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 2021

NOORUL ISLAM CENTRE FOR HIGHER EDUCATION, Kumaracoil

Regulation:2021

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: 67

SEMESTER – I

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	MA3502	Advanced Mathematics for Structural Engineering	3	0	0	3
2	CV3501	Structural Dynamics	3	0	0	3
3	CV3502	Theory of Elasticity and Plasticity	3	0	0	3
4	CV3503	Advanced theory and Design of Concrete Structures	3	0	0	3
5	CV3504	Maintenance and Rehabilitation of Structures	3	0	0	3
6	CVxxx1	Elective I	3	0	0	3
PRACTICAL						
7.	CV3571	Computer Aided Structural Design Lab	0	1	2	2
TOTAL			**18**	**1**	**2**	**20**

SEMESTER – II

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	CV3505	Earthquake Resistant Design of Structures	3	0	0	3
2	CV3506	Stability of Structures	3	0	0	3
3	CV3507	Finite Element Analysis	3	0	0	3
4	CV3508	Theory of Plates and Shells	3	0	0	3
5	CV3509	Advanced Design of Steel & Composite Structures	3	0	0	3
6	CVxxx2	Elective II	3	0	0	3
PRACTICAL						
7.	CV3572	Advanced Structural Engineering Laboratory	0	1	2	2
TOTAL			**18**	**1**	**2**	**20**

SEMESTER – II1

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	CVxxx3	Elective III	3	0	0	3
2	CVxxx4	Elective IV	3	0	0	3
3	CVxxx5	Elective V	3	0	0	3
PRACTICAL						
4	CV35P1	Project Work Phase-1	0	0	12	6
TOTAL			**09**	**0**	**12**	**15**

SEMESTER – IV

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C
1	CV35P2	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.	CV35A1	Aseismic Design of Structures	3	0	0	3
2.	CV35A2	Bridge Engineering	3	0	0	3
3.	CV35A3	Modern Construction Materials & Techniques	3	0	0	3
4.	CV35A4	Design of Offshore Structures	3	0	0	3
5.	CV35A5	Analysis and Design of Tall Buildings	3	0	0	3
6.	CV35A6	Optimization of Structures (add ANN)	3	0	0	3
7.	CV35A7	Industrial Structures	3	0	0	3
8.	CV35A8	Mechanics of Composite Materials	3	0	0	3
9.	CV35A9	Design of sub-Structures	3	0	0	3
10.	CV35B1	Disaster Resistant Structures	3	0	0	3
11.	CV35B2	Nonlinear Analysis of Structures	3	0	0	3
12.	CV35B3	Fracture Mechanics	3	0	0	3
13.	CV35B4	Pre-Engineered Structures	3	0	0	3
14.	CV35B5	Structural Reliability	3	0	0	3

SEMESTER – I

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	MA3502	Advanced Mathematics for Structural Engineering	3	0	0	3
2	CV3501	Structural Dynamics	3	0	0	3
3	CV3502	Theory of Elasticity and Plasticity	3	0	0	3
4	CV3503	Advanced theory and Design of Concrete Structures	3	0	0	3
5	CV3504	Maintenance and Rehabilitation of Structures	3	0	0	3
6	CVxxx1	Elective I	3	0	0	3
PRACTICAL						
7.	CV3571	Computer Aided Structural Design Lab	0	1	2	2
TOTAL			**18**	**1**	**2**	**20**

MA3502	Advanced Mathematics for Structural Engineering	L	T	P	C
		3	0	0	3

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

UNIT I ADVANCED MATRIX THEORY 9

Generalised Eigen vectors– Jordan canonical form — Matrix norms – Singular value decomposition – Pseudo inverse – Least square approximations – QR decomposition.

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.

UNITIII TESTING OF HYPOTHESIS 9

Sampling distributions – Testing of Hypothesis – Large sample tests – Sampling of variables – Sampling of attributes – Test based on Normal, t-distribution, Chi-square and F-distribution.

UNIT IV 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

UNIT V APPLICATIONS OF FOURIER TRANSFORM 9

Fourier Transform methods – one-dimensional heat conduction problems in infinite and semi-infinite rod – Laplace Equation – Poisson Equation

TOTAL: 45 HOURS

REFERENCES:

1. Bronson, R., "Matrix Operations", Schaum's Outline Series, McGraw–Hill, New York, 1989.
2. Dr.Venkataraman, M.K., " Higher Mathematics for Engineering and Science", National Publishing Company.,1992.
3. Gupta, A.S., "Calculus of Variations with Applications", Prentice-Hall of India, New Delhi,1997.
4. S.P.Gupta," Statistical Methods", S.Chand& Co. New Delhi,2004.
5. Anderson, O.D, "Time Series Analysis: Theory and Practice", I . North-Holland, Amsterdam, 1982.
6. Sankara Rao. K., "Introduction to Partial Differential Equations", Prentice Hall of India , 2004.

CV3501	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 create 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 MDOF 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 HOURS

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.

CV3502	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 elastic-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 anlaysis - membrane analogy - torsion of thin rectangular section and hollow thin walled sections.

UNIT IV ENERGY METHODS 9

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

UNIT V INTRODUCTION TO PROBLEMS IN PLASTICITY 9

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

TOTAL: 45 HOURS

REFERENCES:

1. Timoshenko, S. and Goodier T.N. "Theory of Elasticity", McGraw Hill Book Co., Newyork, II Edition 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.

CV3503	**ADVANCED THEORY AND DESIGN OF 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 crack width according to IS and ACI Codes.

UNITII 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 of spandrel beams - Yield line theory and Hiller Borgs strip method of design of slabs.

UNIT IV INELASTIC BEHAVIOUR OF CONCRETE STRUCTURES 9

Inelastic behavior of concrete beams and frames, moment - rotation curves, moment redistribution. Baker's method of 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 HOURS

REFERENCES

1. Unnikrishna Pillai and Devdas Menon "Reinforced concrete Design', Tata McGraw Hill Publishers Company 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", Tata McGra w Hill, 1986.
5. Sinha.N.C. and Roy S .K., "Fundamentals of Reinforced Concrete", S.Chand

CV3504	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 HOURS

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.

CV3571	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

OBJECTIVE

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. Analysis and design of Multi-storey building frames using STAAD.Pro. SAP
2. Analysis and design of Elevated Water Tank using STAAD-Pro.,SAP
3. Analysis and design of bridge decks and other structures using STAAD-Pro.,SAP
4. Analysis and design of steel trusses using STAAD-Pro.,SAP
5. Dynamic response of structures using PULSE software

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 publications Pvt. Ltd.

REFERENCES

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

SEMESTER – II

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	CV3505	Earthquake Resistant Design of Structures	3	0	0	3
2	CV3506	Stability of Structures	3	0	0	3
3	CV3507	Finite Element Analysis	3	0	0	3
4	CV3508	Theory of Plates and Shells	3	0	0	3
5	CV3509	Advanced Design of Steel & Composite Structures	3	0	0	3
6	CVxxx2	Elective II	3	0	0	3
PRACTICAL						
7	CV3572	Advanced Structural Engineering Laboratory	0	1	2	2
		TOTAL	**18**	**1**	**2**	**20**

CV3505	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 amulti-storeyed 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

multistoried 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 multistoried 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 HOURS

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 Indian Standards, 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.

CV3506	**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, distributed load 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 behavior of plates

TOTAL: 45 HOURS

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.

CV3507	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

CO \ PO	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 Galerkin Formulations - 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 - Isoparametric 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 HOURS

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.

CV3508	THEORY OF PLATES AND SHELLS	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 1 CLASSICAL PLATE THEORY 3

Classical Plate Theory – Assumptions – Differential Equation – Boundary Conditions.

UNIT 2 PLATES OF VARIOUS SHADES 15

Navier's Method of Solution for Simply Supported Rectangular Plates –
Leavy's Method of Solution for Rectangular Plates under Different Boundary Conditions. Governing Equation – Solution for Axi-symmetric loading – Annular Plates – Plates of other shapes.

UNIT 3 EIGEN VALUE ANALYSIS 8

Stability and free Vibration Analysis of Rectangular Plates.

UNIT 4 APPROXIMATE METHODS 10

Rayleigh – Ritz, Galerkin Methods– Finite Difference Method – Application to Rectangular Plates for Static, Free Vibration and Stability Analysis.

UNIT 5 SHELLS 9

Basic Concepts of Shell Type of Structures – Membrane and Bending Theories for Circular Cylindrical Shells.

TOTAL: 45 HOURS

TEXT BOOK

1. Timoshenko, S.P. Winowsky. S., and Kreger, "Theory of Plates and Shells", McGraw-Hill Book Co. 1990.

REFERENCES

1. Flugge, W. "Stresses in Shells", Springer – Verlag, 1985.
2. Timoshenko, S.P. and Gere, J.M., "Theory of Elastic Stability", McGraw-Hill Book Co. 1986.

CV3509	**ADVANCED DESIGN OF STEEL & COMPOSITE STRUCTURES**	**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 INDUSTRIAL BUILDINGS 9

Industrial building - Selection of bay width - Structural framing - Knee bracing of columns - Methods to reduce bending moment in columns - Unbraced frames - Design of purlins, girts, rafter, tie runner, side runner, eaves strut and truss members - Design of vierendeel girder.

UNIT II DESIGN OF CONNECTIONS 9

Types of connections - Welded , bolted and riveted - Throat and root stresses in Fillet welds - Seated connections - Unstiffened and stiffened seated connections - Moment resistant connections - Clip angle connections - Split beam connections - Framed connections.

UNIT III STEEL TOWERS AND CHIMNEYS 9

Analysis and design of microwave / transmission line towers - Types of bracing patterns - Sag and tension calculations - Design of self - supporting chimney - Design of base plates, foundations and anchor bolts - guyed steel chimney - Guy ropes - Stresses due to wind - Along wind load calculation.

UNIT IV PLASTIC ANALYSIS OF STRUCTURES 9

Introduction - shape factor - Moment redistribution - combined mechanisms - analysis of portal frames - Effect of axial force - Effect of shear force on plastic moment - Connections - requirement – Moment resisting connections - Design of straight corner connections - Haunched connections - Design of continuous beams.

UNIT V DESIGN OF LIGHT GAUGE STEEL STRUCTURES 9

Cold formed light gauge section - Type of cross sections - stiffened - multiple stiffened and unstiffened element – flat width ratio - effective design width - Design of light gauge compression member - Effective width for load and deflection determination - Design of tension members - Design of flexural members - Shear lag - Flange curling.

TOTAL: 45 HOURS

REFERENCE BOOK:

1. Subramanian .N, "Design of Steel Structures", Oxford University Press, 2008.
2. Dayarathnam.P, "Design of Steel Structures", A.H.Wheeler, India, 2007.
3. John E. Lothers, "Design in structural steel", Prentice Hall of India, New Delhi 1990.
4. Lynn S. Beedle, "Plastic Design of Steel Frames", John Wiley and Sons, New York 1990.
5. Wie Wen Yu, "Design of Cold Formed Steel Structures", McGrawHill Book Company, New York, 2010
6.

CV3572	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

OBJECTIVES:

This course provides an experience to understand the physical behavior of structural elements under different actions.

LIST OF EXPERIMENTS

1. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behaviour.
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 eccentric loading.
4. Dynamic testing of cantilever steel beam
   a. To determine the damping coefficients from free vibrations.
   b. To evaluate the mode shapes.
5. Static cyclic testing of single bay two storied steel frames and evaluate
   a. Drift of the frame.
   b. Stiffness of the frame.
   c. Energy dissipation capacity of the frame.
6. Determination of in-situ strength and quality of concrete using
   i) rebound hammer and ii) Ultrasonic Pulse Velocity Tester.
7. Effect of admixtures in concrete for workability, strength and 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	CVxxxx	Elective IV	3	0	0	3
3	CVxxxx	Elective V	3	0	0	3
PRACTICAL						
4	CV35P1	Project Work Phase-1	0	0	12	6
TOTAL			**09**	**0**	**12**	**15**

CV35P1	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-voceexamination.

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.

SEMESTER – IV

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C
1	CV35P2	Project Work Phase-II	0	0	24	12
TOTAL			**00**	**00**	**24**	**12**

CV35P2	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

CV35A1	Aseismic Design of Structures	L	T	P	C
		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 17 SRM-M.Tech.-STR-2015-16 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 HOURS

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.

CV35A2	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 HOURS

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.

CV35A3	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 HOURS

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. 11

CV35A4	DESIGN OF 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 ON OFFSHORE STRUCTURES **9**

Wind forces, wind forces on vertical, inclined cylinders, structures - current forces and wave forces using Morrison equation,

UNIT III - OFFSHORE SOIL AND STRUCTURE MODELLING **9**

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

UNIT IV - ANALYSIS OF OFFSHORE STRUCTURES **9**

Static methods 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 pipelines - Corrosion and Fatigue Failure.

TOTAL: 45 HOURS

REFERENCES

1. Chakrabarti. S.K, "Hydrodynamics of Offshore Structures", Computational mechanics, Publications, 1987.
2. Thamas .H, Dawson, "Offshore Structural Engineering", Prentice Hall Inc. Englewood, Cliffs, N.J. 1983.
3. API Recommended Practice for Planning, "Designing and Constructing Fixed Offshore Platform", American Petroleum Institute Publication, RP2A, Dallas, Texas, 1983.
4. Wiegel .R.L, "Oceanographical Engineering", Prentice Hall Inc. Englewood, Cliffs, N.J. 1964.
5. Brebia .C.A, Walker .S., "Dynamic Analysis of Offshore Structures", New - Nes Butterworths, U.K 1979.
6. Reddy. DV, and Arockiasamy M, "Offshore Structures", Vol.1, Krieger Publication Company, Malabar, Florida, 1991.

CV35A5	ANALYSIS AND 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 - LOADING AND DESIGN PRINCIPLES 9

Loading- sequential loading, Gravity loading, Wind loading, Earthquake loading, - Equivalent lateral force, modal analysis - combination of loading, – Static and Dynamic approach - Analytical and wind tunnel experimental methods - Design philosophy - working stress method, limit state method and plastic design.

UNIT II - BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS 9

Factors affecting growth, height and structural form. High rise behaviour, Rigid frames, braced frames, In filled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, outrigger - braced and hybrid mega systems.

UNIT III - ANALYSIS AND DESIGN 9

Modeling 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 three dimensional analysis – Assumptions in 3D analysis – Simplified 2D 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 HOURS

REFERENCES:

1. Beedle.L.S., “Advances in Tall Buildings”, CBS Publishers and Distributors, Delhi, 1986.

2. Bryan Stafford Smith and Alexcoull, “Tall Building Structures - Analysis and Design”,John Wiley and Sons, Inc., 2005.
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.
5. Taranath B.S., “Structural Analysis and Design of Tall Buildings”, McGraw Hill, 1988.

CV35A6	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.

UNITIII 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.

UNITIV 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 HOURS

REFERENCES:

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

CV35A7	INDUSTRIAL STRUCTURES	L	T	P	C
		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 HOURS

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.

CV35A8	MECHANICS OF COMPOSITE MATERIALS	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 and 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 HOURS

REFERENCES:

1. Agarwal.B.D., Broutman.L.J., and Chandrashekara.K. "Analysis and Performance of Fiber Composites", John-Wiley and Sons, 2006.
2. Daniel.I.M., and Ishai.O, "Engineering Mechanics of Composite Materials", Oxford University Press, 2005.
3. Hyer M.W., and White S.R., "Stress Analysis of Fiber-Reinforced Composite Materials", D.Estech Publications Inc., 2009
4. Jones R.M., "Mechanics of Composite Materials", Taylor and Francis Group 1999.
5. Mukhopadhyay.M, "Mechanics of Composite Materials and Structures", Universities Press, India, 2005.

CV35A9	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 different 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.

CV35B1	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.

CV35B2	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 - INTRODUCTION TO NONLINEAR ANALYSIS **9**

Material nonlinearity, geometric nonlinearity; 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 HOURS

REFERENCES:

1. Fertis, D.G, "Nonlinear Mechanics", CRC Press, 1999.
2. Reddy.J.N, "Non linear Finite Element Analysis", Oxford University Press, 2008.
3. Sathyamoorthy.M, "Nonlinear Analysis of Structures", CRC Press, 2010.

CV35B3	FRACTURE MECHANICS	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 - ELEMENTS OF SOLID MECHANICS 9

The geometry of stress and strain, elastic deformation, plastic and elasto – plastic deformation – limit analysis – Airy's function – field equation for stress intensity factor.

UNIT II - STATIONARY BALANCE AND CRACK GROWTH 9

Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation – plastic zone size – Dugdaale model – determination of J integral and its relation to crack opening displacement.

UNIT III - ENERGY BALANCE AND CRACK GROWTH 9

Griffith analysis – stable and unstable crack growth – Dynamic energy balance- crack arrest mechanism – K1c test methods –R curves – determination of collapse load.

UNIT IV - FATIGUE CRACK GROWTH CURVE 9

Empirical relation describing crack growth law – life calculation for a given load amplitude – effects of changing the load spectrum – rain flow methods – external factors affecting the K1c values- leak before break analysis.

UNIT V - APPLICATION OF FRACTURE MECHANICS 9

Crack initiation under large scale yielding – thickness as a design parameter – mixed mode fractures – crack instability in thermal and residual stress fields – numerical methods.

TOTAL: 45 HOURS

REFERENCES

1. David Broek, "Elemetary Engineering fracture Mechanics", Fifthoff and Norerdhoff International publisher, 1978.
2. Kare Hellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985.
3. Preshant Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, 1999.
4. John Barson .M, and Stanly Rolfe. T, "Fatigue and fracture control in structures" Prentice hall Inc. Englewood cliffs 1977.

CV35B4	**PRE-ENGINEERED STRUCTURES**	**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 DESIGN PRINCIPLES 9

General Civil Engineering requirements, specific requirements for planning and layout of prefabrication plant. IS Code specifications. Modular co-ordination, standardization, Disuniting of Prefabricates, production, transportation, erection, stages of loading and code 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 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 HOURS

REFERENCES:

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

CV35B5	STRUCTURAL RELIABILITY	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 CONCEPTS OF STRUCTURAL SAFETY 9

General, Design methods. Basic Statistics: Introduction, Data reduction, Histograms, Sample correlation. Probability Theory: Introduction, Random events, Random variables, Functions of random variables, Moments and expectation, Common probability distribution, Extremal distribution.

UNIT II RESISTANCE DISTRIBUTIONS AND PARAMETERS 9

Introduction, Statistics of properties of concrete, Statistics of properties of steel, Statistics of strength of bricks and mortar, Dimensional variations, Characterization of variables, Allowable stresses based on specified reliability.

UNIT III PROBABILISTIC ANALYSIS OF LOADS 9

Gravity loads, Wind load. Basic Structural Reliability: Introduction, Computation of structural reliability. Monte Carlo Study of Structural Safety: General, Monte Carlo method

UNIT IV RELIABILITY METHODS 9

Introduction, Basic variables and failure surface, First-order second moment methods (FOSM). Reliability Based Design: Introduction, Determination of partial safety factors, Safety checking formats, Development of reliability based design criteria, Optimal safety factors, Summary of results of study for Indian standard – RCC design.

UNIT V RELIABILITY OF STRUCTURAL SYSTEMS 9

Preliminary concepts as applied to simple structures.

TOTAL: 45 HOURS

REFERENCES:

1. “Structural Reliability Analysis and Design” by Ranganatham, R.
2. “Structural Reliability” by Melchers, R.E.