modes, super-fixed scheduling modes, free-floating scheduling mode, Pipelining, Handshaking, System Design, High-Level Synthesis for FPGA.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*Philippe Coussy and Adam Morawiec, "**High-level Synthesis from Algorithm to Digital Circuit**", Springer, 2008.*
2	*Sherwani, N., "**Algorithms for VLSI Physical Design Automation**", Springer, 3rd ed., 2005.*
3	*D. Micheli,"**Synthesis and optimization of digital systems**", Mc Graw Hill, 2005.*
4	*Dutt, N. D. and Gajski, D. D., "**High level synthesis**", Kluwer, 2000.*
5	*Gerez S.H., "**Algorithms for VLSI Design Automation**", John Wiley (1998)*
6	*David. C. Ku and G. De Micheli, "**High-level Syntheses of ASICs Under Timing and Synchronization Constraints**", Kluwer Academic Publishers, 1992.*
7	*K. Parhi, "**VLSI Digital Signal Processing Systems: Design and Implementation**", Jan 1999, Wiley.*
8	*Egon Boerger and Robert Staerk "**Abstract State Machines: A Method for High-Level System Design and Analysis**", Springer,2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the fundamentals of High level synthesis	K2
CO2	Synthesis the HDL for operation scheduling	K2
CO3	Simulate and verify any digital systems	K2
CO4	Apply CAD tools for synthesis	K2
CO5	Have knowledge on various scheduling modes	K2

COURSE ARTICULATION MATRIX:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	-	2	2	-
CO2	2	2	-	2	2	-
CO3	2	2	-	2	2	-
CO4	2	2	-	2	2	-
CO5	2	2	-	2	2	-
23VLOE30	**2**	**2**	**-**	**2**	**2**	**-**

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50%	50%		-	-	-	100%
CAT2	50%	50%		-	-	-	100%
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1	-	50%	50%	-	-	-	100%
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	50%	50%	-	-	-	100%
ESE	50%	50%		-	-	-	100%

23CSOE31	ARTIFICIAL INTELLIGENCE (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	Identify and apply AI techniques in the design of systems that act intelligently, making automatic decisions and learn from experience.	
UNIT – I	**SEARCH STRATEGIES**	**9 Periods**
Uninformed Strategies – BFS, DFS, Djisktra, Informed Strategies – A* search, Heuristic functions, Hill Climbing, Adversarial Search – Min-max algorithm, Alpha-beta Pruning		
UNIT – II	**PLANNING AND REASONING**	**9 Periods**
State Space search, Planning Graphs, Partial order planning, Uncertain Reasoning – Probabilistic Reasoning, Bayesian Networks, Dempster Shafer Theory, Fuzzy logic		
UNIT – III	**PROBABILISTIC REASONING**	**9 Periods**
Probabilistic Reasoning over Time - Hidden Markov Models, Kalman Filters, Dynamic Bayesian Networks. Knowledge Representations – Ontological Engineering, Semantic Networks and description logics.		
UNIT – IV	**DECISION MAKING**	**9 Periods**
Utility Theory, Utility Functions, Decision Networks – Sequential Decision Problems – Partially Observable MDPs – Game Theory.		
UNIT – V	**REINFORCEMENT LEARNING**	**9 Periods**
Reinforcement Learning - Passive and active reinforcement learning - Generations in Reinforcement Learning - Policy Search – Deep Reinforcement Learning.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Deepak Khemani,* ***"A First Course in Artificial Intelligence",*** *Tata Mc Graw Hill Education 2013*
2	*Yang Q,* ***" Intelligent Planning: A decomposition and Abstraction based Approach",*** *Springer, 2006*
3	*Russell and Norvig,* ***"Artificial Intelligence, A Modern Approach****", 3rd edition, Pearson Prentice Hall,2010.*
4	*Elaine Rich,Kevin Knight,Shivashankar B. Nair,* ***"Artificial Intelligence",*** *3rd edition, TataMcGraw Hill, 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Use search techniques to solve AI problems	K2
CO2	Reason facts by constructing plans and understand uncertainty efficiently.	K3
CO3	Examine data using statistical codes and solve complex AI problems	K6
CO4	Apply techniques to make apt decisions.	K4
CO5	Use deep reinforcement learning to solve complex AI problems	K6

COURSE ARTICULATION MATRIX

COs/ POs	PO 1	PO2	PO 3	PO 4	PO5	PO6
CO1	3		2		3	3
CO2	3		2		3	3
CO3	3		3		3	3
CO4	3		3		3	3
CO5	3		3		3	3
23CSOE31	3		3		3	3

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		20	40	20	20		100
CAT2		10	20	40	10	20	100
Individual Assessment 1/ Case study 1/ Seminar 1/ Project 1					50	50	100
Individual Assessment 2/ Case study 2/ Seminar 2/ Project 2					50	50	100
ESE	30	30	40				100

23CSOE32	COMPUTER NETWORK MANAGEMENT (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	After the completion of the course, the students will be able to understand the concept of layering in networks, functions of protocols of each layer of TCP/IP protocol suite, concepts related to network addressing and routing and build simple LANs, perform basic configurations for routers and switches, and implement IPv4 and IPv6 addressing schemes using Cisco Packet Tracer.					
UNIT – I	**INTRODUCTION AND APPLICATION LAYER**					**9 Periods**
Building network – Network Edge and Core – Layered Architecture – OSI Model – Internet Architecture (TCP/IP) Networking Devices: Hubs, Bridges, Switches, Routers, and Gateways – Performance Metrics - Ethernet Networking – Introduction to Sockets – Application Layer protocols – HTTP – FTP Email Protocols – DNS.						
UNIT – II	**TRANSPORT LAYER AND ROUTING**					**9 Periods**
Transport Layer functions –User Datagram Protocol – Transmission Control Protocol – Flow Control – Retransmission Strategies – Congestion Control - Routing Principles – Distance Vector Routing – Link State Routing – RIP – OSPF – BGP – Introduction to Quality of Service (QoS).Case Study: Configuring RIP, OSPF BGP using Packet tracer						
UNIT – III	**NETWORK LAYER**					**9 Periods**
Network Layer: Switching concepts – Internet Protocol – IPV4 Packet Format – IP Addressing – Subnetting – Classless Inter Domain Routing (CIDR) – Variable Length Subnet Mask (VLSM) – DHCP – ARP – Network Address Translation (NAT) – ICMP – Concept of SDN.Case Study: Configuring VLAN, DHCP, NAT using Packet tracer						
UNIT – IV	**INTERNETWORK MANAGEMENT**					**9 Periods**
Introduction to the Cisco IOS - Router User Interface – CLI - Router and Switch Administrative Functions - Router Interfaces - Viewing, Saving, and Erasing Configurations - Switching Services - Configuring Switches - Managing Configuration Registers - Backing Up and Restoring IOS - Backing Up and Restoring the Configuration - Using Discovery Protocol (CDP) - Checking Network Connectivity						
UNIT – V	**TRAFFIC MANAGEMENT AND WAN PROTOCOLS**					**9 Periods**
Managing Traffic with Access Lists: Introduction to Access Lists - Standard Access Lists - Extended Access Lists - Named Access Lists - Monitoring Access Lists - Wide Area Networking Protocols: Introduction to Wide Area Networks - Cabling the Wide Area Network - High-Level Data-Link Control (HDLC) Protocol - Point-to-Point Protocol (PPP) - Frame Relay: Frame Relay Implementation and Monitoring - Integrated Services Digital Network (ISDN) - Dial-on-Demand Routing (DDR): Configuring DDR						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*James F. Kurose, Keith W. Ross,* ***"Computer Networking: A Top-Down Approach",*** *Seventh Edition, Pearson Education, 2017.*
2	*William Stallings,* ***"Data and Computer Communications",*** *Tenth Edition, Pearson Education, 2014*
3	*Larry L. Peterson, Bruce S. Davie,* ***"Computer Networks: A Systems Approach",*** *Fifth Edition, Morgan Kaufmann Publishers Inc., 2011.*
4	*Todd Lammle,* ***"CCNA™: Cisco® Certified Network Associate Study Guide",*** *5th Edition, Sybex, 2003*
5	*Ying-Dar Lin, Ren-Hung Hwang, Fred Baker,* ***"Computer Networks: An Open Source Approach",*** *McGraw Hill, 2012.*
6	*Ron Gilster, Jeff Bienvenu, and Kevin Ulstad,* ***"CCNA for Dummies",*** *IDG Books Worldwide, 2000*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Highlight the significance of the functions of each layer in the network.	K1
CO2	Identify the devices and protocols to design a network and implement it.	K4
CO3	Apply addressing principles such as subnetting and VLSM for efficient routing.	K3
CO4	Build simple LANs, perform basic configurations for routers and switches	K6
CO5	Illustrate various WAN protocols	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3		3		2	1
CO2	3		3		2	2
CO3	3		3		3	2
CO4	3		3		3	3
CO5	3		3		3	3
23CSOE32	3		3		3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20			100
CAT2		30	20	30	10	10	100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project 1	10	30	20	20	20		100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2		20	20	20	20	20	100
ESE	20	40	40				100

23CSOE33	BLOCKCHAIN TECHNOLOGIES (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	The objective of the course is to explore basics of block chain technology and its application in various domaiin	
UNIT – I	**INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN**	**9 Periods**
History of Blockchain - Types of blockchain- CAP theorem and blockchain – benefits and Limitations of Blockchain – Decentalization using blockchain – Blockchain implementations- Block chain in practical use - Legal and Governance Use Cases		
UNIT – II	**BITCOIN AND CRYPTOCURRENCY**	**9 Periods**
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	**ETHEREUM**	**9 Periods**
Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts		
UNIT – IV	**HYPERLEDGER AND SOLIDITY PROGRAMMING**	**9 Periods**
Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity – Programming with solidity		
UNIT – V	**BLOCKCHAIN APPLICATIONS**	**9 Periods**
Ten Steps to build your Blockchain application – Application: Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

REFERENCES:

1	*Imran Bashir,* ***"Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained"****, Second Edition, Packt Publishing, 2018.*
2	*Joseph J. Bambara Paul R. Allen,* ***"Blockchain A Practical Guide to Developing Business, Law, and Technology Solutions"****,McGraw Hill Education ,2018.*
3	*Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder,* ***"Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction"*** *Princeton University Press, 2016.*
4	*Manav Gupta* ***"Blockchain for Dummies",*** *IBM Limited Edition 2017.*
5	*Antonopoulos and G. Wood,* ***"Mastering Ethereum: Building Smart Contracts and Dapps",*** *O'Reilly Publishing, 2018*
6	***NPTEL Course : Blockchain and its applications*** *https://archive.nptel.ac.in/courses/106/105/106105235/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Comprehend the working of Blockchain technology	K2
CO2	Narrate working principle of smart contracts and create them using solidity for given scenario.	K3
CO3	Comprehend the working of Hyperledger in an real time application	K2
CO4	Apply the learning of solidity to build de-centralized apps on Ethereum	K3
CO5	Develop applications on Blockchain	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		3	2		3
CO2	2	3	3	3	2	3
CO3	3		3	2		3
CO4	3	3	3	3	2	3
CO5	3	3	3	3	2	3
23CSOE33	**3**	**3**	**3**	**3**	**2**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	30	50				100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project1		30	70				100
Individual Assessment 2/ Case Study 2/ Seminar 2 / Project 2		40	60				100
ESE	10	60	30				100

23SEACZ1	ENGLISH FOR RESEARCH PAPER WRITING (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**AC**	**2**	**0**	**0**	**0**
Course Objectives	The objective of the course is to make the learners understand the format and intricacies involved in writing a research paper.					
UNIT – I	**PLANNING AND PREPARATION**					**6 Periods**
Need for publishing articles, Choosing the journal, Identifying a model journal paper, Creation of files for each section, Expectations of Referees, Online Resources.						
UNIT – II	**SENTENCES AND PARAGRAPHS**					**6 Periods**
Basic word in English, Word order in English and Vernacular, placing nouns, Verbs, Adjectives, and Adverb suitably in a sentence, Using Short Sentences, Discourse Markers and Punctuations- Structure of a Paragraph, Breaking up lengthy Paragraphs.						
UNIT – III	**ACCURACY, BREVITY AND CLARITY (ABC) OF WRITING**					**6 Periods**
Accuracy, Brevity and Clarity in Writing, Reducing the linking words, Avoiding redundancy, Appropriate use of Relative and Reflexive Pronouns, Monologophobia, verifying the journal style, Logical Connections between others author's findings and yours.						
UNIT – IV	**HIGHLIGHTING FINDINGS, HEDGING AND PARAPHRASING**					**6 Periods**
Making your findings stand out, Using bullet points headings, Tables and Graphs- Availing non-experts opinions, Hedging, Toning Down Verbs, Adjectives, Not over hedging, Limitations of your research.						
UNIT – V	**SECTIONS OF A PAPER**					**6 Periods**
Titles, Abstracts, Introduction, Review of Literature, Methods, Results, Discussion, Conclusions, References.						
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**						

REFERENCES :

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

COURSE OUTCOMES : Upon completion of this course the learners will be able to		**Bloom's Taxonomy Mapped**
CO1	**U**nderstand the need for writing good research paper.	K2
CO2	Practice the appropriate word order, sentence structure and paragraph writing.	K4
CO3	Practice unambiguous writing.	K3
CO4	Avoid wordiness in writing.	K2
CO5	Exercise the elements involved in writing journal paper.	K3

COURSE ARTICULATION MATRIX :						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	1	1	1	1
CO2	3	3	1	1	1	1
CO3	3	3	1	1	1	1
CO4	3	3	1	1	1	1
CO5	3	3	1	1	1	1
23SEACZ1	3	3	1	1	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project 1	-	50	50	-	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	50	50	-	-	-	100
ESE	30	30	40	-	-	-	100

23SEACZ2	DISASTER MANAGEMENT (Common to all Branches)	
Course Objectives	• To become familiar in key concepts and consequences about hazards, disaster and area of occurrence. • To know the various steps in disaster planning. • To create awareness on disaster preparedness and management.	
UNIT – I	**INTRODUCTION**	**6 Periods**
Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Areas proneto ,EarthquakesFloods ,Droughts, Landslides , Avalanches ,Cyclone and Coastal Hazards with Special Reference to Tsunami.		
UNIT – II	**REPERCUSSIONS OF DISASTERS AND HAZARDS**	**6 Periods**
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 PLANNING**	**6 Periods**
Disaster Planning-Disaster Response Personnel roles and duties, Community MitigationGoals, Pre-Disaster Mitigation Plan, Personnel Training, Comprehensive Emergency Management, Early Warning Systems.		
UNIT – IV	**DISASTER PREPAREDNESS AND MANAGEMENT**	**6 Periods**
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 Periods**
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.		
Contact Periods: **Lecture:30 Periods Tutorial: 0 Periods Practical: 0Periods Total: 30 Periods**		

REFERENCES:

1	*R. Nishith, Singh AK,* ***"Disaster Management In India: Perspectives, Issues And Strategies"****, New Royal Company, 2007.*
2	*Sahni, PardeepEt.Al. (Eds.),* ***"Disaster Mitigation Experiences And Reflections"****, Prentice Hall Of India, New Delhi, 2010*
3	*Goel S. L,* ***"Disaster Administration And Management Text And Case Studies"****, Deep &Deep Publication Pvt. Ltd., New Delhi, 2008.*
4	*Jagbir Singh,* ***"Disaster Management: Future Challenges And Opportunities"****, I.K. International Publishing House Pvt. Ltd., New Delhi, 2007.*
5	*Damon Coppola* ***"Introduction To International Disaster Management"****, Butterworth-Heinemann, 2015*
6	*Ryan Lanclos* ***"Dealing With Disasters: Gis For Emergency Management"****, ESRI Press 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Differentiate hazard and disaster with their significance.	K4
CO2	Analyse the causes and impact of natural and manmade disaster.	K4
CO3	Execute the steps involved in disaster planning.	K4
CO4	Predict vulnerability of disaster and to prevent, mitigate their impact.	K4

CO5	Prepare risk assessment strategy for national and global disaster.	K4

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	2	2
CO2	1	2	1	1	1
CO3	1	1	1	2	2
CO4	1	1	1	2	2
CO5	2	1	1	2	2
23SEACZ2	1	1	1	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	50					100
CAT2			100				100
Individual Assessment 1/ Case Study 1/ Seminar 1/ Project 1	50	50					100
Individual Assessment 2 / Case Study 2/ Seminar 2/ Project 2			100				100
ESE	25	25	50				100

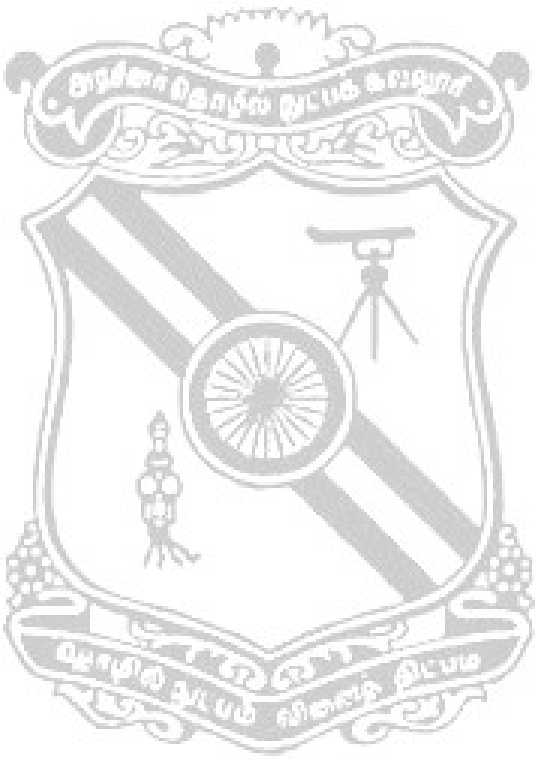
23SEACZ3	VALUE EDUCATION (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**AC**	**2**	**0**	**0**	**0**

Course Objectives	• Value of education and self- development • Requirements of good values in students • Importance of character	
UNIT – I	**ETHICS AND SELF-DEVELOPMENT**	**6 Periods**
Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements.		
UNIT – II	**PERSONALITY AND BEHAVIOR DEVELOPMENT**	**6 Periods**
Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance.		
UNIT – III	**VALUES IN HUMAN LIFE**	**6 Periods**
Importance of cultivation of values, Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline.		
UNIT – IV	**VALUES IN SOCIETY**	**6 Periods**
True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association andCooperation. Doing best for saving nature.		
UNIT – V	**POSITIVE VALUES**	**6 Periods**
Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.		
Contact Periods: **Lecture: 30 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 30 Periods**		

REFERENCES :

1	*Chakroborty, S.K.* ***"Values and Ethics for organizations Theory and practice"****, Oxford University Press, New Delhi,1998*
2	*Dr. Yogesh Kumar Singh,* ***"Value Education"****, A.P.H Publishing Corporation, New Delhi,2010*
3	*R.P Shukla,* ***"Value Education and Human Rights"****, Sarup and Sons, NewDelhi,2004*
4	*https://nptel.ac.in/courses/109104068/36*

COURSE OUTCOMES : Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know the values and work ethics.	K3
CO2	Enhance personality and 167ehavior development.	K3
CO3	Apply the values in human life.	K3
CO4	Gain Knowledge of values in society.	K3
CO5	Learn the importance of positive values in human life.	K3



COURSE ARTICULATION MATRIX						
Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	3	-	-	1
CO2	-	-	3	-	-	1
CO3	-	-	3	-	-	1
CO4	-	-	3	-	-	1
CO5	-	-	3	-	-	1
23SEACZ3	-	-	3	-	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%

23SEACZ4	CONSTITUTION OF INDIA (Common to all Branches)		SEMESTER			
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**AC**	**2**	**0**	**0**	**0**

Course Objectives	• To address the importance of constitutional rights and duties • To familiarize about Indian governance and local administration. • To know about the functions of election commission.

UNIT – I	**INDIAN CONSTITUTION**	**6 Periods**
History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working) - Philosophy of the Indian Constitution: Preamble Salient Features.		
UNIT – II	**CONSTITUTIONAL RIGHTS & DUTIES**	**6 Periods**
Contours of Constitutional Rights & 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 – III	**ORGANS OF GOVERNANCE**	**6 Periods**
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 – IV	**LOCAL ADMINISTRATION**	**6 Periods**
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of 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 – V	**ELECTION COMMISSION**	**6 Periods**
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.		

Contact Periods:
Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods

REFERENCES:

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

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Discuss the growth of the demand for civil rights in India.	K2
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.	K2
CO3	Understand the various organs of Indian governance.	K2
CO4	Familiarize with the various levels of local administration.	K2
CO5	Gain knowledge on election commission of india.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	1	1	1
CO2	-	-	1	1	1	2
CO3	-	-	1	1	2	1
CO4	-	-	1	1	1	1
CO5	-	-	1	1	1	1
23SEACZ4	**-**	**-**	**1**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%

23SEACZ5	PEDAGOGY STUDIES (Common to all Branches)	SEMESTER

PREREQUISITES	CATEGORY	L	T	P	C
NIL	AC	2	0	0	0

Course Objectives	• To understand of various theories of learning, prevailing pedagogical practices and design of curriculum in engineering studies. • Application of knowledge in modification of curriculum, its assessment and introduction of innovation in teaching methodology.

UNIT – I	INTRODUCTION	6 Periods

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

UNIT – II	PEDAGOGICAL PRACTICES	6 Periods

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education. Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies.

UNIT – III	PEDAGOGICAL APPROACHES	6 Periods

How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teacher's attitudes and beliefs and Pedagogic strategies.

UNIT – IV	PROFESSIONAL DEVELOPMENT	6 Periods

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

UNIT – V	CURRICULUM AND ASSESSMENT	6 Periods

Research gaps and future directions Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.

Contact Periods:
Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods

REFERENCES:

1	*Ackers J, Hardman F ,* ***Classroom interaction in Kenyan primary schools, Compare****, 31 (2): 245-261, 2001.*
2	*Alexander RJ ,* ***Culture and pedagogy: International comparisons in primary education****. Oxford and Boston: Blackwell, 2001*
3	*Akyeampong K, Lussier K, Pryor J, Westbrook J,* ***Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count?*** *International Journal Educational Development, 33 (3): 272–282, 2013.*
4	*Agrawal M ,****Curricular reform in schools: The importance of evaluation****, Journal of Curriculum Studies, 36 (3): 361-379, 2004*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the concept of curriculum, formal and informal education systems and teacher education.	K3
CO2	Explain the present pedagogical practices and the changes occurring in pedagogical approaches	K3
CO3	Understand the relation between teacher and community, support from various levels of teachers to students and limitation in resources and size of the class.	K3
CO4	Perform research in design a problem in pedagogy and curriculum development.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	1	2	1
CO2	-	-	1	1	1	2
CO3	-	-	1	1	2	1
CO4	-	-	1	1	2	1
23SEACZ5	**-**	**-**	**1**	**1**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%

23SEACZ6	STRESS MANAGEMENT BY YOGA (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		AC	2	0	0	0

Course Objectives	• To create awareness on the benefits of yoga and meditation. • To understand the significance of Asana and Pranayama.	
UNIT – I	**PHYSICAL STRUCTURE AND ITS FUNCTIONS**	**6 Periods**
Yoga - Physical structure, Importance of physical exercise, Rules and regulation of simplified physical exercises, hand exercise, leg exercise, breathing exercise, eye exercise, kapalapathy, maharasana, body massage, acupressure, body relaxation.		
UNIT – II	**YOGA TERMINOLOGIES**	**6 Periods**
Yamas - Ahimsa, satya, astheya, bramhacharya, aparigraha Niyamas- Saucha, santosha, tapas, svadhyaya, Ishvara pranidhana.		
UNIT – III	**ASANA**	**6 Periods**
Asana - Rules & Regulations – Types & Benefits		
UNIT – IV	**PRANAYAMA**	**6 Periods**
Regularization of breathing techniques and its effects-Types of pranayama		
UNIT – V	**MIND**	**6 Periods**
Bio magnetism& mind - imprinting & magnifying – eight essential factors of living beings, Mental frequency and ten stages of mind, benefits of meditation, such as perspicacity, magnanimity, receptivity, adaptability, creativity.		

Contact Periods:
Lecture: 30 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 30 Periods**

REFERENCES :

1	*Janardan Swami Yogabhyasi Mandal , **"Yogic Asanas for Group Training-Part-I"**, Nagpur.*
2	*Swami Vivekananda, **"Rajayoga or conquering the Internal Nature"**, Advaita Ashrama (Publication Department), Kolkata.*
3	*Pandit Shambu Nath, **"Speaking of Stress Management Through Yoga and Meditation"**, New Dawn Press, New Delhi, 2016.*
4	*K. N. Udupa, **"Stress and its management by Yoga"**, Motilal Banarsidass Publishers, New Delhi, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Practice physical exercises and maintain good health.	K3
CO2	Attain knowledge on the various concepts of Yoga.	K2
CO3	Perform various asanas with an understanding on their benefits.	K3
CO4	Practice breathing techniques in a precise manner.	K3
CO5	Attain emotional stability and higher level of consciousness.	K2

COURSE ARTICULATION MATRIX					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	-	-	-	-	2
CO2	-	-	-	-	3
CO3	-	-	-	-	2
CO4	-	-	-	-	1
CO5	-	-	-	-	1
23SEACZ6	-	-	-	-	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	30%	30%	-	-	-	100%
CAT2	30%	40%	30%	-	-	-	100%
Individual Assessment1/ Case study1/ Seminar 1/ Project1	40%	40%	20%	-	-	-	100%
Individual Assessment2/ Case study2/ Seminar 2 / Project2	30%	30%	40%	-	-	-	100%
ESE	30%	30%	40%	-	-	-	100%

23SEACZ7	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (Common to all Branches)					
PREREQUISITES :		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		AC	**2**	**0**	**0**	**0**
Course Objectives	• To familiar with Techniques to achieve the highest goal in life. • To become a person with stable mind, pleasing personality and determination.					
UNIT – I						**6 Periods**
Neetisatakam-Holistic development of personality-Verses- 19,20,21,22 (wisdom)-Verses29,31,32 (pride & heroism)-Verses- 26,28,6.						
UNIT – II						**6 Periods**
Verses- 52,53,59 (dont's)-Verses- 71,73,75,78 (do's). - Approach to day to day work and duties.- Shrimad BhagwadGeeta - Chapter 2-Verses 41, 47,48,						
UNIT – III						**6 Periods**
Shrimad BhagwadGeeta -Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,- Chapter 18-Verses 45, 46, 48.						
UNIT – IV						**6 Periods**
Statements of basic knowledge.-Shrimad BhagwadGeeta: -Chapter2-Verses 56, 62, 68 -Chapter 12 -Verses 13, 14, 15, 16,17, 18-Personality of Role model.						
UNIT – V						**6 Periods**
Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39-Chapter18 – Verses 37,38,63.						
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**						

REFERENCES :

1	*Swami SwarupanandaAdvaita Ashram "**Srimad Bhagavad Gita**", AdvaitaAshrama, Kolkata,2016*
2	*P.Gopinath, Rashtriya Sanskrit Sansthanam "**Bhartrihari's Three Satakam**" (Niti-sringar-vairagya), New Delhi, 1986.*
3	*Swami Mukundananda, JagadguruKripalujiYog "**Bhagavad Gita: The Song Of God**", USA,2019*
4	*A.C. Bhaktivedanta Swami Prabhupada "**Bhagavad-Gita As It Is**",Bhaktivedanta Book Trust Publications,2001*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the Holistic development in life	K4
CO2	Effective Planning of day to day work and duties	K4
CO3	Identify mankind to peace and prosperity	K4
CO4	Develop versatile personality.	K4
CO5	Awakening wisdom in life	K4

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	-	-	-
CO2	-	-	1	-	-	-
CO3	-	-	1	-	-	-
CO4	-	-	1	-	-	-
CO5	-	-	1	-	-	-
23SEACZ7	**-**	**-**	**1**	**-**	**-**	**-**

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%

23SEACZ8	SANSKRIT FOR TECHNICAL KNOWLEDGE (Common to all Branches)				SEMESTER
PREREQUISITES:	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**AC**	**2**	**0**	**0**	**0**

Course Objectives	• To get a working knowledge in illustrious Sanskrit, the scientific language in the world. • Learning of Sanskrit to improve brain functioning. • Enhancing the memory power. • Learning of Sanskrit to develop the logic in mathematics, science & other subjects.

UNIT – I	**BASICS OF SANSKRIT**	**6 Periods**
Alphabets in Sanskrit, Past/Present/Future Tense.		
UNIT – II	**SENTENCES AND ROOTS**	**6 Periods**
Simple Sentences - Order, Introduction of roots		
UNIT – III	**SANSKRIT LITERATURE**	**6 Periods**
Technical information about Sanskrit Literature		
UNIT – IV	**TECHNICAL CONCEPTS -1**	**6 Periods**
Technical concepts of Engineering-Electrical, Mechanical		
UNIT – V	**TECHNICAL CONCEPTS -2**	**6 Periods**
Technical concepts of Engineering-Architecture, Mathematics		

Contact Periods:
Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods

REFERENCES:

1	*Dr.Vishwas, "**Abhyaspustakam",** Samskrita -Bharti Publication, New Delhi, 2020.*
2	*Prathama Deeksha Vempati Kutumbshastri, "**Teach Yourself Sanskrit**", Rashtriya Sanskrit Sansthanam, New Delhi, Publication, 2009.*
3	*Suresh Soni, **"India's Glorious Scientific Tradition**" , Ocean books (P) Ltd., New Delhi,2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recognize ancient literature and their basics	K3
CO2	Formulate the sentences with order and understand the roots of Sanskrit	K2
CO3	Acquire familiarity of the major traditions of literatures written in Sanskrit	K3
CO4	Distinguish the Technical concepts of Electrical & Mechanical Engineering	K2
CO5	Categorize the Technical concepts of Architecture & Mathematics	K2

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	1	2	1
CO2	-	-	-	1	2	-
CO3	-	-	-	1	1	1
CO4	-	-	-	2	1	1
CO5	-	-	-	1	2	1
23SEACZ8	**-**	**-**	**-**	**1**	**2**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20%	50%	30%	-	-	-	100%
CAT2	20%	50%	30%	-	-	-	100%
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	20%	50%	30%	-	-	-	100%
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	20%	50%	30%	-	-	-	100%
ESE	20%	50%	30%	-	-	-	100%