NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

(Deemed to be University Under Section 3 of the UGC Act, 1956)
Kumaracoil, Thuckalay

DEPARTMENT OF CIVIL ENGINEERING

M.E. STRUCTURAL ENGINEERING

CURRICULUM AND SYLLABI

REGULATION 2023

NOORUL ISLAM CENTRE FOR HIGHER EDUCATION, Kumaracoil

Regulation:2023

Curriculum and Syllabi

M.E Programme

DEPARTMENT OF CIVIL ENGINEERING

M.E. STRUCTURAL ENGINEERING

Vision of the University

To be recognized by the Government and society at large as an institution able to deliver excellence with relevance in the field of higher education and research focusing on the needs of the nation in tune with the technological revolution to cope with the knowledge explosion and global competence.

Mission of the University

To develop the institution as a Centre of Excellence, keeping pace with the advances in the field, so as to provide quality higher education to the students and instill in them high standards of discipline and ethics so that they become enlightened individuals in the service of humanity and to carry out focused research in the frontier areas of science and technology.

Faculty of Civil Engineering

Department of Civil Engineering

Vision Statement:

To advance the structural engineering profession through research, teaching and service by integrating engineering mechanics theories, computational modeling simulations, experimental testing observations, and practical design concepts.

Mission Statement:

- Provide a comprehensive education and training to engineers using a holistic approach to structural systems engineering by emphasizing and building on the commonality of engineering structures at the levels of materials, mechanics, analysis and design. Take

advantage of a strong technical education at the undergraduate level to embark on successful professional careers in industry or to continue with a graduate education in their area of specialization.

- Consistently and successfully apply fundamental Structural Engineering principles within their chosen engineering application area within the department (i.e., Aerospace Structures, Civil Structures, Geotechnical, Computational Mechanics, Structural Health-Monitoring/Non-destructive Evaluation).
- Apply broad multi-disciplinary skills necessary to accomplish professional objectives in a rapidly changing technological world.
- Understand the ethical issues pertaining to engineering, adopt industry standards of ethical behavior, and apply appropriate communication and collaboration skills essential for professional practice.

Programme Educational Objectives - PEO	
PEO-01	Apply advanced mathematics and scientific principles to structural engineering problems
PEO-02	Practice their profession with good communication, leadership, ethics and social responsibility and formulate solutions that are technically sound, economically feasible, and socially acceptable.
PEO-03	Design and analyze complex structures using computational methods
PEO-04	Gain knowledge and skills in structural engineering which will enable them to have a career and professional accomplishment in the public or private sector organizations
PEO-05	Graduates will function in multi-disciplinary teams and adapt to evolving technologies through life-long learning and innovation

Graduate Attributes-GA	
GA-1	**Advanced Engineering Expertise** Master advanced engineering principles and apply them to design, analyze, and innovate systems that address both present and emerging global challenges across diverse industries.
GA-2	**Leadership in Research and Innovation** Lead groundbreaking research and foster innovation by identifying opportunities for technological advancements, contributing original ideas that push the boundaries of engineering knowledge.
GA-3	**Sustainable Engineering Practices** Develop and implement engineering solutions that integrate sustainability, environmental stewardship, and resource efficiency, ensuring the long-term impact and responsibility of all projects.
GA-4	**Ethical and Strategic Decision-Making** Make informed, ethical decisions in complex engineering contexts, considering societal needs, environmental implications, and the long-term consequences of engineering practices.
GA-5	**Global Competence in Engineering Solutions** Exhibit a deep understanding of global engineering standards and practices, addressing international challenges and cultural sensitivities in engineering projects to make a broader societal impact.
GA-6	**Technological Agility and Lifelong Learning** Stay ahead of technological trends and exhibit agility in learning new tools, methodologies, and technologies, ensuring continuous professional growth in a rapidly evolving engineering landscape.
GA-7	**Interdisciplinary and Collaborative Innovation** Excel in multidisciplinary collaborations, leveraging knowledge from multiple fields to solve complex, large-scale engineering problems that require comprehensive and innovative solutions.
GA-8	**Data-Driven Decision-Making** Employ advanced data analytics, machine learning, and computational tools to derive insights and make informed engineering decisions that improve performance, efficiency,
GA-9	**Entrepreneurial Mindset and Innovation Leadership** Cultivate an entrepreneurial mindset, translating engineering innovations into viable products, solutions, or services, and leading teams toward commercialization and societal impact.
GA-10	**Safety, Risk, and Crisis Management** Implement and manage advanced safety protocols and risk mitigation strategies to protect individuals, communities, and ecosystems in engineering practices, particularly in high-stakes and crisis environments.

Programme Outcome – Pos	
PO-A	Graduates of the program will be able to demonstrate in-depth knowledge of Structural Engineering discipline and build capability to apply that knowledge to real problems.
PO-B	Program graduates will gain knowledge and skill in integrating Structural engineering concepts across multiple disciplines.
PO-C	Graduates will have the ability to employ technical knowledge and leadership skills to Structural Engineering research and consultancy problems.
P0-D	Graduates of the Structural Engineering program will demonstrate the abilityto carry out original and useful research in key areas of Structural Engineering.
PO-E	Program graduates will be able to identify and analyze the impact of Structural Engineering in development project and find a suitable solution from number of alternatives
PO-F	Graduates of the program will develop skills to communicate technical valuesof Structural Engineering research with the public, learners, practitioners and other community members of concern.
PO-G	Program graduates will develop confidence in Structural analysis and management with high ethical value towards social, environmental and economic issues.
PO-H	Graduates will develop enthusiasm and confidence to pursue lifelong learningfor professional advancement.
PO-I	Program graduates will develop the spirit of working in team for common objectives.
PO-J	Graduates of the program will develop interest to pursue higher studies and research

Mapping of Graduate Attributes and Programme Educational Objectives (PEO)

GAs / PEOs	**GA-01**	**GA-02**	**GA-03**	**GA-04**	**GA-05**	**GA-06**	**GA-07**	**GA-08**	**GA-09**	**GA-10**	**GA-11**	**GA-12**
PEO-01	H	A	H	H	A	H	A	A	A	N	H	H
PEO-02	H	H	H	A	A	A	A	A	A	H	A	A

PEO-03	H	A	A	A	H	H	H	H	H	A	H	H
PE0-04	H	H	H	A	A	A	A	A	A	A	H	A
PEO-05	N	H	H	H	H	A	A	A	A	A	H	H

H- Highly Associated A- Associated Not – Not Associated

Mapping of Graduate Attributes and Programme Outcomes (PO)

GAs / PEOs	**GA-01**	**GA-02**	**GA-03**	**GA-04**	**GA-05**	**GA-06**	**GA-07**	**GA-08**	**GA-09**	**GA-10**	**GA-11**	**GA-12**
PO-A	H	A	A	A	A	H	H	H	H	H	H	H
PO-B	H	H	H	H	A	A	A	A	A	A	A	H
PO-C	H	H	H	H	H	H	A	A	A	H	A	H
P0-D	H	H	A	H	A	A	H	H	H	H	A	A
PO-E	H	A	H	H	H	H	A	A	A	A	A	A
PO-F	A	A	A	A	A	A	H	H	H	H	H	A
PO-G	A	H	H	H	H	H	H	H	H	A	A	A
PO-H	H	H	A	A	A	H	H	H	A	A	A	A
PO-I	N	H	N	H	H	A	A	A	A	N	H	A
PO-J	A	A	A	H	A	H	H	A	A	H	H	H

H- Highly Associated A- Associated Not – Not Associated

Mapping of Programme Educational Objective (PEOs) and Programme Outcomes (POs)

PEO / PO	PEO-01	PEO-02	PEO-03	PEO-04	PEO-05
PO-A	A	H	H	A	A
PO-B	H	H	A	A	H
PO-C	H	H	H	A	A
P0-D	A	A	A	A	A
PO-E	H	H	H	H	A
PO-F	H	H	A	A	A
PO-G	H	A	A	A	A
PO-H	H	A	A	A	A
PO-I	H	H	H	H	A
PO-J	H	H	H	H	H

H- Highly Associated A- Associated Not – Not Associated

Duration of the programme: 2/4

Total credit: 66

SEMESTER – I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	OEXXXX	Open Elective	2	0	0	2
2	MA4503	Mathematical Methods for Structural Engineering	3	1	0	4
3	CV4501	Structural Dynamics	3	0	0	3
4	CV4502	Theory of Elasticity and Plasticity	3	0	0	3
5	CV4503	Concrete Structures	3	0	0	3
6	CV4504	Maintenance and Rehabilitation of Structures	3	0	0	3
PRACTICAL						
7.	CV4571	Computer Aided Structural Design Laboratory	0	1	2	2
Total			**17**	**2**	**2**	**20**

SEMESTER – II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	CV4505	Earthquake Resistant Design of Structures	3	0	0	3
2.	CV4506	Stability of Structures	3	0	0	3
3.	CV4507	Finite Element Analysis	3	0	0	3
4.	CV4508	Experimental Techniques and Instrumentation	3	0	0	3
5.	CV4509	Advanced Concrete Technology	3	0	0	3
6.	CVXXXX	Elective - I	3	0	0	3
PRACTICAL						
7.	CV4572	Advanced Structural Engineering Laboratory	0	1	2	2
TOTAL			**18**	**1**	**2**	**20**

SEMESTER – III

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	CVXXXX	Elective - III	3	0	0	3
2	OEC	Open Elective	3	0	0	3
PRACTICAL						
3	CV45P1	Project Work Phase-1	0	0	12	6
4	CV45P2	Technical Seminar	0	0	2	1
5	CV45P3	Practical Training (4 Weeks)	0	0	0	1
TOTAL			**06**	**0**	**14**	**14**

SEMESTER – IV

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C
1	CV45P5	Project Work Phase-II	0	0	24	12
TOTAL			**00**	**00**	**24**	**12**

LIST OF ELECTIVES

SI. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CV45A1	Aseismic Design of Structures	3	0	0	3
2.	CV45A2	Bridge Engineering	3	0	0	3
3.	CV45A3	Design of Shell and Spatial Structures	3	0	0	3
4.	CV45A4	Design of Composite Construction	3	0	0	3
5.	CV45A5	Design of Tall Buildings	3	0	0	3
6.	CV45A6	Design of Sub Structures	3	0	0	3
7.	CV45A7	Disaster Resistant Structures	3	0	0	3
8.	CV45A8	Industrial Structures	3	0	0	3
9.	CV45A9	Mechanics of Composite Materials	3	0	0	3
10	CV45B1	Modern Construction Materials & Techniques	3	0	0	3
11	CV45B2	Nonlinear Analysis of Structures	3	0	0	3
12	CV45B3	Offshore Structures	3	0	0	3
13	CV45B4	Optimization of Structures	3	0	0	3
14	CV45B5	Prefabricated Structures	3	0	0	3
15	CV45B6	Pre-stressed Concrete	3	0	0	3
16	CV45B7	Smart Structures and Smart Materials	3	0	0	3
17	CV45B8	Theory of Plates	3	0	0	3
18	CV45B9	Wind And Cyclone Effects on Structures	3	0	0	3

OPEN ELECTIVE

SI. No.	SUBJECT CODE	SUBJECT NAME	L	T	P	C
1.	OE45D1	Research Methodology and IPR	2	0	0	2
2.	OE45D2	Business Analytics	3	0	0	3
3.	OE45D3	Industrial Safety	3	0	0	3
4.	OE45D4	Operations Research	3	0	0	3
5.	OE45D5	Composite Materials	3	0	0	3
6.	OE45D6	Waste to Energy	3	0	0	3

SEMESTER – I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1	OEXXXX	Open Elective	2	0	0	2
2	MA4503	Mathematical Methods for Structural Engineering	3	1	0	4
3	CV4501	Structural Dynamics	3	0	0	3
4	CV4502	Theory of Elasticity and Plasticity	3	0	0	3
5	CV4503	Concrete Structures	3	0	0	3
6	CV4504	Maintenance and Rehabilitation of Structures	3	0	0	3
PRACTICAL						
7.	CV4571	Computer Aided Structural Design Laboratory	0	1	2	2
Total			**18**	**2**	**2**	**20**

MA4503	Mathematical Methods for Structural Engineering	L	T	P	C
		3	1	0	4

OBJECTIVES

1. Understand advanced mathematical concepts relevant to structural engineering.
2. Familiarize with mathematical modeling techniques for structural analysis.
3. Learn numerical methods for solving structural engineering problems.
4. Understand the application of mathematical theories to real-world structural engineering problems.

Course Outcome		Cognitive Skill
CO-01	To Understand the Laplace Equation, Inverse Laplace transform, Convolution theorem, Poisson Equation and solve the partial differential equations by Fourier Transform methods.	R,U,A.An,E
CO-02	To Know the maximizing and minimizing function, Euler's equation that occur in various branches of Engineering Disciplines.	R,U,A.An,E
CO-03	To Understand the knowledge about formulating and testing of hypothesis, using critical values to draw conclusions in hypothesis tests.	R,U,A.An,E
CO-04	To Analyze the applications of simulation to solving inventory and queuing models for real world applications	R,U,A.An,E
CO-05	To Understand the concepts of time series analysis and evaluate the measurement of trends and curve fitting using different methods	R,U,A.An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	M	S	M	M	M	S	M	M	M
CO-02	S	M	S	M	M	S	M	M	S	S
CO-03	S	M	M	S	M	S	M	S	S	S
CO-04	S	S	S	M	M	M	M	L	M	S
CO-05	S	S	M	S	M	S	M	S	L	S

S-Strong, M-Medium,L-Low,N-Not relevant

UNITI APPLICATION OF TRANSFORMS (9)

Laplace transform – Definitions – Properties -Unit step functions– Inverse Laplace transform - Fourier Transform- Definitions – Convolution theorem - Solutions to partial differential equations: Heat equation, Wave equation and Poisson Equation

UNIT II CALCULUS OF VARIATIONS (9)

Euler's equation – Functional dependent on first and higher order derivatives – Functional dependent on functions of several independent variables – Isoperimetric Problems -Direct methods: Ritz and Kantorovich methods.

UNIT III TESTING OF HYPOTHESIS (9)

Sampling distributions – Type I and Type II errors – Small and Large samples – Tests based on Normal, t, and F distributions for testing of proportions, mean and variance– Chi square Tests for independence of attributes andgoodness of fit.

UNIT IV SIMULATION (9)

Discrete Event Simulation – Stochastic Simulation - Monte Carlo Simulation – Generation of Random Numbers using Congruent method – Applications to inventory and queueing models.

UNIT V TIME SERIES ANALYSIS (9)

Time Series Analysis – Definition – Components of time series- Secular trend seasonal variations – Cyclical variations – Irregular variations – Measurement of trends- Graphic method – Semi average method – Moving average method – Curve fitting by the method of Least Squares.

L: 45 + T: 15, TOTAL: 60 PERIODS

REFERENCES

1. Dr.Venkataraman, M.K., "Higher Mathematics for Engineering and Science", National PublishingCompany.,1992.
2. SankaraRao. K., "Introduction to Partial Differential Equations", Prentice Hall of India, 2004.
3. Andrews L.C. and Shivamoggi, B., "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd.,New Delhi, 2003.
4. Gupta, A.S., "Calculus of Variations with Applications", Prentice-Hall of India, New Delhi,1997.
5. Elsgolc, L.D., "Calculus of Variations", Dover Publications Inc., New York, 2007.
6. S.P.Gupta," Statistical Methods", S.Chand& Co. New Delhi,2004.
7. Taha, H.A. "Operations Research: An Introduction", Ninth Edition, Pearson Education Edition, Asia, NewDelhi, 2002.
8. Anderson, O.D, "Time Series Analysis: Theory and Practice", I. North-Holland, Amsterdam, 1982.

CV4501	STRUCTURAL DYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVE:

To make the students understand the basics of structural dynamics and earthquake engineering and to develop the ability to design an earthquake resistant structure**.**

Course Outcome		Cognitive Skill
CO-01	Do understand about vibration analysis of system/structures with a single degree of freedom and canexplain the method of damping the systems	R

CO-02	Ability to ctreate equations of motion for single degree of freedom structures subjected to various dynamic loads.	S
CO-03	Structures with Multi degrees of freedom under free and forced vibration	E
CO-04	To analyze the free vibrations of a beam.	A
CO-05	Study the Non-linear analysis by step-by-step method with linear acceleration	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	M	S	M	S	L	L	M	M	M	M
CO-02	S	M	S	M	M	L	L	L	N	L
CO-03	M	M	L	L	L	M	S	S	N	M
CO-04	M	S	S	L	L	L	M	L	N	N
CO-05	S	M	M	M	M	N	N	N	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: INTRODUCTION TO STRUCTURAL DYNAMICS 7

Nature of exciting forces, degrees of freedom and mathematical modeling of dynamic systems. Single degree freedom system (SDOF): An undamped and damped free vibrations, Viscous and Coulomb's damping.

UNIT II: SDOF SYSTEMS 8

SDOF system: Undamped and damped Forced Vibrations to harmonic excitations, Fourier analysis of periodic forces. Response to unit impulse and arbitrary loading by Duhamel's integral. SDOF system: Step and Ramp forces, Pulse loadings.

UNIT III: MD OF SYSTEMS 8

Multiple degrees of freedom (MDOF) system: Free vibrations of a shear building, fundamental frequencies and mode shapes, Orthogonality of mode shapes. MDOF System: Forced Vibrations of shear building, transformation of coordinates and mode superposition method.

UNIT IV: CONTINOUS SYSTEM 7

Continuous system: Free transverse vibrations of beams for various boundary conditions. Free vibration analysis of a cantilever beam by Rayleigh Ritz and Finite Element Method. Power and Stodola methods. Concept of Tuned Mass Dampers.

UNIT V:

RESPONSE TO GROUND MOTION 7

Response to ground motion and transmissibility. Non-linear analysis by step-by-step method

with linear acceleration .Response to ground motion. Non-linear analysis by Wilson-Theta method.

TOTAL: 45 PERIODS

REFERENCES:

1. Mario Paz – Structural Dynamics Theory and Computation, CBS Publications
2. Anil K Chopra – Dynamics of Structures Theory and Applications to Earthquake Engineering, Prentice-Hall Publications.
3. R.W Clough and J Penzin – Dynamics of Structures, McGraw Hill Publications
4. R.C. Roy - Structural Dynamics an Introduction to Computer Methods, John Wiley & Sons Publications.
5. Madhujit Mukhopadhyay – Structural Dynamics Vibrations and Systems, Ane Books India Publishers.

CV4502	THEORY OF ELASTICITY AND PLASTICITY	L	T	P	C
		3	0	0	3

OBJECTIVES

The student knows the concepts and quantities from solid mechanics and understands the relations between them. The student can write the full set of equations for an elastic and an elasto-plastic analysis of a body with an arbitrary shape in two- or three-dimensional space.

Course Outcome		Cognitive Skill
CO-01	Do vibration analysis of system/structures with a single degree of freedom and can explain the method of damping the systems	U, A , R
CO-02	Do the dynamic analysis of system/structures with Multi degrees of freedom under free and forced vibration	U, A ,E, An
CO-03	Derive a mathematical model of a continuous system and do a dynamic analysis under free and forced vibration	U, A
CO-04	Explain the causes and effects of an earthquake	U, A , An,E
CO-05	Design masonry and RC structures for the earthquake forces as per their commendations of IS codes of practice	An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	M	M	S	M	L	S	M	M	S	N
CO-02	S	L	N	M	M	S	L	N	L	M

CO-03	M	S	M	N	L	N	S	M	S	N
CO-04	S	M	N	S	L	M	L	N	S	M
CO-05	S	L	S	L	M	S	M	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: ANALYSIS OF STRESS AND STRAIN **9**

Analysis of stress and strain, stress strain relationship. Generalized Hooke's law. Plane stress and plane strain.

UNIT II: 2D PROBLEMS **9**

Two dimensional problems in Cartesian and polar co-ordinates for simple problems.

UNIT III: TORSION **9**

Torsion of non-circular section - methods of analysis - membrane analogy - torsion of thin rectangular section andhollow thin-walled sections.

UNIT IV: ENERGY METHODS **9**

Energy methods - principle of virtual work - energy theorem - Rayleigh Ritz methods - Finite Differencemethod.

UNIT V: INTRODUCTION TO PROBLEMS IN PLASTICITY **9**

Physical assumption - criteria of yielding, yield surface, Flow rule (plastic stress strain relationship). Elastic plastic problems of beams in bending - plastic torsion.

TOTAL: 45PERIODS

REFERENCES:

1. Timoshenko, S. and Goodier T.N. "Theory of Elasticity", McGraw Hill Book Co., Newyork, IIEdition 1988.
2. Chwo P.C. and Pagano, N.J. "Elasticity Tensor, Dyadic and Engineering applications", D.VanNestrandCo., In Co., 1967.
3. Chenn, W.P. and Henry D.J. "Plasticity for Structural Engineers", Springer Verlag Newyork 1988.
4. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi 1988.
5. Verma, PDS, "Theory of Elasticity", Vikas Publishing Pvt. Ltd. New Delhi -1997.
6. Sadhu Singh, "Theory of Plasticity", Khanna Publishers, New Delhi 1988.

CV4503	**CONCRETE STRUCTURES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

To achieve the designed/ desired workability in the plastic stage.
To achieve the desired minimum strength in the hardened stage.
To achieve the desired durability in the given environment conditions.

Course Outcome		**Cognitive Skill**
CO-01	Explain the structural behaviour of flexural members and columns	U, A , R
CO-02	Design the compression members and construct interaction diagrams	U, E, An

CO-03	Design the special elements like corbels, deep beams and grid floors	U, A
CO-04	Design flat slab and spandrel beams	U, A , E
CO-05	Predict the moment curvature behavior and design and detail concrete elements based on ductility	An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	M	M	S	M	L	S	S	M	S	N
CO-02	L	L	N	M	M	L	L	N	L	M
CO-03	M	S	M	N	L	N	S	M	L	N
CO-04	M	M	N	S	L	M	L	N	S	M
CO-05	S	L	M	L	M	S	M	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT – I OVERALL REVIEW **9**

Review of limit state design of beams, slabs and columns according to IS Codes. Calculation of deflection and crackwidth according to IS and ACI Codes.

UNIT – II DESIGN OF SPECIAL RC ELEMENTS **9**

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

UNIT – III FLAT SLABS AND FLAT PLATES **9**

Design of flat slabs and flat plates according to IS and ACI methods - Design of shear reinforcement - Design ofspandrel beams - Yield line theory and Hillerborgs strip method of design of slabs.

UNIT - IV INELASTIC BEHAVIOUR OF CONCRETE STRUCTURES **9**

Inelastic behaviour of concrete beams and frames, moment - rotation curves, moment redistribution. Baker's methodof plastic design. Design of cast-in-situ joints in frames.

UNIT - V DETAILING AND FIELD PRACTICE **9**

Detailing for ductility - Fire resistance of structural members – Quality of control of concrete

TOTAL: 45 PERIODS

REFERENCES

1. UnnikrishnaPillai and Devdas Menon “Reinf orced concrete Design’, Tata McGraw Hill PublishersCompany Ltd., New Delhi, 2006.

2. Varghese, P.C., “LimitState Design of Reinforced Concrete”, Prentice Hall of India, 2007.

3. Varghese, P.C, “Advanced Reinforced Concrete Design”, Prentice Hall of India 2005.

4. Purushothaman, P, "Reinforced Concrete Structural Elements: Behaviour Analysis and Design", TataMcGra w Hill, 1986.

5. Sinha.N.C. and Roy S .K., "Fundamentals of Reinforced Concrete", S.Chand

CV4504	MAINTENANCE AND REHABILITATION OF STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVES

To get the knowledge on quality of concrete, durability aspects, causes of deterioration, assessment of distressed structures, repairing of structures and demolition procedures

Course Outcome		Cognitive Skill
CO-01	Understand the Repair Strategies	U
CO-02	Understand the Durability of concrete	U
CO-03	Understand the properties of repair materials	U
CO-04	Get an idea of repair to Structures.	U, A
CO-05	Know the strategies Demolition of Structures	U, An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	L	S	S	L	M	L	M	L	L	L
CO-02	L	L	M	S	M	L	L	M	M	M
CO-03	M	M	L	M	M	L	L	M	L	L
CO-04	M	M	M	S	L	M	M	M	L	L
CO-05	M	L	M	M	L	L	L	L	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I Maintenance and Repair Strategies 9

Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration.

UNIT II Serviceability and Durability of Concrete 9

Quality assurance for concrete construction concrete properties- strength, permeability, thermal properties and cracking. - Effects due to climate, temperature, chemicals, corrosion - design and construction errors - Effects of cover thickness and cracking

UNIT III Materials and Techniques for Repair 9

Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement and polymers coating for rebars loadings from concrete, mortar and dry pack, vacuum concrete,

Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels and cathodic protection.

UNIT IV Repairs to Structures 9

Repair of structures distressed due to earthquake – Strengthening using FRP - Strengthening and stabilization techniques for repair.

UNIT V Demolition of Structures 9

Engineered demolition techniques for structures - case studies

TOTAL: 45 PERIODS

REFERENCES:

1. Denison Campbell, Allen and Harold Roper, "Concrete Structures, Materials, Maintenance and Repair",Longman Scientific and Technical, UK, 1991.
2. Allen R.T and Edwards S.C, "Repair of Concrete Structures", Blakie and Sons, UK, 1987
3. Raikar, R.N., "Learning from failures - Deficiencies in Design, Construction and Service" - RandD Centre(SDCPL), Raikar Bhavan, Bombay, 1987.
4. Santhakumar A.R., "Concrete Technology" OxfordUniversity Press, 2007 Printed in India by RadhaPress,New Delhi, 110 031
5. Peter H.Emmons, "Concrete Repair and Maintenance Illustrated", Galgotia Publications pvt. Ltd., 2001.

CV4571	Computer Aided Structural Design Laboratory	L	T	P	C
		0	1	2	2

OBJECTIVES

- Learn the usage of any fundamental software for design.
- Create geometries using Pre-Processor.
- Analyse the interpret the result using processor.
- Design the structural elements

Course Outcome		Cognitive Skill
CO-01	Understand CAD software and basic functions	An, E
CO-02	Evaluate plans of Single storied building & multistoried buildings	An, A
CO-03	Develop different sections at different elevations	A, An
CO-04	Detailing of building components like doors, windows roof trusses	A, E
CO-05	Develop section and elevation for single and multistoried buildings using CAD software.	A,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J

CO-01	S	M	M	L	S	M	L	S	M	M
CO-02	M	M	S	M	M	M	M	M	L	S
CO-03	M	S	M	S	L	S	M	M	M	M
CO-04	S	M	M	S	M	S	L	M	S	L
CO-05	M	L	S	M	M	M	M	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

At the end of the course the student acquires hands on experience in design and preparation of structural drawings for concrete / steel structures normally encountered in Civil Engineering practice.

LIST OF EXPERIMENTS:

1. Design and drawing of RCC cantilever beam, Fixed beam.
2. Design and drawing of RCC Portal frame.
3. Analysis and Design of Two-storied framed structures
4. Design of solid slab and RCC Tee beam bridges for IRC loading and reinforcement details
5. Analysis and Design of Multistoried framed structures
6. Design, Drafting and Detailing of circular water tanks.
7. Design, Drafting and Detailing of rectangular water tanks
8. Design, Drafting and Detailing of Octagonal water tanks
9. Design of single span plate girder bridge
10. Design of single span plate– Roof Truss – Gantry Girder.

TOTAL: 45 HOURS

TEXT BOOKS

1. Krishna Raju, "Structural Design & Drawing (Concrete & Steel)", CBS Publishers
2. Punmia, B.C., Ashok Kumar Jain, Arun Kumar Jain, "Design of steel structures", Lakshmi publicationsPvt. Ltd.

REFERENCES

1. Krishnamurthy, D., "Structural Design & Drawing – Vol. II", CBS Publishers & Distributors, Delhi
2. Krishnamurthy, D., "Structural Design & Drawing – Vol.IIISteelStructures", CBS Publishers & Distributors, New Delhi.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No	Description of Equipment	Quantity
1.	Models of Structures	1 each
2.	Computers Pentium IV	30 Nos
3.	Analysis and Design Software - Minimum 5 use License	1 No

SEMESTER – II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	CV4505	Earthquake Resistant Design of Structures	3	0	0	3
2.	CV4506	Stability of Structures	3	0	0	3
3.	CV4507	Finite Element Analysis	3	0	0	3
4.	CV4508	Experimental Techniques and Instrumentation	3	0	0	3
5.	CV4509	Advanced Concrete Technology	3	0	0	3
6.	CVXXXX	Elective - I	3	0	0	3
PRACTICAL						
7.	CV4572	Advanced Structural Engineering Laboratory	0	1	2	2
TOTAL			**18**	**1**	**2**	**20**

CV4505	**Earthquake Resistant Design of Structures**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

- Anticipate the effects of strong earthquakes on urban areas and civil infrastructure.
- Design, build, and maintain structures to perform as expected and in accordance with building codes during earthquake exposure.
- A properly engineered structure does not have to be extremely strong or costly. It must be properly designed to withstand seismic forces while sustaining a reasonable amount of damage.

Course Outcome		**Cognitive Skill**
CO-01	Discuss the equations of motion for undamped free vibrations for SDOF and 2DOF systems	U
CO-02	Explain the engineering seismology including causes and effects of earthquakes	U
CO-03	Analyse a multistoried structure using Equivalent Static Method and Response Spectrum methods	A, An
CO-04	Assess various irregularities in buildings	A
CO-05	Apply the provisions of IS:13920 and IS: 4326 to building structures	A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	M	M	M	S	M	M	S	M	M
CO-02	M	M	S	M	M	M	M	M	M	S
CO-03	M	S	M	S	M	S	M	M	M	M
CO-04	S	M	M	S	M	S	M	M	S	M
CO-05	M	M	S	M	M	M	M	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: ENGINEERING SEISMOLOGY 9

Engineering Seismology, Elastic rebound theory, Theory of plate tectonics and movement of Indian plate. Seismic waves. Seismic intensity, Richter scale, Tsunami. Seismic zoning maps of India and comparison study. Response spectra. Strong motion characteristics.

UNIT II: SEISMIC MODELING OF STRUCTURES 9

Earthquake effects on the structures, classification of loads, Seismic methods of analysis, seismic design methods. Seismic damages during past earthquakes and effect of irregularities and building architecture on the performance of RC structures. Mathematical modelling of multi storied RC buildings with modelling of floor

diaphragms and soil-foundation, Winkler model.

UNIT III: STATIC AND DYNAMIC ANALYSIS 9

Design of multi-story RC structure with foundation as per latest IS: 1893 by Equivalent static lateral load method and Response Spectrum Method. Introduction to Time history method. Capacity based design of soft story RC building, design of Shear Walls. Ductile detailing as per latest IS:13920.

UNIT IV: SEISMIC DESIGN OF STRUCTURES 9

Seismic design of multi- storied steel structures with various bracing systems. Lateral load analysis and design of two- storied masonry buildings. P-delta analysis. Seismic design of Elevated RC Circular Water Tanks. Ductility requirements, types of ductility, factors affecting ductility. IS code provisions

UNIT V: SEISMIC RETROFITTING OF SOURCES 9

Seismic retrofitting, Sources of weakness in RC framed buildings, Classification of retrofitting techniques, Conventional and non-conventional methods, Comparative study of various methods and case studies. Introduction to Base Isolation systems. IS code provisions for retrofitting of masonry structures, failure modes of masonry structures and repairing techniques.

TOTAL: 45 PERIODS

REFERENCES:

1. P. Agarwal and M. Shrikhande – Earthquake Resistant Design of Structures, Prentice-Hall Publications.
2. IS:1893 – Indian Standard Criteria for Earthquake Resistant Design of Structures, Bureau of IndianStandards, New Delhi.
3. IS:13935 – Repair and Seismic Strengthening of Buildings – Guidelines, 1993
4. IS:4326 – Earthquake Resistant Design and Construction of Buildings – Code of Practice, 1993

CV4506	STABILITY OF STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVE:

To study the concept of buckling and analysis of structural elements.

Course Outcome - COs		Cognitive Skill
CO-01	Knowledge about buckling of columns and their analysis for various boundary conditions.	U
CO-02	To analysis of beam, column and frames by moment distribution, slope deflection and stiffness method	E
CO-03	To study the torsional and lateral buckling of simply supported beams and cantilever beams.	U
CO-04	To analysis the equilibrium and energy approach of plates	An
CO-05	To study the inelastic buckling of plates	R

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	S	M	M	M	M	L	L	N	L
CO-02	M	S	S	S	L	M	L	N	L	N
CO-03	M	S	S	S	L	S	M	L	L	N
CO-04	S	S	M	M	M	M	M	L	N	L
CO-05	S	S	M	S	M	M	M	N	M	N

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I Buckling of Columns **9**

States of equilibrium - Classification of buckling problems - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis - Eigen value problem. Governing equation for columns - Analysis for various boundary conditions - using Equilibrium, Energy methods. Approximate methods - Rayleigh Ritz, Galerkins approach - Numerical Techniques - Finite difference method - Effect of shear on buckling

UNIT II Buckling of Beam-Columns and Frames 9

Theory of beam column - Stability analysis of beam column with single and several concentrated loads, distributedload and end couples Analysis of rigid jointed frames with and without sway - Moment distribution - Slope deflection and stiffness method.

UNIT III Torsional and Lateral Buckling 9

Torsional buckling - Torsional and flexural buckling - Local buckling. Buckling of Open Sections. Numerical solutions. Lateral buckling of beams, pure bending of simply supported beam and cantilever,

UNIT IV Buckling of Plates 9

Governing differential equation - Buckling of thin plates, various edge conditions -Analysis by equilibrium and energy approach - Approximate and Numerical techniques

UNIT V Inelastic Buckling 9

Double modulus theory - Tangent modulus theory - Shanley's model - Eccentrically loaded inelastic column. Inelastic buckling of plates - Post buckling behaviour of plates

TOTAL:45 PERIODS

REFERENCES:

1. Timoshenko, S., and Gere., "Theory of Elastic Stability", McGraw Hill Book Company, 1963.
2. Chajes, A. "Principles of Structures Stability Theory", Prentice Hall, 1974.
3. Ashwini Kumar, "Stability Theory of Structures", Tata McGraw Hill Publishing Company Ltd., New Delhi,1995.
4. Iyenger.N.G.R.,, "Structural stability of columns and plates", Affiliated East West Press,1986.
5. Gambhir, "Stability Analysis and Design of Structures", springer, New York, 2004
6.

.CV4507	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES

Finite Element Analysis works by discretizing the domain of interest and then assembling physics equations to solve the engineering problem at hand. By assembling these elements together to represent the physical system, engineers can predict the behavior of the whole structure.

Course Outcome		Cognitive Skill
CO-01	Formulate a finite element problem using basic mathematical principles	U, A , R
CO-02	Explain the various types of elements and select the appropriate element for modelling	U, E, An
CO-03	Analyse a frame using truss element	U, A
CO-04	Formulate and analyse the two- and three-dimensional solid finite element problems	U, A , E

CO-05	Analyse shells, thick and thin plates and explain the dynamic analysis using FEM	An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	M	M	S	M	L	S	M	M	S	N
CO-02	S	L	N	M	M	S	L	M	L	M
CO-03	M	S	S	N	L	N	S	M	S	N
CO-04	S	M	M	S	L	M	L	N	S	M
CO-05	S	L	S	L	M	S	M	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: Introduction **9**

Boundary Value Problem - Approximate Solution - Variational and Weighted Residual Methods - Ritz and GalerkinFormulations - Concepts of Piecewise Approximation and Finite Elements - Displacement and Shape Functions - Weak Formulation - Minimum Potential Energy - Generation of Stiffness Matrix and Load Vector.

UNIT II: Stress Analysis **9**

Two Dimensional problems - Plane Stress, Plain Strain and Axisymmetric Problems - Triangular and Quadrilateral Elements - Natural Coordinates – Iso parametric Formulation - Numerical Integration - Plate Bending and Shell Elements - Brick Elements - Elements for Fracture Analysis.

UNIT III: Meshing and Solution Problems **9**

Higher Order Elements - p and h Methods of refinement - IIL conditioned Elements - Discretization Errors - Auto and Adaptive Mesh Generation Techniques - Error Evaluation.

UNIT IV: Nonlinear and Vibration Problems **9**

Material and Geometric Nonlinearity - Methods of Treatment - Consistent System Matrices – Dynamic.Condensation- Eigen Value Extraction.

UNIT V: Thermal Analysis **9**

Application to Thermal analysis Problems.

TOTAL: 45 PERIODS

REFERENCES:

1. Bathe , K.J., Finite Elements Procedures in Engineering analysis, Prentice Hall Inc., 1995.
2. Zienkiewicz, O.C, and Taylor, R.L., The Finite Elements Methods , Mc Graw Hill , 1987.
3. Chandrupatla, R.T. and Belegundu, A.D ., Introduction to Finite Elements in Engineering, 2nd Edition , Prentice Hall of India, 1997.
4. Moaveni,S., Finite Element Analysis : Theory and Application with ANSYS, Prentice Hall Inc., 1999.

CV4508	Experimental Techniques and Instrumentation	L	T	P	C
		3	0	0	3

OBJECTIVES

To learn the principles of measurements of static and dynamic response of structures and carryout the analysis of results.

Course Outcome		Cognitive Skill
CO-01	At the end of this course students will know about measurement of strain.	A, An
CO-02	At the end of this course students will know about measurement of vibrations.	U, A
CO-03	At the end of this course students will know about measurement of wind blow.	U, A
CO-04	They will be able to analyze the structure by damage assessment and controlled blasting for demolition.	U, E
CO-05	They will be able to analyze the structure by non-destructive testing methods.	U, An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	S	S	S	M	M	L	L	S	M
CO-02	S	S	S	S	M	M	L	L	S	M
CO-03	S	S	S	S	M	M	L	L	S	M
CO-04	S	S	S	S	M	M	L	L	S	M
CO-05	S	S	S	S	M	M	L	L	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT - I FORCES AND STRAIN MEAS UREMENT 9

Choice of Experimental stress analysis methods, Errors in measurements – Strain gauge, principle, types, performance and uses. Photo elasticity - principle and applications - Hydraulic jacks and pressure gauges – Electronic

load cells – Proving Rings – Calibration of Testing Machines – Long-term monitoring – vibrating wire sensors– Fibre optic sensors.

UNIT - II VIBRATION MEASUREMENTS 9

Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for velocity and acceleration measurements. Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters – Digital data Acquisition systems.

UNIT – III ACOUSTICS AND WIND FLOW MEASURES 9

Principles of Pressure and flow measurements – pressure transducers – 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 AND CONTROL 9

Diagnosis of distress in structures – crack observation and measurements – corrosion of reinforcement in concrete- Half cell, construction and use – damage assessment – controlled blasting for demolition – Techniques for residualstress measurements.

UNIT – V NON-DESTRUCTIVE TESTING METHODS 9

Load testing on structures, buildings, bridges and towers – Rebound Hammer – acoustic emission – ultrasonic testingprinciples and application – Holography – use of laser for structural testing – Brittle coating, Advanced NDT methods Ultrasonic pulse echo, Impact echo, impulse radar techniques, GECOR, Ground penetrating radar (GPR).

TOTAL: 45 PERIODS

REFERENCES:

1. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi,1996
2. Dalley .J.W and Riley.W.F, "Experimental Stress Analysis", McGraw HillBook Company, N.Y. 1991
3. Srinath.L.S, Raghavan.M.R, ingaiah.K, Gargesha.G, Pant.B and Ramachandra.K, "Experimental StressAnalysis", Tata McGraw Hill Company, New Delhi, 1984
4. Sirohi.R.S., Radhakrishna.H.C, "Mechanical Measurements", New Age International (P) Ltd. 1997

CV4509	ADVANCED CONCRETE TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

To identify and comprehend ideas connected to concrete technology, which includes the various types and properties of concrete as well as various adhesive materials and their critical application in the construction of safe and cost-effective structures.

Course Outcome		Cognitive Skill
CO-01	Discuss the concrete ingredients and its influence at gaining strength.	U, A
CO-02	Design of concrete mix and grade as per IS codes.	U, E
CO-03	Summarize the concepts of conventional concrete and its differences with other concretes like no fines, light weight etc.	U, An
CO-04	Describe the application and use of fiber reinforced concrete.	U, A, E
CO-05	Design and develop the self-compacting and high-performance concrete.	An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	N	M	M	L	S	S	M	S	N
CO-02	L	N	S	M	M	L	L	N	L	N
CO-03	S	S	L	N	S	N	M	L	L	N
CO-04	M	M	N	S	L	M	L	M	S	S
CO-05	S	L	M	L	S	M	M	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I CONCRETE MAKING MATERIALS 9

Aggregates classification IS Specifications, Properties, Grading, Methods of combining aggregates, specified gradings, testing of aggregates - Cement, Grade of cement, Chemical composition, Testingof concrete, Hydration of cement, Structure of hydrated cement, special cements - Water - Chemicaladmixtures, Mineral admixture.

UNIT II MIX DESIGN 9

Principles of concrete mix design, Methods of concrete mix design, IS Method, ACI Method, DOE Method – Mix design for special concretes- changes in Mix design for special materials.

UNIT III CONCRETING METHODS 9

Process of manufacturing of concrete, methods of transportation, placing and curing, cracking, plastic shrinkage, Extreme weather concreting, special concreting methods. Vacuum dewatering – Underwater Concrete

UNIT IV SPECIAL CONCRETES 9

Light weight concrete Fly ash concrete, Fiber reinforced concrete, Sulphur impregnated concrete,Polymer Concrete – High performance concrete. High performance fiber reinforced concrete, Self- Compacting Concrete, Geo Polymer Concrete, Waste material-based concrete – Ready mixed concrete.

UNIT V TESTS ON CONCRETE 9

Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and shrinkage

- Durability of concrete. Non-destructive Testing Techniques - microstructure of concrete

TOTAL: 45 PERIODS

REFERENCES:

1. Gupta.B.L., Amit Gupta, "Concrete Technology, Jain Book Agency, 2017.
2. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi, 2019.
3. Gambhir.M.L., Concrete Technology, McGraw Hill Education, 2006.
3. Neville, A.M., Properties of Concrete, Prentice Hall, 1995, London.
4. Job Thomas., Concrete Technology, Cencage learning India Private Ltd, New Delhi, 2015.

CV4572	Advanced Structural Engineering Laboratory	L	T	P	C
		0	1	2	2

OBJECTIVES

- Provide technical and engineering solutions for structural engineering problems using the knowledge of science, mathematics and basic engineering concepts.
- Analyse complex structural engineering problems critically and apply them in practice using adequate theoretical background.
- To Prepare the students applying the established engineering methods and software to solve complex and challenging engineering problems

Course Outcome		Cognitive Skill
CO-01	Perform basic test for the constituent materials of concrete	An, E
CO-02	Perform mix design for various types of concrete as per IS guidelines	An, A
CO-03	Analyse the behaviour of steel and reinforced concrete structural elements.	An
CO-04	Perform scheduling of construction projects	A, E
CO-05	Prepare building drawings and lab reports	A,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	M	M	M	S	M	L	S	M	M
CO-02	S	M	S	M	S	M	M	S	M	S
CO-03	S	S	M	S	S	S	M	S	M	M
CO-04	S	M	M	S	L	S	M	S	S	M
CO-05	M	M	S	M	M	M	M	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS

1. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflectionbehaviour.
2. Testing of simply supported steel beam for strength and deflection behaviour.
3. Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentricloading.
4. Dynamic testing of cantilever steel beam
   a. To determine the damping coefficients from free vibrations.
   b. To evaluate the mode shapes.
5. Effect of admixtures in concrete for workability fresh concrete

a) slump core
b) Compaction Factor
c) Vee Bee Test

6. Effect of admixtures in concrete for strength
7. Effect of admixtures in concrete for durability

TOTAL: 45 PERIODS

REFERENCES:

1. Dally J W, and Riley W F, “Experimental Stress Analysis”, McGraw-Hill Inc. New York, 1991.

SEMESTER – III

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	CVXXXX	Elective - III	3	0	0	3
2	OEC	Open Elective	3	0	0	3
PRACTICAL						
3	CV45P1	Project Work Phase-1	0	0	12	6
4	CV45P2	Technical Seminar	0	0	2	1
5	CV45P3	Practical Training (4 Weeks)	0	0	0	1
TOTAL			**06**	**0**	**14**	**14**

CV45P1	PROJECT WORK PHASE-1	L	T	P	C
		0	0	12	6

OBJECTIVE:

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

Course Outcome		Cognitive Skill
CO-01	Apply the knowledge gained from theoretical and practical courses in solving problems	An, E
CO-02	Recognize the importance of literature review	An, A
CO-03	Develop a clear outline and methodology for the project	An
CO-04	Identify the potential research gap and list parameters to work with	A, E
CO-05	Report and present the findings of the work conducted.	A,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	M	M	M	S	M	L	S	M	M
CO-02	S	M	S	M	S	M	M	S	M	S
CO-03	S	S	M	S	S	S	M	S	M	M

CO-04	S	M	M	S	L	S	M	S	S	M
CO-05	M	M	S	M	M	M	M	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

SYLLABUS:

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

OUTCOME:

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

CV45P2	**TECHNICAL SEMINAR**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

OBJECTIVE:

- To work on a specific technical topic in Structural Engineering and acquire the skills of written and oral presentation.
- To acquire writing abilities for seminars and conferences.

Course Outcome		**Cognitive Skill**
CO-01	Identify the latest developments in the field of Structural Engineering	An, E
CO-02	Acquire technical writing abilities for seminars, conferences and journal publications	A
CO-03	Use modern tools to present the technical details	An
CO-04	Conduct brainstorming sessions on technical concepts	A, E
CO-05	Gain insight on upcoming trends in Structural Engineering	A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / **CO**	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	M	S	M	L	S	S	M	S	N
CO-02	L	N	N	M	M	L	L	N	L	N
CO-03	S	S	L	N	S	N	S	L	L	N
CO-04	M	M	N	S	L	M	L	M	S	M
CO-05	S	L	M	L	S	S	M	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

SYLLABUS:

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

OUTCOME:

- The students will be trained to face an audience and to tackle any problem during group discussion in the Interviews.

CV45P3	**PRACTICAL TRAINING**	**L**	**T**	**P**	**C**
		0	**0**	**0**	**1**

OBJECTIVES

• To Provide hands on experience in fitting, carpentry, sheet metal and lathe shop
• To provide practical training on household wiring and electron circuits
• To offer real time activity on plumbing connections in domestic applications

Course Outcome		**Cognitive Skill**
CO-01	Develop a centre line for different building components Apply	U, A
CO-02	Study the properties of construction materials Understand	U, E
CO-03	Construct and demonstrate electrical wiring circuits.	U, An
CO-04	Understand the plumbing requirements and construct the basic pipe connections for water supply Understand	U, A , E
CO-05	Identify the building components from building drawing.	An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

CO / **PO**	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	M	S	M	L	S	S	M	S	N
CO-02	L	N	N	M	M	L	L	N	L	N
CO-03	S	S	L	N	S	N	S	L	L	N
CO-04	M	M	N	S	L	M	L	M	S	M
CO-05	S	L	M	L	S	S	M	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

OBJECTIVE:

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

SYLLABUS:

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

SEMESTER – IV

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C
1	CV45P5	Project Work Phase-II	0	0	24	12
TOTAL			**00**	**00**	**24**	**12**

CV45P5	PROJECT WORK PHASE-II	L	T	P	C
		0	0	24	12

OBJECTIVE:

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

Course Outcome		Cognitive Skill
CO-01	Discover potential research areas in the field of Structural Engineering.	U
CO-02	Apply the knowledge gained from theoretical and practical courses to be creative, well-planned, organized and coordinated	U, E
CO-03	Represent data acquired in graphical and reader-friendly formats	U, An
CO-04	Derive detailed conclusions from work carried out	U, A, E
CO-05	Report and present the findings of the work conducted	An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	L	M	M	S	M	M	M	M	M
CO-02	M	M	S	M	M	M	L	M	M	S
CO-03	M	S	L	S	M	S	M	M	M	L
CO-04	S	M	M	M	M	S	M	M	S	M
CO-05	M	M	S	M	M	M	L	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

SYLLABUS:

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

ELECTIVES

		L	T	P	C
CV45A1	**Aseismic Design of Structures**	**3**	**0**	**0**	**3**

OBJECTIVES

- Structural design is the methodical investigation of the stability, strength and rigidity of structures.
- The basic objective in structural analysis and design is to produce a structure capable of resisting all applied loads without failure during its intended life.

- The designed structure should sustain all loads and deform within limits for construction and use.

Course Outcome		Cognitive Skill
CO-01	Plan a good structural configuration for seismic resistance	U
CO-02	Calculate the earthquake design forces using appropriate methods as per IS 1893-2002(Part-I).	U
CO-03	Apply the concept of Ductility and Base isolation in designing earthquake resistant structures	U
CO-04	Design the structure using IS 13920 code provisions.	U, An
CO-05	Apply the principles, procedures and Codal requirements to the analysis and design of tension members, compression members, bases, beams, and connections.	A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	L	M	M	S	M	M	M	M	M
CO-02	M	M	S	M	M	M	L	M	M	S
CO-03	M	S	L	S	M	S	M	M	M	L
CO-04	S	M	M	M	M	S	M	M	S	M
CO-05	M	M	S	M	M	M	L	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I - INTRODUCTION **9**

Introduction to engineering seismology - various theories - measurement scales - vibration measuring instruments - Past earthquakes in India and world - Response spectrum - significance - construction & use.

UNIT II - STRUCTURAL MATERIALS AND SYSTEMS **9**

Performance of structural materials under cyclic loads - masonry - steel - concrete - soil. Various structural systems in steel and concrete for horizontal load transfer - their behavior and limitations - braced frames - rigid frames - shear walls - wall-frame systems.

UNIT III - STRUCTURAL PLANNING AND ANALYSIS **9**

Seismic design philosophy - Design spectrum - ductility based analysis - capacity design concepts

- pushover analysis concepts - energy based design Layout and planning of buildings in seismic zones - regular and irregular buildings - centre of rigidity and centre of mass - torsion. Computing storey shear - drift - using provisions of Bureau of Indian Standards (BIS) codes.

UNIT IV - DESIGN AND DUCTILE DETAILING 9

Load combinations - Ductility based design - Detailing for seismic performance - Provisions of IS: 13920 for RCC structural elements, frames, shear walls - design of shear walls.

UNIT V - SEISMIC RETROFITTING AND ISOLATION 9

Damage Assessment techniques - safety analysis and rating - Reliability assessment - Retrofitting techniques - materials. Base Isolation techniques - Active and passive control devices.

TOTAL:45 PERIODS

REFERENCES

1. Paulay. Tand Priestly. M.N.J, "Aseismic Design of Reinforced Concrete and Masonry Building", John Wiley and Sons, 1987.
2. Agarwal. P, and Shrikhande. M, “Earthquake Resistant Design of Structures” Prentice Hall of India, New Delhi, 2007.
3. Anil.K.Chopra, “Dynamics of Structures (Theory and Applications to Earthquake Engineering)”, 3rd Edition, Prentice Hall of India Private Limited. New Delhi, 2009.
4. Short course on Seismic Design of Reinforced Concrete Buildings, CEP, IIT, Kanpur, Dec.1995.
5. Course Notes, "Structural Design for Dynamic Loads", SRM Engineering College, 2002.
6. Allen.R.T, and Edwards.S.C, "Repair of Concrete Structures”, second edition Blackie Academic & Professional, an imprint of Chapman hall, U.K. 1993.
7. Lecture Notes, "Health Monitoring of Structures - A Proactive Strategy", ISTE Sponsored course held at SRMEC, Jan 2003.
8. Guidelines for - "Improving Earthquake Resistance of Housing", Building Materials and Technology Promotion Council, Ministry Of Urban Development and Poverty Alleviation, Department of Urban Employment and Poverty Alleviation, Government of India, New Delhi, 1999 – 2000.

CV45A2	Bridge Engineering	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the various types of bridges
- To understand the codal provisions for loading and design standards of bridges.
- To design the superstructure of bridge using different methods and loading conditions.
- To understand the design of bearings

Course Outcome		Cognitive Skill
CO-01	To familiarize with the usage of codal provisions in the design of bridges	A
CO-02	To analyze and design substructure elements of bridges	An

CO-03	To analyze and design various types of bridges like T-Beam bridge, Slab bridge, box culvert.	U, An
CO-04	To understand the suitability of bearings for bridges.	U, An
CO-05	Design box girder concrete bridges and bearings.	A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	M	M	M	S	M	M	S	M	M
CO-02	M	M	S	M	M	M	L	M	M	S
CO-03	M	S	L	S	M	S	M	M	M	L
CO-04	S	M	M	S	M	S	M	M	S	M
CO-05	M	M	S	M	M	M	L	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I - INTRODUCTION AND INVESTIGATION FOR BRIDGES 9

Components of bridge - Classification - Need for investigation - Bridge site - Data collection - design discharge - linear waterway - economical span - scour depth - traffic projection - choice of bridge type.

UNIT II - LOADS ON BRIDGES 9

Indian Road Congress (IRC) bridge codes - dimensions - dead and live loads - impact effect - wind and seismic forces - longitudinal and centrifugal forces - hydraulic forces - earth pressure - temperature effect and secondary stresses.

UNIT III - SLAB AND T - BEAM BRIDGES 9

Design of slab bridges - skew slab culverts - box culverts. T - beam bridges - Pigeaud curves - Courbon's theory - Hendry Jaegar method - analysis and design of T - beam bridges.

UNIT IV - LONG SPAN BRIDGES 9

Hollow girder bridges - balanced cantilever bridges - continuous girder bridges - rigid frame bridges - arch bridges - bow string girder bridges. Prestressed concrete bridges - composite prestressed concrete super structures - erection of precast girders - continuous construction - recent trends.

UNIT V - BEARINGS AND SUBSTRUCTURE 9

Design of bearings for slab, girder, skew bridges - Design of piers - abutments - trestles, Joints - expansion joints.

TOTAL:45 PERIODS

REFERENCES

1. Johnson Victor. D, "Essentials of Bridge Engineering", Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2006.

2. Krishna Raju .N, "Design of Bridges", fourth edition Oxford & IBM Publishing Co, Bombay,2009.

3. Raina .V.K. "Concrete Bridge Practice", Tata McGraw Hill Publishing Co., New Delhi - 1991

4. Taylor. F.W, Thomson S.E, and Smulski .E. "Reinforced Concrete Bridges", John Wiley & Sons, New York 1955.

5. Conference Proceedings, 'Advances and Innovations in Bridge Engineering', IIT, Madras and Indian Institute of Bridge Engineers, Tamilnadu, Allied Publisher, New Delhi, 1999.

CV45A3	DESIGN OF SHELL AND SPATIAL STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVES

Study the behaviour and design of shells, folded plates, space frames and application of FORMIAN software.

Course Outcome		Cognitive Skill
CO-01	Identify the concept of shells and design of circular domes and conical roofs.	A, An
CO-02	analyse the folded plates subjected to different loading and boundary conditions	U, A
CO-03	Discuss the behaviour of space frame.	U, A
CO-04	Analyze different types of shells subjected to different loading criterion and boundary conditions with software packages.	U, E
CO-05	They will be able to analyze the structure Application of Formex Algebra, FORMIAN for generation of configuration.	U, An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	S	S	S	M	M	L	M	M	M
CO-02	S	S	S	S	M	M	L	M	M	M
CO-03	S	S	S	S	M	M	L	M	M	M

CO-04	S	S	S	S	M	M	L	M	M	M
CO-05	S	S	S	S	M	M	L	M	M	M

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: Classification of Shells **9**

Classification of shells, types of shells, structural action, - Design of circular domes, conical roofs, circular cylindrical shells by ASCE Manual No.31.

UNIT II: Folded Plates **9**

Folded Plate structures, structural behaviour, types, design by ACI - ASCE Task Committee method – pyramidal roof.

UNIT III: Introduction to Space Frame **9**

Space frames - configuration - types of nodes - general principles of design Philosophy - Behaviour.

UNIT IV: Analysis and Design **9**

Analysis of space frames – detailed design of Space frames – Introduction to Computer Aided Design and Software Packages.

UNIT V: Special Methods **9**

Application of Formex Algebra, FORMIAN for generation of configuration.

TOTAL:45 PERIODS

REFERENCES:

1. Billington.D.P, “Thin Shell Concrete Structures”, McGraw Hill Book Co., New York, 1982.
2. Santhakumar.A.R and Senthil.R, “Proceedings of International Conference on Space Structures”, AnnaUniversity, Chennai, 1997.
3. Subramanian.N ,”Principles of Space Structures”, Wheeler Publishing Co. 1999.
4. Ramasamy, G.S., “Design and Construction of Concrete Shells Roofs”, CBS Publishers, 1986.
5. ASCE Manual No.31, “Design of Cylindrical Shells”.

CV45A4	**DESIGN OF COMPOSITE CONSTRUCTION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

To develop an understanding of the behaviour and design study of Steel concrete composite elements and structures.

Course Outcome		**Cognitive Skill**
CO-01	Apply the concept of serviceability and construction issue in design.	A, An
CO-02	Design the composite members for structures	U, A
CO-03	Compare the shear connection required in structures	U, A

CO-04	Analyses the composite box girder bridge	U, E
CO-05	Evaluate the seismic behavior of composite structures	U, An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	S	S	S	M	M	M	M	S	M
CO-02	S	S	S	S	M	M	M	M	S	M
CO-03	S	S	S	S	M	M	M	M	S	M
CO-04	S	S	S	S	M	M	M	M	S	M
CO-05	S	S	S	S	M	M	M	M	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: INTRODUCTION **9**

Introduction to steel - concrete composite construction - theory of composite structures - construction.

UNIT II: DESIGN OF COMPOSITE MEMBERS. **9**

Design of composite beams, slabs, columns, beam – columns - design of composite trusses.

UNIT III: DESIGN OF CONNECTIONS **9**

Types of connections, Design of connections in the composite structures - shear connections. Degree of shear connection – Partial shear interaction

UNIT IV: COMPOSITE BOX GIRDER BRIDGES **9**

Introduction - behaviour of box girder bridges - design concepts.

UNIT V: GENERAL **9**

Case studies on steel - concrete composite construction in buildings - seismic behaviour of composite structures.

TOTAL:45 PERIODS

REFERENCES:

1. Johnson R.P., “Composite Structures of Steel and Concrete”, Blackwell Scientific Publications, UK, 2004.
2. Oehlers D.J. and Bradford M.A., “Composite Steel and Concrete Structural Members, Fundamental behaviour”, Pergamon press, Oxford, 1995.
3. Proceedings of Workshop on “Steel Concrete Composite Structures”, Anna University, 2007.

CV45A5	DESIGN OF TALL BUILDINGS	L	T	P	C
		3	0	0	3

OBJECTIVES

To study the behaviour, analysis and design of tall structures.

Course Outcome		Cognitive Skill
CO-01	Describe the development of tall building structure including loading and other serviceability parameters.	A, An
CO-02	Discuss about various various Structural Systems like high rise behaviour, Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wall-frames.	U, A
CO-03	Discuss modelling for approximate analysis and computerised general three-dimensional analysis.	U, A
CO-04	They will be able to analyze the structural element and temperature effects and fire resistance.	U, E
CO-05	Analyse buckling analysis of frames, effect of foundation rotation.	U, An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	S	S	S	S	S	L	M	S	M
CO-02	S	S	S	S	S	S	L	M	S	M
CO-03	S	S	S	S	S	S	L	M	S	M
CO-04	S	S	S	S	S	S	L	M	S	M
CO-05	S	S	S	S	S	S	L	M	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: Design Principles and Loading 9

Design philosophy, Loading, sequential loading, materials - high performance, concrete - Fibre reinforced Concrete - Lightweight concrete - design mixes. Gravity loading Wind loading Earthquake loading

UNIT II: Behavior of Various Structural Systems 9

Factors affecting growth, Height and Structural form. High rise behavior, Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, Fu trigger - braced and hybrid mega systems.

UNIT III: Analysis and Design 9

Modelling for approximate analysis, Accurate analysis and reduction techniques, Analysis of buildings as total structural system considering overall integrity and major subsystem interaction,

Analysis for member forces, drift and twist, computerized general three-dimensional analysis.

UNIT IV: Structural Elements **9**

Sectional shapes, properties and resisting capacity, design, deflection, cracking, prestressing, shear flow, Design for differential movement, creep and shrinkage effects, temperature effects and fire resistance.

UNIT V: Stability of Tall Buildings **9**

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

TOTAL: 45 PERIODS

REFERENCES:

1. Bryan Stafford Smith and Alexcoull, "TallBuilding Structures - Analysis and Design", John Wiley and Sons, Inc., 1991.
2. Taranath B.S., "Structural Analysis and Design of Tall Buildings", McGraw Hill, 1988.
3. Gupta.Y.P.,(Editor), Proceedings of National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities, New Age International Limited, New Delhi,1995.
4. Lin T.Y and Stotes Burry D, "Structural Concepts and systems for Architects and Engineers", John Wiley, 1988.

CV45A6	DESIGN OF SUB STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To prepare students to excel in research and to succeed in Structural engineering profession through global, rigorous post graduate education
- To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve structural engineering problems
- To train students with good scientific and engineering knowledge so as to comprehend, analyze, design, and create novel products and solutions for the real life problems

Course Outcome		Cognitive Skill
CO-01	Learn various types of shallow foundation and its test	U , R
CO-02	Know the different types of pile foundation, pile cape and its design.	E
CO-03	Know the different types of well foundation and its design construction	A
CO-04	Learn the diiifferent types of machine foundation.	U
CO-05	Know the special types of foundation such as chimney tower etc	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	S	L	M	S	M	L	M	L	L
CO-02	S	S	M	L	M	L	M	S	M	L
CO-03	S	S	M	L	M	L	L	L	M	L
CO-04	M	S	M	L	M	L	L	L	M	L
CO-05	L	S	M	L	M	L	M	L	M	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I - SHALLOW FOUNDATIONS **9**

Soil investigation – Basic requirements of foundation – Types and selection of foundations. Bearing capacity of soil - plate load test – Design of reinforced concrete isolated, strip, combined and strap footings – mat foundation.

UNIT II - PILE FOUNDATIONS **9**

Introduction – Types of pile foundations – load carrying capacity - pile load test – structural design of straight piles – different shapes of piles cap – structural design of pile cap.

UNIT - III WELL FOUNDATIONS **9**

Types of well foundation – Grip length – load carrying capacity – construction of wells – Failures and Remedies – Design of well foundation – Lateral stability.

UNIT - IV MACHINE FOUNDATIONS **9**

Introduction – Types of machine foundation – Basic principles of design of machine foundation – Dynamic properties of soil – vibration analysis of machine foundation – Design of foundation for Reciprocating machines and Impact machines – Reinforcement and construction details – vibration isolation.

UNIT - V SPECIAL FOUNDATIONS **9**

Foundation on expansive soils – choice of foundation – under-reamed pile foundation. Foundation for concrete Towers, chimneys – Design of anchors- Reinforced earth retailing walls.

TOTAL: 45 HOURS

REFERENCES:

1. Bowles .J.E., “Foundation Analysis and Design”, McGraw Hill Publishing co., New York, 1986.
2. Swamy Saran, "Analysis and Design of substructures", Oxford and IBH Publishing Co. Pvt. Ltd., 2006.
3. Tomlinson.M.J, “Foundation Design and Construction”, Longman, Sixth Edition, New Delhi, 1995.
4. Varghese.P.C, “Design of Reinforced Concrete Foundations” – PHI learning private limited, New Delhi – 2009.

CV45A7	DISASTER RESISTANT STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVES

To understand the nature of earthquakes, behavior of structures under the ground motion, and learns the analysis and design of structures subjected to earthquake ground motions.

Course Outcome		Cognitive Skill
CO-01	Students study about the behaviour of life line structure and know about the history	U , R
CO-02	Will able to know about reliability assessment repairs and retrofitting techniques of community structures	E
CO-03	Study about the methods and materials for strengthening for different disaster.	A
CO-04	Will able to know about modern materials for disaster reduction and construction techniques	U
CO-05	Students will able to study about techniques of damage structure	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	M	S	L	S	M	L	S	L	L
CO-02	M	L	S	M	L	L	M	S	M	S
CO-03	S	M	L	S	L	M	S	L	M	L
CO-04	M	S	M	L	M	L	L	L	M	L
CO-05	M	L	S	L	M	S	M	S	M	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I - BEHAVIOUR OF LIFE LINE STRUCTURES **9**

Design philosophy to resist flood, cyclone, and earthquake and fire disasters-National and International Codes of practice - By-laws of urban and semi-urban areas - history and lessons from disasters - Approach to traditional and Modern Structures - Concept of life period-based Design - case studies.

UNIT II - COMMUNITY STRUCTURES **9**

Safety analysis and rating - Reliability assessment repairs and Retrofitting techniques of Community Structures - Protection of Nuclear Structures - Dams, bridges and buildings.

UNIT III - REHABILITATION AND RETROFITTING **9**

Testing and evaluation - Classification according to safety level - methods and materials for

strengthening for different disasters - qualification test.

UNIT IV - MATERIALS, DESIGN AND DETAILING **9**

Modern Materials for disasters reduction - Detailing aspects of structures subject to probable disasters - Construction techniques - Analysis methodology - Techniques for optimal performance - Provisions for artificial disasters - blast and impact.

UNIT V - TECHNIQUES OF DAMAGE ASSESSMENT **9**

Damage surveys - Maintenance and modification to improve hazard resistance - application GIS in disaster management - foundation improvement techniques.

TOTAL: 45 HOURS

REFERENCES

1. Raiker .R.N, "Learning from failures, Deficiencies in Design, Construction and Service", R&D Center, Raiker Bhavan, 1987.
2. Allen .R.T, and Edwards .S.C., "Repairs of Concrete Structure", #CCCCCC;ie and Sons, U.K.1987.
3. Moskvin .V "Concrete and Reinforced Concrete" - Deterioration and protection - MIR Publishers - Moscow 1983.
4. Lecture notes on the course "Disasters Management" - conducted by Anna University, 2000.

		L	T	P	C
CV45A8	**Industrial Structures**	**3**	**0**	**0**	**3**

OBJECTIVES

The main objective of this course is to develop an in-depth knowledge in the area of design of industrial structure with the latest code of practice as per the Indian Standard. On completion of this course student gain good confidence in designing major industrial structures like plate girders, industrial structures like gantry girders, high rise chimneys and machine foundation.

Course Outcome		**Cognitive Skill**
CO-01	At the end of the course the student will be able to Discuss the planning and functional requirements of Industrial structures.	A, E
CO-02	Discover the need to learn about the design concepts, and constructional aspects of Industrial buildings.	U
CO-03	Analyse and evaluate the importance of various types of power plants.	An
CO-04	Design of transmission line structures and chimneys.	U, E
CO-05	Analyse and design of various types of machine foundation	U, An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	S	S	S	S	M	S	M	S	M
CO-02	S	S	S	S	S	M	S	M	S	M
CO-03	S	S	S	S	S	M	S	M	S	M
CO-04	S	S	S	S	S	M	S	M	S	M
CO-05	S	S	S	S	S	M	S	M	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT - I PLANNING AND FUNCTIONAL REQUIREMENTS 9

Classification of Industries and Industrial structures - planning for Layout Requirements regarding Lighting, Ventilation and Fire Safety - Protection against noise and vibration - Guidelines of Factories Act.

UNIT - II INDUSTRIAL BUILDINGS 9

Steel and RCC - Gantry Girder, Crane Girders - Design of Corbels and Nibs – Design of Staircase.

UNIT - III POWER PLANT STRUCTURES 9

Types of power plants – Containment structures - Cooling Towers - Bunkers and Silos - Pipe supporting structures

UNIT - IV TRANSMISSION LINE STRUCTURES AND CHIMNEYS 9

Analysis and design of transmission line towers - Saj and Tension calculations, Testing of towers – Design of self-supporting chimney, Design of Chimney bases.

UNIT - V FOUNDATION 9

Design of foundation for Towers, Chimneys and Cooling Towers - Machine Foundation - Design of Turbo Generator Foundation.

TOTAL:45 PERIODS

REFERENCES:

1. Jurgen Axel Adam, Katharria Hausmann, Frank Juttner, Klauss Daniel, "Industrial Buildings: A Design Manual", Birkhauser Publishers, 2004.
2. Manohar S.N, "Tall Chimneys - Design and Construction", Tata McGraw Hill, 1985
3. Santhakumar A.R. and Murthy S.S., "Transmission Line Structures", Tata McGraw Hill, 1992.
4. Srinivasulu P and Vaidyanathan.C, "Handbook of Machine Foundations", Tata McGraw Hill, 1976.

CV45A9	**Mechanics of Composite Materials & Techniques**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

- Explain the behavior of constituents in the composite materials
- Enlighten the students in different types of reinforcement

- Develop the student's skills in understanding the different manufacturing methods available for composite material.
- Illuminate the knowledge and analysis skills in applying basic laws in mechanics to the composite materials.

Course Outcome		Cognitive Skill
CO-01	Explain the mechanical behavior of layered composites compared to isotropic materials	U
CO-02	Apply constitutive equations of composite materials and understand mechanical behavior at micro and macro levels.	U
CO-03	Determine stresses and strains relation in composites materials.	U
CO-04	Analyse the micromechanical properties of fibre reinforced composites.	U, An
CO-05	Demonstrate a practical understanding of composite properties and fabrication techniques, and to be able to make realistic suggestions for the evaluation of composite behaviour, where appropriate.	A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	L	M	M	S	M	M	M	M	M
CO-02	M	M	S	M	M	M	L	M	M	S
CO-03	M	S	L	S	M	S	M	M	M	L
CO-04	S	M	M	M	M	S	M	M	S	M
CO-05	M	M	S	M	M	M	L	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: Introduction **9**

Introduction to Composites, Classifying composite materials, commonly used fiber and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites, Short Fiber Composites,

UNIT II: Stress Strain Relations **9**

Concepts in solid mechanics, Hooke's law for orthotropic and anisotropic materials, Linear Elasticity for Anisotropic Materials, Rotations of Stresses, Strains, Residual Stresses

UNIT III: Analysis of Laminated Composites **9**

Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates. Static, dynamic and stability analysis for simpler cases of composite plates. Interlaminar stresses.

UNIT IV: Failure and Fracture of Composites **9**

Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics of Composites, Sandwich Construction.

UNIT V: Applications and Design **9**

Metal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues

TOTAL:45 PERIODS

REFERENCES:

1. Daniel and Ishai, "Engineering Mechanics of Composite Materials", OxfordUniversity Press, 2005.
2. Jones R.M., "Mechanics of composite materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1975.
3. Agarwal.B.D. and Broutman.L.J., "Analysis and Performance of fiber composites", John-Wiley and Sons, 1980.
4. Michael W.Hyer, "Stress Analysis of Fiber-Reinforced Composite Materials", McGraw Hill, 1999.
5. Mukhopadhyay.M, " Mechanics of Composite Materials and Structures", University Press, India, 2004.

CV45B1	**MODERN CONSTRUCTION MATERIALS & TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

Usage of technology in construction showcases benefits like standardizing processes, increasing productivity, improving labour safety, managing labour shortages and enhancing collaboration.

Course Outcome		**Cognitive Skill**
CO-01	Distinguish between various types of building stones, bricks and tiles and their structural requirements.	U, A , R
CO-02	To Recognize the need and process of manufacture of cement and lime	U, E, An
CO-03	To Identify function of various materials like wood, glass, paints and building components	U, A
CO-04	To Find the importance of masonry, finishing and form woks	U, A , E
CO-05	To Assess various building services and principles of building planning.	An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / **CO**	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	N	M	M	L	S	S	M	S	N
CO-02	L	N	S	M	M	L	L	N	L	N
CO-03	S	S	L	N	S	N	M	L	L	N

CO-04	M	M	N	S	L	M	L	M	S	S
CO-05	S	L	M	L	S	M	M	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I - SPECIAL CONCRETES **9**

Concretes, Behaviour of concretes – Properties and Advantages of High Strength and High-Performance Concrete – Properties and Applications of Fibre Reinforced Concrete, Self-compacting concrete, Alternate Materials to concrete on high performance & high Strength concrete.

UNIT II - METALS **9**

Types of Steels – Manufacturing process of steel – Advantages of new alloy steels –Properties and advantages of aluminium and its products – Types of Coatings & Coatings to reinforcement – Applications of Coatings.

UNIT III - COMPOSITES **9**

Types of Plastics – Properties & Manufacturing process – Advantages of Reinforced polymers – Types of FRP – FRP on different structural elements – Applications of FRP.

UNIT IV - OTHER MATERIALS **9**

Types and properties of Water Proofing Compounds – Types of Non-weathering Materials and its uses – Types of Flooring and Facade Materials and its application, concrete admixtures and construction chemicals.

UNIT V - SMART AND INTELLIGENT MATERIALS **9**

Types & Differences between Smart and Intelligent Materials – Special features – Case studies showing the applications of smart & Intelligent Materials.

TOTAL:45 PERIODS

REFERENCES:

1. ACI Report 440.2R-02, "Guide for the design and construction of externally bonded RP systems for strengthening concrete structures", American Concrete Institute, 2002.
2. Aitkens , High Performance Concrete, McGraw Hill, 1999
3. Ashby, M.F. and Jones.D.R.H.H. "Engineering Materials 1: An introduction to Properties, applications and designs", Elsevier Publications, 2005.
4. Deucher, K.N, Korfiatis, G.P and Ezeldin, A.S, Materials for civil and Highway Engineers, Prentice Hall Inc., 1998.
5. Ganapathy, C., Modern Construction Materials, Eswar Press, 2015.
6. Mamlouk, M.S. and Zaniewski, J.P., Materials for Civil and Construction Engineers, Prentice Hall Inc., 1999.
7. Santhakumar.A.R., Concrete Technology, Oxford University press, New Delhi, 2005.
8. Shan Somayaji, Civil Engineering Materials, Prentice Hall Inc., 2001
9. Shetty M.S, Concrete Technology: Theory and Practice, S.Chand& Company Ltd., 2005.

CV45B2	**Non-Linear Analysis of Structures**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

The objectives of the course are to

- To provide a thorough background of nonlinear structural analysis along with exposure to some of the commonly used modern modelling and analysis techniques.

- The course will help prepare the students with the requisite knowledge to comprehend relevant research work, to analyse and design laboratory experiments, and to design and evaluate the performance of real-world structures.

Course Outcome		Cognitive Skill
CO-01	Design the various structural steel members and connections.	An, E
CO-02	Apply the principles, procedures and Codal requirements to the analysis and design of tension members, compression members, bases, beams, and connections.	A
CO-03	Implement nonlinear finite element approaches for truss elements	A, An
CO-04	Choose appropriate finite element formulations for nonlinear structural analysis problems	A, E
CO-05	Develop models that represent the essentials of the nonlinear response of structures	An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	M	M	L	S	M	L	S	M	M	M	M	S
CO-02	M	M	S	M	M	M	M	M	L	S	M	M	M
CO-03	M	S	M	S	L	S	M	M	M	M	S	M	L
CO-04	S	M	M	S	M	S	L	M	S	L	M	M	M
CO-05	M	L	S	M	M	M	M	M	M	S	M	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: Elastic Analysis of Flexural Members **9**

Introduction to nonlinear mechanics; statically determinate and statically indeterminate flexible bars of uniform and variable thickness.

UNIT II: Inelastic Analysis of Flexural Members **9**

Inelastic analysis of uniform and variable thickness members subjected to small deformations; inelastic analysis of flexible bars of uniform and variable stiffness members with and without axial restraints

UNIT III: Vibration Theory and Analysis of Flexural Members **9**

Vibration theory and analysis of flexible members; hysteretic models and analysis of uniform and variable stiffness members under cyclic loading.

UNIT IV: Elastic and Inelastic Analysis of Plates **9**

Elastic and inelastic analysis of uniform and variable thickness plates

UNIT V: Nonlinear Vibration and Instability **9**

Nonlinear vibration and Instabilities of elastically supported beams.

TOTAL: 45 PERIODS

REFERENCES:

1. Sathyamoorthy, M.,"Nonlinear Analysis of Structures", CRC Press, Boca Raton, Florida, 1997.
2. Fertis, D. G.,"Nonlinear Mechanics", CRC Press, Boca Raton, Florida, 1998.
3. Reddy.J.N, "Non linear Finite Element Analysis", Oxford University Press, 2008.

CV45B3	OFFSHORE STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study the concept of wave theories, forces and design of jacket towers, pipes and cables**.**

Course Outcome		Cognitive Skill
CO-01	To understand the basic characteristics of wave-induced water motion	U , R
CO-02	To understand the forces that act on offshore structures include waves, wind, and hydrodynamic drag	U
CO-03	To study different types of structure and foundations	A
CO-04	To understand field: Improve understanding of offshore structural engineering and develop the skills needed to become a competent offshore structural engineer.	U
CO-05	To ensure the structure is stable, strong, and rigid enough to withstand all loads without failing during its intended life	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	S	L	M	S	M	L	M	L	L
CO-02	S	S	M	L	M	L	M	S	M	L
CO-03	S	S	M	L	M	L	L	L	M	L

CO-04	M	S	M	L	M	L	L	L	M	L
CO-05	L	S	M	L	M	L	M	L	M	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: Wave Theories **9**

Wave generation process, small and finite amplitude wave theories.

UNIT II: Forces of Offshore Structures **9**

Wind forces, wave forces on vertical, inclined cylinders, structures - current forces and use of Morison equation.

UNIT III: Offshore Soil and Structure Modeling **9**

Different types of offshore structures, foundation modeling, structural modeling.

UNIT IV: Analysis of Offshore Structures **9**

Static method of analysis, foundation analysis and dynamics of offshore structures.

UNIT V: Design of Offshore Structures **9**

Design of platforms, helipads, Jacket tower and mooring cables and pipe lines.

Total:45 PERIODS

REFERENCES:

1. Chakrabarti, S.K. "Hydrodynamics of Offshore Structures", Computational Mechanics Publications, 1987.
2. Dawson.T.H., "Offshore Structural Engineering", Prentice Hall Inc Englewood Cliffs, N.J. 1983
3. Brebia, C.A and Walker, S., "Dynamic Analysis of Offshore Structures", New Butterworths, U.K. 1979.
4. API, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, American Petroleum Institute Publication, RP2A, Dalls, Tex,2000.
5. Reddy, D.V. and Arockiasamy, M., "Offshore Structures", Vol.1 and Vol.2, Krieger Publishing Company, Florida, 1991.

CV45B4	**Optimization of Structures**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

- To familiarize the student on various methods of optimization and design of structural members.
- To introduce the concepts of design optimization and review major conventional and modern optimization methods used in structural optimization applications.
- To understand the formulation of structural optimization problems.
- To get exposed to unconstrained and constrained optimization.

Course Outcome		Cognitive Skill
CO-01	Describe problem formulation for a given structure and learn to analysis by classical methods	U
CO-02	Prepare solutions for non-linear problems.	U
CO-03	Discuss the basics and application of Genetic Algorithm for structures.	U
CO-04	Explain the concept of Simulated Annealing technique in structures.	U, An
CO-05	Use Artificial Neural Networks in structural application.	A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	L	M	M	S	M	M	M	M	M	M	M	S
CO-02	M	M	S	M	M	M	L	M	M	S	M	M	M
CO-03	M	S	L	S	M	S	M	M	M	L	S	M	S
CO-04	S	M	M	M	M	S	M	M	S	M	L	M	M
CO-05	M	M	S	M	M	M	L	M	M	S	M	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: Basic Principles and Classical Optimization Techniques 9

Definition - Objective Function; Constraints - Equality and inequality - Linear and non-linear, Side, Non-negativity, Behaviour and other constraints - Design space - Feasible and infeasible - Convex and Concave - Active constraint - Local and global optima. Differential calculus - Optimality criteria - Single variable optimization - Multivariable optimization with no constraints - (Lagrange Multiplier method) - with inequality constraints (Khun - Tucker Criteria).

UNIT II: Linear and Non-Linear Programming 9

LINEAR PROGRAMMING: Formulation of problems - Graphical solution - Analytical methods - Standard form - Slack, surplus and artificial variables - Canonical form - Basic feasible solution - simplex method - Two phase method - Penalty method - Duality theory - Primal - Dual algorithm.

NON-LINEAR PROGRAMMING: One Dimensional minimization methods: Unidimensional - Unimodal function - Exhaustive and unrestricted search - Dichotomous search - Fibonacci Method - Golden section method - Interpolation methods. Unconstrained optimization Techniques.

UNIT III: Geometric Programming **9**

Posynomial - degree of difficulty - reducing G.P.P to a set of simultaneous equations - Unconstrained and constrained problems with zero difficulty - Concept of solving problems with one degree of difficulty.

UNIT IV: Dynamic Programming **9**

Bellman's principle of optimality - Representation of a multistage decision problem - concept of sub-optimization problems using classical and tabular methods.

UNIT V: Structural Applications **9**

Methods for optimal design of structural elements, continuous beams and single storied frames using plastic theory - Minimum weight design for truss members - Fully stressed design - Optimization principles to design of R.C. structures such as multistorey buildings, water tanks and bridges.

TOTAL:45 PERIODS

REFERENCES:

1. Rao,S.S. "Optimization theory and applications", Wiley Eastern (P) Ltd., 1984
2. Uri Krish, "Optimum Structural Design", McGraw Hill Book Co. 1981
3. Spunt, "Optimization in Structural Design", Civil Engineering and Engineering Mechanics Services, Prentice-Hall, New Jersey 1971.
4. Iyengar.N.G.R and Gupta.S.K, "Structural Design Optimisation", Affiliated East West Press Ltd, New Delhi, 1997

CV45B5	PREFABRICATED STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVES

To introduce prefabrication and its types.

To make students know the different types of prefabrication systems.

To make students learn different structural connections.

To make students exposed to erection of RC structures.

To make students familiarize with designing and detailing of prefabricated units.

	Course Outcome	Cognitive Skill
CO-01	To get introduced to prefabrication and its types	U, R
CO-02	To know the different types of prefabrication systems.	U, E, An
CO-03	To learn different structural connections.	U, A
CO-04	To be exposed to erection of RC structures.	U, E
CO-05	To be familiar with designing and detailing of prefabricated units.	An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	L	N	M	M	L	L	M	M	S	N
CO-02	L	N	S	M	M	L	L	N	L	N

CO-03	S	S	L	N	S	N	M	L	L	N
CO-04	M	M	M	S	L	M	L	M	S	S
CO-05	S	L	M	L	S	M	M	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I DESIGN PRINCIPLES 9

General Civil Engineering requirements, specific requirements for planning and layout of prefabricates plant. IS Code specifications. Modular co-ordination, standardization, Disuniting of Prefabricates, production, transportation, erection, stages of loading and codal provisions, safety factors, material properties, Deflection control, Lateral load resistance, Location and types of shear walls.

UNIT II REINFORCED CONCRETE 9

Prefabricated structures - long wall and cross-wall large panel buildings, one way and two way prefabricated slabs, Framed buildings with partial and curtain walls, -Connections – Beam to column and column to column.

UNIT III FLOORS, STAIRS AND ROOFS 9

Types of floor slabs, analysis and design example of cored and panel types and two-way systems, staircase slab design, types of roof slabs and insulation requirements, Description of joints, their behaviour and reinforcement requirements, Deflection control for short term and long-term loads,Ultimate strength calculations in shear and flexure.

UNIT IV WALLS 9

Types of wall panels, Blocks and large panels, Curtain, Partition and load bearing walls, load transfer from floor to wall panels, vertical loads, Eccentricity and stability of wall panels, Design Curves, types of wall joints, their behaviour and design, Leak prevention, joint sealants, sandwich wall panels, approximate design of shear walls.

UNIT V INDUSTRIALBUILDINGS AND SHELL ROOFS 9

Components of single-story industrial sheds with crane gantry systems, R.C. Roof Trusses, Roof Panels, corbels and columns, wind bracing design. Cylindrical, Folded plate and hypar-prefabricated shells, Erection and jointing, joint design, hand book-based design.

TOTAL: 45 PERIODS

REFERENCES:

1. B.Lewicki, Building with Large Prefabricates, Elsevier Publishing Company, Amsterdam/ London/New York, 1966. Koncz.T., Manual of Precast Concrete Construction, Vol.I II and III, Bauverlag, GMBH, 1971.
2. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the use of Precase Concrete, Netherland Betor Verlag, 1978.
3. Lasslo Mokk, Prefabricated Concrete for Industrial and Public Sectors, Akademiai Kiado, Budapest, 1964.
4. Murashev.V., Sigalov.E., and Bailov.V., Design of Reinforced Concrete Structures, Mir Publishers, 1968.

CV45B6	PRESTRESSED CONCRETE	L	T	P	C
		3	0	0	3

OBJECTIVE:

- Principle of prestressing, analysis and design of prestressed concrete structures**.**

Course Outcome		Cognitive Skill
CO-01	Describe typical prestressing systems.	U, R
CO-02	Describe the mechanical behavior of typical concrete and steel used in prestressed concrete construction.	U, E, An
CO-03	Calculate prestress losses.	U, A
CO-04	Analyze and design prestressed concrete members in bending under service loads.	U, E
CO-05	Analyze and design prestressed concrete members in bending under ultimate loads.	An,E

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	M	N	M	M	L	S	S	M	S	N
CO-02	L	N	S	M	M	L	L	N	L	N
CO-03	S	S	M	N	S	N	M	L	L	N
CO-04	M	M	N	S	L	N	L	M	S	L
CO-05	S	L	M	L	S	M	M	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I Principles of Prestressing 9

Principles of Prestressing - types and systems of prestressing, need for High Strength materials, Analysis methods losses, deflection (short-long term), camber, cable layouts.

UNIT II Design of Flexural Members 9

Behaviour of flexural members, determination of ultimate flexural strength – Codal provisions - Design of flexural members, Design for shear, bond and torsion. Design of end blocks.

UNIT III Design of Continuous Beams 9

Analysis and design of continuous beams - Methods of achieving continuity - concept of linear transformations, concordant cable profile and gap cables

UNIT IV Design of Tension and Compression Members 9

Design of tension members - application in the design of prestressed pipes and prestressed concrete cylindrical water tanks - Design of compression members with and without flexure - its application in the design piles, flagmasts and similar structures.

UNIT V Design of Composite Members 9

Composite beams - analysis and design, ultimate strength - their applications. Partial prestressing - its advantages and applications.

TOTAL:45 PERIODS

REFERENCES:

1. Krishna Raju, "Prestressed Concrete", Tata McGraw Hill Publishing Co,2000.
2. Sinha.N.C.and.Roy.S.K, "Fundamentals of Prestressed Concrete", S.Chand and Co., 1998.
3. Lin.T.Y., "Design of Prestressed Concrete Structures", John Wiley and Sons Inc,1981.
4. Evans, R.H. and Bennett, E.W., "Prestressed Concrete", Champman and Hall, London, 1958.
5. Rajagopalan.N, Prestressed Concrete, Narosa Publications, New Delhi, 2008.

CV45B7	SMART STRUCTURES AND SMART MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES

Smart materials change properties in response to stimuli like electric fields, temperature, pressure, or light. This ability drives innovation in industries from construction to automotive, creating more efficient, durable, and adaptable products.

Course Outcome		Cognitive Skill
CO-01	To study basics of sensors and its engineering application	U, A , R
CO-02	Understand various smart material and its importance in engineering application	U, E, An
CO-03	Know various processing technics of smart materials	U, A
CO-04	Get knowledge of use of smart material as sensors and actuators	U, A , E
CO-05	To study basics of actuators and its engineering application	An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	M	S	M	L	S	S	M	S	N
CO-02	L	L	N	M	M	L	L	N	L	S

CO-03	M	S	N	N	L	N	S	M	L	N
CO-04	M	M	N	S	L	M	L	N	S	M
CO-05	S	L	M	L	M	L	M	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT 1: Introduction **9**

Introduction to Smart Materials and Structures – Instrumented structures functions and response – Sensing systems – Self diagnosis – Signal processing consideration – Actuation systems and effectors.

UNIT : II Measuring Techniques **9**

Strain Measuring Techniques using Electrical strain gauges, Types – Resistance – Capacitance – Inductance – Wheatstone bridges – Pressure transducers – Load cells – Temperature Compensation – Strain Rosettes.

UNIT : III Sensors **9**

Sensing Technology – Types of Sensors – Physical Measurement using Piezo Electric Strain measurement – Inductively Read Transducers – The LVOT – Fiber optic Techniques. Chemical and Bio-Chemical sensing in structural Assessment – Absorptive chemical sensors – Spectroscopes – Fibre Optic Chemical Sensing Systems and Distributed measurement.

UNIT : IV ACTUATORS **9**

Actuator Techniques – Actuator and actuator materials – Piezoelectric and Electro strictive Material – Magneto structure Material – Shape Memory Alloys – Electro rheological Fluids– Electro magnetic actuation – Role of actuators and Actuator Materials.

UNIT : V SIGNAL PROCESSING AND CONTROL SYSTEMS **9**

Data Acquisition and Processing – Signal Processing and Control for Smart Structures – Sensors as Geometrical Processors – Signal Processing – Control System – Linear and Non-Linear.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Brain Culshaw – Smart Structure and Materials Artech House – Borton. London-1996.

REFERENCES

1. L. S. Srinath – Experimental Stress Analysis – Tata McGraw-Hill, 1998.
2. J. W. Dally & W. F. Riley – Experimental Stress Analysis – Tata McGraw-Hill, 1998.

CV45B8	**Theory of Plates**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

- To impart Knowledge on the analysis of different types of plates and shells under different boundary conditions.
- To impart knowledge on the behavior of plates and shell elements, their places of utility and of course the design procedure of such elements in practical applications.

- To provide a knowledge of the fundamentals of theory of shells and folded plates.
- To appreciate the general solution of plate problems and relate them with their simplified counter parts in strength of materials.

Course Outcome		Cognitive Skill
CO-01	Understand the Simple bending of Plates and Different Boundary Conditions for plates.	A
CO-02	Analyze circular plates subjected to different kinds of loads.	An
CO-03	Understand the concept of Material Orthotropy, Structural Orthotropy and Plates on elastic foundation	U,
CO-04	Design various types of shells structures and folded pipes.	U, A
CO-05	Use numerical techniques in solving special plate problems	A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	M	M	M	S	M	M	S	M	M	M	M	S
CO-02	M	M	S	M	M	M	L	M	M	S	M	M	M
CO-03	M	S	L	S	M	S	M	M	M	L	S	M	S
CO-04	S	M	M	S	M	S	M	M	S	M	M	M	M
CO-05	M	M	S	M	M	M	L	M	M	S	M	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I INTRODUCTION TO PLATES THEORY 9

Thin Plates with small deflection. Laterally loaded thin plates, governing differential equation, various boundary conditions.

UNIT II RECTANGULAR PLATES 9

Rectangular plates. Simply supported rectangular plates, Navier solution and Levy's method, rectangular plates with various edge conditions, plates on elastic foundation.

UNIT III CIRCULAR PLATES 9

Symmetrical bending of circular plates.

UNIT IV SPECIAL AND APPROXIMATE METHODS 9

Energy methods, Finite difference and Finite element methods.

UNIT V ANISOTROPIC PLATES AND THICK PLATES 9

Orthotropic plates and grids, moderately thick plates.

TOTAL: 45 PERIODS

REFERENCES:

1. Timoshenko, S. and Krieger S.W. "Theory of Plates and Shells", McGraw Hill Book Company, New York, 1990.
2. Bairagi, "Plate Analysis", Khanna Publishers, 1996.
3. Reddy J N, "Theory and Analysis of Elastic Plates and Shells", McGraw Hill Book Company, 2006.
4. Szilard, R., "Theory and Analysis of Plates", Prentice Hall Inc., 1995.
5. Chandrashekahara, K. Theory of Plates, University Press (India) Ltd., Hyderabad, 2001.

CV45B9	WIND AND CYCLONE EFFECTS ON STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVE:

To study the concept of wind effects, analysis and design of structures

Course Outcome		Cognitive Skill
CO-01	To study the concept of wind effects on design of structures.	U , R
CO-02	To familiarize on the modeling and designing the structures for wind and cyclone effects as per the codal recommendations.	U, E, An
CO-03	To impart sufficient knowledge on the analysis of wind effects on structures	U, A
CO-04	To understand the design philosophy of tall buildings, the loading and behaviour of structural systems	U, A ,
CO-05	To study about the cyclone effect on design of structures.	An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	M	M	S	M	L	S	S	M	S	N
CO-02	L	L	N	M	M	L	L	N	L	S
CO-03	M	S	L	N	L	N	S	M	M	N
CO-04	M	M	N	S	L	M	L	N	S	N
CO-05	S	L	M	L	M	L	S	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I INTRODUCTION 9

Introduction, Spectral studies, Gust factor, Wind velocity, Method of measurement, variation of speed with height, shape factor, aspect ratio, drag effects.

UNIT II WIND TUNNEL STUDIES 9

Wind Tunnel Studies, Types of tunnels, Modeling requirements, Interpretation of results, Aero-elastic models.

UNIT III EFFECT OF WIND ON STRUCTURES 9

Wind on structures, Rigid structures, Flexible structures, Static and dynamic effects, Tall buildings, chimneys.

UNIT IV IS CODES AND SPECIAL STRUCTURES 9

Application to design, IS 875 code method, Buildings, Chimneys, Roofs, Shelters

UNIT V CYCLONE EFFECTS 9

Cyclone effect on structures, cladding design, window glass design.

TOTAL: 45 PERIODS

REFERENCES:

1. Cook.N.J., "The Designer's Guide to Wind Loading of Building Structures", Butterworths, 1989.
2. Kolousek.V, Pirner.M, Fischer.O and Naprstek.J, "Wind Effects on Civil Engineering Structures", Elsevier Publications, 1984
3. Peter Sachs, "Wind Forces in Engineering", Pergamon Press, New York, 1972.
4. Lawson T.V., "Wind Effects on Building Vol. I and II", Applied Science Publishers, London, 1980.

OPEN ELECTIVE

OE45D1	Research Methodology and IPR	L	T	P	C
		2	0	0	2

OBJECTIVES

To impart knowledge on formulation of research problem, research methodology, and ethics involved in doing research and importance of IPR protection.

Course Outcome		Cognitive Skill
CO-01	Illustrate research problem formulation.	U
CO-02	Analyze research related information and research ethics.	An
CO-03	Correlate the results of any research article with other published results and write areview article in the field of engineering.	An
CO-04	Explain why intellectual property rights (IPR) will play such a significant role in the development of people and nations, and briefly discuss the necessity to spread awareness of IPR among students in general and engineers in particular.	U
CO-05	Discuss how IPR protection encourages innovators to conduct additional research and invest in R & D, which results in the development of new and improved products, which in turn leads to economic growth and societal benefits.	E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	M	M	S	M	L	S	M	M	S	N
CO-02	S	L	N	M	M	S	L	N	L	M
CO-03	M	S	S	N	L	N	S	M	S	N
CO-04	S	M	N	S	L	M	L	N	S	M
CO-05	S	L	S	L	M	S	M	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I RESEARCH METHODOLOGY 6

Meaning of research problem, Sources of research problem, Criteria and Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT II: LITERATURE SURVEY AND ETHICS 6

Effective literature studies approaches - analysis Plagiarism - Research ethics.

UNIT III TECHNICAL WRITING 6

Effective technical writing - how to write a manuscript/ response to reviewers comments - preparation of research article/ research report - Writing a Research Proposal - presentation and assessment by a review committee.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Nature of Intellectual Property: Patents, Designs, Trade Mark and Copyright - Process of Patenting and Development: technological research, innovation, patenting & development - Procedure for grants of patents - Patenting under PCT.

UNIT V PATENT RIGTS AND NEW DEVELOPMENTS IN IPR 6

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

TOTAL: 30 PERIODS

TEXT BOOKS:

1. C.R.Kothari, "Research Methodology", 3rd Edition, New Age International, 2017.
2. Ranjit Kumar, "Research Methodology – A Step by Step for Beginner's", 2nd Edition, Pearson, Education, 2016.
3. Ann M. Korner, Guide to Publishing a Scientific paper, Bioscript Press 2004.
4. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.
5. Kompal Bansal & Parshit Bansal, "Fundamentals of IPR for Beginner's", 1st Edition, BS Publications, 2016.

REFERENCES:

1. Kothari, C. R. Research Methodology - Methods and Techniques, New Age International publishers, New Delhi, 2004.
2. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students', Juta & Company, 1996.
3. Robert P. Merges, Peter S. Menell and Mark A. Lemley, "Intellectual Property in New Technological Age", Aspen Publishers, 2016.
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall , "Industrial Design", McGraw Hill, 1992.
6. Niebel , "Product Design", McGraw Hill, 1974. 7. Asimov , "Introduction to Design", Prentice Hall, 1962.

WEB RESOURCES:

1. https://nptel.ac.in/courses/106/105/106105077/

OE45D2	BUSINESS ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVE

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

- Mange business process using analytical and management tools.
- Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

Course Outcomes		Cognitive Skill
CO-01	Understand the role of business analytics within an organization.	R
CO-02	Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.	U
CO-03	To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.	A
CO-04	To become familiar with processes needed to develop, report, and analyzebusiness data.	U
CO-05	Use decision-making tools/Operations research techniques.	R

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcomes with Programme Outcomes

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	M	M	S	S	M	S	S	N	N	N	N	N
CO-02	M	S	M	M	S	S	M	S	N	N	N	N	N
CO-03	S	M	M	S	M	M	S	M	N	N	N	N	N
CO-04	M	S	M	M	S	M	S	M	N	N	N	N	N
CO-05	S	M	S	S	M	S	M	S	N	N	N	N	N

S-Strong, M-Medium, L-Low, N-Not relevant

UNIT I **9**

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, 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 **9**

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 **9**

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 **9**

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 **9**

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making, Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

TOTAL: 45 PERIODS

REFERENCE BOOKS:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

OE45D3	**Industrial Safety**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

- To ensure protection of worker's rights and to redress their grievances
- To prevent not only the major industrial accidents, but also prevent the accidents causing permanent or partial disablement.
- To stay in a given safe set and prevent a player from winning by blocking time.

Course Outcome		**Cognitive Skill**
CO-01	Knowledge about the theories of accident causation and preventive measures of industrial accidents.	U
CO-02	Explain about personal protective equipment, its selection, safety performance & indicators and importance of housekeeping.	U

CO-03	Understand the different issues in construction industries.	U
CO-04	Analyze the various hazards associated with different machines and mechanical material handling.	U, An
CO-05	Utilize different hazard identification tools in different industries with the knowledge of different types of chemical hazards.	A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	S	M	M	M	S	M	M	S	M	M	M	M	S
CO-02	M	M	S	M	M	M	L	M	M	S	M	M	M
CO-03	M	S	L	S	M	S	M	M	M	L	S	M	S
CO-04	S	M	M	S	M	S	M	M	S	M	M	M	M
CO-05	M	M	S	M	M	M	L	M	M	S	M	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I **9**

Industrial safety: 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 **9**

Fundamentals of maintenance engineering: 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 **9**

Wear and Corrosion and their prevention: 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 **9**

Fault tracing: 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 **9**

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

TOTAL: 45 PERIODS

REFERENCE BOOKS:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

OE45D4	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

OBJECTIVES

1. Develop analytical and critical thinking skills.
2. Recognize the importance of OR in decision-making.
3. Appreciate the limitations and assumptions of OR models.
4. Cultivate a systematic approach to problem-solving.

Course Outcome – Cos		Cognitive Skill
CO-01	Understand the fundamentals of operations research (OR) and its applications.	An,E
CO-02	Familiarity with mathematical modeling techniques for decision-making.	A
CO-03	Knowledge of optimization methods and algorithms.	,An,E
CO-04	Understanding of stochastic processes and probability theory.	R,U,
CO-05	Develop problem-solving skills using OR tools and techniques.	R,U

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	S	S	S	S	N	L	N	N	N	N	M	L	N
CO-02	S	S	S	M	N	N	N	L	N	N	N	N	N
CO-03	S	S	S	S	N	N	N	N	N	L	N	L	M
CO-04	S	M	S	S	N	M	M	N	N	N	L	N	N
CO-05	S	S	M	M	N	N	N	N	N	M	N	M	N

S- Strong, M- Medium, L-Low, N- Not Relevant

UNIT I **9**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.

UNIT II **9**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming.

UNIT III **9**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.

UNIT IV **9**

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

UNIT V **9**

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

TOTAL: 45 PERIODS

REFERENCE BOOKS:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

OE45D5	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES

To study the behaviour of composite materials and to investigate the failure and fracture characteristics

Course Outcome		Cognitive Skill
CO-01	. Explain the various types of composites and their constituents	U, A , R
CO-02	Derive the constitutive relationship and determine the stresses and strains in a Composite material	U, E, An
CO-03	Analyze a laminated plate	U, A
CO-04	Explain the various failure criteria and fracture mechanics of composites	U, A , E
CO-05	Design simple composite elements	An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J
CO-01	S	M	S	M	L	S	S	M	S	N
CO-02	S	L	N	M	M	L	L	N	L	S
CO-03	M	S	N	M	L	N	S	M	L	N
CO-04	M	M	N	S	L	M	L	M	S	M
CO-05	S	L	M	L	M	S	M	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I INTRODUCTION 9

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

UNIT II REINFORCEMENTS 9

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

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

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

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

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

UNIT V STRENGTH 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

REFERENCES:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

OE45D6	**WASTE TO ENERGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

1. Understand waste management principles and practices.
2. Learn about energy conversion technologies from waste.
3. Familiarize with waste-to-energy (WtE) systems and processes.
4. Understand environmental and economic benefits of WtE.

Course Outcome		**Cognitive Skill**
CO-01	Analyze waste composition and characteristics.	U
CO-02	Design and evaluate WTE systems.	E
CO-03	Assess energy recovery potential from waste.	A
CO-04	Develop waste management plans and strategies.	A
CO-05	Develop innovative solutions for waste reduction and energy recovery.	An

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L	PO-M
CO-01	M	M	L	M	S	N	M	S	N	N	M	L	M
CO-02	S	L	N	S	N	N	L	N	M	S	S	N	S
CO-03	M	L	L	N	M	L	S	N	L	N	L	M	M
CO-04	M	N	M	N	L	N	M	N	N	L	L	N	L
CO-05	S	L	M	S	N	M	N	N	M	N	S	M	M

S-Strong, M-Medium, L-Low, N-Not relevant

UNIT I INTRODUCTION TO ENERGY FROM WASTE 9

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

UNIT II BIOMASS PYROLYSIS 9

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

UNIT III BIOMASS GASIFICATION 9

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

UNIT IV BIOMASS COMBUSTION 9

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

UNIT V BIOGAS 9

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

TOTAL: 45 PERIODS

REFERENCES:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 19