Dr. MAHALINGAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
Udumalai Road, Pollachi, Coimbatore District - 642003
Established in 1998 ♦ Approved by AICTE ♦ Affiliated to Anna University
(A DIVISION OF NIA EDUCATIONAL INSTITUTIONS)
An Autonomous Institution
NAAC A++ GRADE
Cycle 3 (2023-2030)
The Highest Grade

Curriculum and Syllabi

M.E. Structural Engineering

Semesters I & II

Regulations 2024

Programme: M.E. STRUCTURAL ENGINEERING
Curriculum and Syllabi: Semesters – I & II
Recommended by Board of Studies on
Approved by Academic Council on

Action	Responsibility	Signature of Authorized Signatory
Designed and Developed by	BoS Civil Engineering	
Compiled by	Office of the Controller of Examinations	
Approved by	Principal	

Dr. Mahalingam College of Engineering and Technology

Department of Civil Engineering

Vision

To develop Competent Civil Engineers to meet the infrastructure challenges of India and the world.

Mission

- To become one of the reputed departments offering Civil Engineering Program in the country.
- To produce excellent engineers to cope up with the changes through dynamic, innovative, and flexible curriculum.
- To provide a conducive environment for teaching & learning and to develop leaders with effective communication skills.
- To conduct quality research driven by industry & societal needs and provide affordable engineering solutions in an ethical way.

Programme: M.E. Structural Engineering

Programme Educational Objectives (PEOs) - Regulation 2024

After completion of the programme the graduates will be able to:

PEO.1 Effectively demonstrate engineering knowledge, problem solving skill, design capabilities and entrepreneurial skills by providing practical solutions.

PEO.2 Effectively demonstrate professionalism in multi-disciplinary engineering environment, leadership quality, teamwork and engage in life-long learning.

Programme Outcomes (POs) - Regulations 2024

On successful completion of the programme the graduates will be able to:

PO1. Solve engineering problems after evaluating a wide range of potential solutions for those problems and arrive at feasible, optimal solutions with due consideration for public health, safety, cultural, societal and environmental factors.

PO2. Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data.

PO3. Communicate with the engineering community and with society at large, regarding complex engineering activities by being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, and making effective presentations.

PO4. Use engineering, management and IT tools for prediction and modeling of complex engineering activities with an understanding of the limitations.

Dr. Mahalingam College of Technology, Pollachi

2024 Regulations - Course Code Generation Procedure for PG Courses

Regulation

Mode of Assessment	
Character Type – Number	
T	Theory
I	Theory with Practical
L	Practical
E	Elective
O	Open Elective
P	Project
A	Audit Course

Semester Number	
Character Type – Number	
1 to 4	Semester
0	Floating

Sequence Number
Character Type – Number
01, 02, 03, . . . , 99

1	2	3	4	5	6	7	8
2	4	C	C	X	X	0	1

Board/Department/Programme/Course Type	
Character Type – Alphabet	
CC	CAD/CAM
CO	Communication Systems
CP	Computer Science and Engineering
ES	Embedded System Technologies
ST	Structural Engineering
CA	Computer Application
SH	Science and Humanities

Dr.Mahalingam College of Engineering and Technology, Pollachi
Department of CIVIL ENGINEERING
M.E. STRUCTURAL ENGINEERING
2024 Regulation – Curriculum for Semesters I to IV
Semester I

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24MAT104	Applied Mathematics for Structural Engineers	3	0	0	3	100	-
24STT101	Theory of Elasticity and Plasticity	3	0	0	3	100	-
24STT102	Structural Dynamics	3	0	0	3	100	-
24XXXXX	PE-I	3	0	0	3	100	-
24CCT101	Research Methodology and IPR	3	0	0	3	100	All
24STL101	Structural Engineering Laboratory	0	0	6	3	100	-
24SHA101	English for Research Paper Writing(Audit Course)	2	0	0	-	100	All
Total					**18**		

Semester II

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24STT201	Design of Advanced Reinforced Concrete Structures	3	0	0	3	100	-
24STT202	Finite Element Analysis in Structural Engineering	3	0	0	3	100	-
24STT203	Design of Advanced Steel Structures	3	0	0	3	100	-
24XXXX	PE-II	3	0	0	3	100	-
24XXXX	PE– III	3	0	0	3	100	-
24STL201	Design Studio	0	0	6	3	100	-
24STL202	Research Paper seminar	0	0	2	1	100	-
24SHA201	Teaching and Learning in Engineering	0	0	4	-	100	-
Total					**19**		

Semester III

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24XXXX	PE–III	3	0	0	3	100	-
24XXXX	PE–IV	3	0	0	3	100	-
24XXXX	Open Elective/Online Course	3	0	0	3	100	
24STP301	Project – I	0	0	20	10	200	-
Total					**19**		

Semester IV

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24STP401	Project – II	0	0	32	16	400	-
Total		**0**	**0**	**32**	**16**	**400**	

Total Credits: 72

Professional Electives

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
24STE001	Advanced Concrete Technology	3	0	0	3	100
24STE002	Health Monitoring of Structures	3	0	0	3	100
24STE003	Fracture Mechanism in Concrete Structures	3	0	0	3	100
24STE004	Structural Optimization	3	0	0	3	100
24STE005	Structural Stability	3	0	0	3	100
24STE006	Advanced Composite Materials for Structures	3	0	0	3	100
24STE007	Design of Off-Shore Structures	3	0	0	3	100
24STE008	Theory of Plates and shells	3	0	0	3	100
24STE009	Disaster Mitigation and Management	3	0	0	3	100
24STE010	Green Building Technology	3	0	0	3	100
24STE011	Retrofitting and Rehabilitation of Structures	3	0	0	3	100
24STE012	Design of Industrial Structures	3	0	0	3	100
24STE013	Design of Bridges	3	0	0	3	100
24STE014	Design of Sub-Structures	3	0	0	3	100
24STE015	Earthquake Resistant Structures	3	0	0	3	100
24STE016	Prefabricated Structures	3	0	0	3	100

SEMESTER I

Course Code: 24MAT104		Course Title: Applied Mathematics for Structural Engineers	
Course Category: Foundation Course		Course Level: Introductory	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours:	Max Marks: 100

Course Objectives:

The course is intended to:

1. Solve the variational problems with boundary conditions.
2. Solve the system of linear equations and apply numerical techniques to evaluate integrals.
3. Identify and solve engineering problems by applying the knowledge of partial differential equations.
4. Interpret the notion of sampling distributions and statistical techniques used in engineering problems.
5. Explain the systematic problem solving techniques using design of experiments.

Module I	22 Hours

Variational approach and Solution to set of Equations

Variation and its properties –Euler's equation – Functionals dependent on first and higher order derivatives - Functionals dependent on functions of several independent variables – Rayleigh Ritz method- Galerkin method.

Solving the set of equations, Choleski method, Iterative methods, Relaxation method, Trapezoidal rule, Simpson's rules, Gaussian quadrature, Examples.

Solution to Higher Order Partial Differential Equations

Second order linear equations and their classification, Initial and boundary conditions, DAlembert's solution of the wave equation. Separation of variables method to simple problems

Module II	23 Hours

Testing of Hypotheses and Design of Experiments

Statistical hypothesis, Large sample test based on Normal distribution for single mean and difference of means, Tests based on t, Chi-square and F distributions for mean, variance and proportion, Contingency table (test for independent), Goodness of fit.

Aim of Design of Experiments-Basic Principles of Experimental Design-Completely Randomized Design (CRD)-Analysis of Variance (AVOVA) - Randomized Design (RBD)-Latin Square Design(LSD)-Comparison of RBD and LSD.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Solve the set of equations using variational method and numerical method	Apply

CO2: Test the hypothesis and conduct experiments to decide the effect of responses	Apply
CO 3: Select an experiment no of inputs and its effect on response through a case study.	Apply
Reference Book(s):	
R1. T.Veerarajan, “Probability, Statistics and Random Process”, 3rd Edition, Tata McGrawHill, New Delhi,2017 R2. Erwin Kreyszig , “Advanced Engineering Mathematics”, (10th Edition), , John Wiley India,2013 Curtis F Gerald and Patrick O Wheatley, "Applied Numerical Analysis", Seventh Edition, Pearson, New Delhi, 2007 R3. R4. P.Kandasamy,K.Thilagavathy, K.Gunavathy, “Numerical Methods” S.CHAND, Latest Edition 2006	

Course Code: 24STT101		Course Title: THEORY OF ELASTICITY AND PLASTICITY	
Course Category: Professional Core		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks: 100

Course Objectives:

The course is indented to impart knowledge on the concepts of stress and strain in cartesian and polar coordinates, various energy theorems and plastic analysis of structures.

Module I	**25 Hours**

Basic concepts of deformation of deformable bodies- Notations of stress and strain in a 3D field Transformations of stresses and strains in Cartesian and polar co-ordinates- Equilibrium and compatibility equations in two and three dimensions in Cartesian co-ordinates.

Plane stress and plane strain problems - Two dimensional problems in Cartesian co-ordinates as applied in beam bending, using Airy's stress function - Polar co-ordinates. Equations of equilibrium and compatibility-two dimensional problems in polar co-ordinates-Stress concentration in holes.

Module II	**20 Hours**

Energy principle -theorem of minimum potential energy and complementary potential energy Torsion of various shaped bars- Prandtl's membrane analogy- energy method- Torsion of rolled Profiles- Stress concentration at re-entrant corners.

Introduction, yield criteria for metals, graphical representation of yield criteria, Flow laws of plastic mass, Plastic strain relations-Application to thick cylinders - Hollow spheres -Torsion.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Solve the 2D problems in the cartesian and polar coordinates.	Apply
CO2: Solve the problems on the energy principles, torsional behaviour of the members and plastic analysis.	Apply

REFERENCE BOOK:

R1.Timoshenko S P and Goodier J N, "Theory of Elasticity", Third edition, McGraw Hill Education, 2017.

R2. Jane Helena H, "Theory of Elasticity and Plasticity", First Edition, PHI Learning, New Delhi, 2017

R3. Chandramouli P N, "Theory of Elasticity", First Edition, Yes Dee Publications, 2017.

Course Code: 24STT102		Course Title: Structural Dynamics	
Course Category: Professional Core		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours:	Max Marks: 100

Course Objectives:

The objective of this course is to make students to learn principles of Structural Dynamics, To implement these principles through different methods and to apply the same for free and forced vibration of structures. To evaluate the dynamic characteristics of the structures

Module I	22 Hours

Introduction: Objectives - Importance of vibration analysis - Nature of exciting forces - Basic terminology related to vibration – natural frequency - natural period, resonance etc, - Dynamic degree of freedom - Assumption to reduce dynamic DoF - Mathematical modeling of dynamic systems.

Single Degree of Freedom System: Free and forced vibration with and without damping - Response to Harmonic Loading - Response to general dynamic loading using Duhamel's integral - Numerical solution of response using Newmark's method & Direct Integration, Concept of response spectrum.

Module II	23 Hours

Multiple Degree of Freedom System: Equation of motion of symmetrical and un-symmetrical structures in plan - Natural frequencies and mode shapes of vibrating system, Orthogonality of modes - Dynamic response by Modal Superposition Method - Response Spectrum Analysis, Missing mass correction - Introduction to multiple degree of freedom system with distributed mass and loading - Generalized Single Degree of Freedom System

Special Topics in Structural Dynamics:

Dynamic effects of Wind loading - Moving loads, Vibrations caused by High Speed Traffic - Blasting and Pile driving - Foundations for industrial machinery - Base-isolation.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply the concepts of vibration analysis.	Apply
CO 2: Apply and Interpret dynamics response of single degree freedom system using fundamental theory and experiments.	Apply
CO 3: Apply dynamic analysis of system/structures with Multi degrees of freedom under free and forced vibration.	Apply
Text Book(s):	
T1. Anil K.Chopra, Dynamics of Structures, Fifth edition, Pearson Education, 2020. T2. Mario Paz, Structural Dynamics -Theory and Computation, Kluwer Academic Publishers, Fifth Edition, 2006.	
Reference Book(s):	
R1. Roy R.Craig, Jr, Andrew J. Kurdila, Fundamentals of Structural Dynamics, John Wiley & Sons, 2011. R2. Madhujit Mukhopadhyay," Structural Dynamics: Vibrations and Systems", Ane's Student Edition,2017	

Course Code: 24CCT101		Course Title: RESEARCH METHODOLOGY AND IPR	
Course Category: Professional Core		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to describe the attitude measurements, scales and sampling methods and to apply hypotheses testing in research problem. Elucidate the research report writing and presentation effectively to encourage applying for patent and copyrighting for their innovative works.

MODULE I **22 Hours**

OVERVIEW OF RESEARCH METHODOLOGY

Research methodology – definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources ofdata, external sources of data.

ATTITUDE MEASUREMENTS, SCALES AND SAMPLING METHODS

Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's SemanticDifferential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods

– simple random sampling with replacement, simple random sampling without replacement,stratified, sampling, cluster sampling. Non- probability sampling method– convenience. **MODULE II** **23**

Hours

HYPOTHESES TESTING

Hypotheses testing – Testing of hypotheses concerning means (one mean and differencebetween two means -one tailed and two tailed tests).

REPORT WRITING AND PRESENTATION

Report writing- Types of report, guidelines to review report, typing instructions, oral presentation.

PATENTING

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting andDevelopment: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the attitude measurements, scales and sampling methods	**Apply**
CO2: Apply hypotheses testing in research problem.	**Apply**
CO3: Apply the patent and copyright for their innovative works	**Apply**
Reference Book(s):	
R1. Panneerselvam, R.,Research Methodology, Prentice-Hall of India, New Delhi, 2004.	
R2. Kumar, Ranjit, , "Research Methodology: A Step by Step Guide for beginners", London. Sage: Publications, 2005.	
R3. Halbert, "Resisting Intellectual Property", Taylor & Francis Publications,2007.	
R4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in NewTechnological Age", Clause 8 Publishing,2016.	
R5. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand Publications, 2008.	

Course Code: 24SHA101		Course Title: ENGLISH FOR RESEARCH PAPER WRITING (Common to all PG Programme)	
Course Category :Humanities		Course Level : Introductory	
L:T:P(Hours/Week) 2:0:0	Credits: -	Total Contact Hours: 30	Max Marks : 100

Course Objectives:

The course is intended to enhance the language skills concerning research paper writing and to explain the crucial role of technology in enhancing the quality and credibility of research.

Module I **15 hours**

Foundations of Academic English in Research: Academic English - Key Language Aspects - Clarity and Precision - Objectivity - Formal Tone - Integrating References.

Effective Writing Style for Research Papers: Word Order - Sentences and Paragraphs - Link Words for Cohesion - Avoiding Redundancy / Repetition - Breaking up long sentences - Paraphrasing Skills.

Advanced Reading and Research Vocabulary Development: Critical Reading Strategies - Analysing Research Articles - Identifying Arguments - Evaluating Findings - Formulaic Expressions - Academic Phrase Bank - Discipline-Specific Vocabulary - Commonly Misused Words.

Module II **15 hours**

Presentation Language Skills: Written vs. Spoken English - Dynamic Vocabulary for Presentations -Expressive Language for Audience Engagement- Language for Clear and Impactful Slides - Adapting Language Style to Different Audiences.

Grammar Refinement for Research Writing: Advanced Punctuation Usage- Proper Use of Modifiers - Avoiding Ambiguous Pronoun References - Verb Tense Consistency - Conditional Sentences.

Technology and Language for Research: Technology and Role of AI in Research Writing - Citations and References - Plagiarism and Ethical Considerations - Tools and Awareness - Fair Practices. Course Outcomes	Cognitive Level
At the end of the course the student will be able to :	
CO 1: Enhance their English Language Skills concerning research paper writing	Understand
CO 2: Develop a comprehensive set of linguistic skills essential for academic research.	Apply
CO 3: Produce well-structured research papers using a variety of research and presentation technologies.	Apply

Reference Book(s):

R1: Craswell, G. 2004. Writing for Academic Success. Sage Publications. Springer, New York
R2: Wallwork, Adrian. 2015. English for Academic Research: Grammar, Usage and Style
R3: Swales, J. & C. Feak. 2012. Academic Writing for Graduate Students: Essential Skills
and Tasks. Michigan University Press.
R4: ---2011. English for Writing Research Papers, Springer, New York.

Web References:

1. https://tiramisutes.github.io/images/PDF/English+for+Writing+Research+Papers.pdf
2. https://libguides.usc.edu/writingguide/grammar
3. https://onlinecourses.swayam2.ac.in/ntr24_ed15/preview.

Course Code: 24STL101	Course Title: STRUCTURAL ENGINEERING LABORATORY		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 0: 0: 4	Credits:2	Total Contact Hours: 60	Max Marks:100

Course Objectives

The course is intended to determine properties of the concrete specimens for NDT, behavior of structural members, effect of concrete and steel beam for flexure and for shear and buckling of the concrete column.

LIST OF EXPERIMENTS:

1. Demonstrations to instrumentation (LVDT, Load cell, Hydraulic jack, Strain gauges)
2. Testing of constitutive behavior of steel, aluminum and wood specimens
3. Casting and Testing of Simply Supported Reinforced Concrete beams for Flexure and Shear
4. Casting and Testing of Reinforced Concrete Columns for Buckling Behavior
5. Testing of Simply Supported Steel beams for Flexure and Shear
6. Non-destructive testing of concrete (a) Rebound hammer (b) Impact-Echo method and
   (c) Ultrasonic pulse velocity.

Course Outcomes	Cognitive Level
At the end of this course, student will be able to:	
CO.1. Determine properties of the concrete specimens for NDT	Apply
CO.2. Determine the behavior of structural members	Apply
CO.3. Determine the effect of concrete and steel beam for flexure and for shear.	Apply
CO.4. Determine the concrete column for buckling	Apply

Reference (s):

R1. A.R. Santhakumar, Concrete Technology, Oxford University Press,2007, New Delhi

R2. Relevant BIS Codes of practice for mix design, rebar testing, concrete design etc.

R3. Structural Engineering Laboratory Manual of Civil Engineering Department,MCET,2019.

SEMESTER II

Course Code: 24STT201		Course Title: Design of Advanced Concrete Structures	
Course Category: Core		**Course Level: Mastery**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours:45**	**Max Marks: 100**

Course Objectives:

The course is indented to impart knowledge on the concepts of design of basic concrete elements, walls, flat slab, frames and inelastic behaviour of structures.

Module I	**25 Hours**

Design for limit state of collapse - Design of beams for combined effect of shear, bending moment and torsion - Design of slabs - Design of short and slender columns including biaxial bending – detailing of reinforcements - Design for limit state of serviceability - Calculation of deflection and crack width as per IS : 456 – 2000.

Design and detailing of continuous beams and portal frames-design of multibay, multistoreyed R.C. frames: preliminary design-use of substitute frames for calculating stress resultants caused by gravity loading-portal and cantilever methods for lateral loads -detailing of reinforcements.

Classification and design principles of R.C. Wall and Shear wall, Design of curved beams and deep beams - Checking for Local Failures- Design of Ribbed slab.

Module II	**20 Hours**

Design of flat slab- Hillerborg's strip method - Equivalent frame method of design- Design of grid floors-detailing of reinforcements.

Inelastic behaviour of concrete beams and Baker's method -moment-rotation curves-moment redistribution in continuous beams- Design of cast-in-situ joints in frames. Detailing requirements for ductility, durability and fire resistance.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Design and detail RCC beams, columns, frames, and special elements using limit state method.	Analyze
CO2: Design and detail grid floor, flat slab and determine the inelastic behaviour of concrete beams using IS codes.	Analyze

Reference Book(s):

R1. Unnikrishna Pillai S and Devdas Menon, Reinforced concrete Design, 4th Edition, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2021.

R2. Park R and Paulay T, "Reinforced Concrete Structure", Wiley India Pvt Ltd., New Delhi, 2009.

Course Code: 24STT202		Course Title: FINITE ELEMENT ANALYSIS IN STRUCTURAL ENGINEERING	
Course Category: Core		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max Marks: 100**

Course Objectives:

The course aims to impart the knowledge on various finite element concepts, analyzing one and two dimensional solids, framed structures, plates and shells.

Module I	**23 Hours**

APPROXIMATE SOLUTIONS AND FINITE ELEMENT CONCEPTS

Approximate solutions of boundary value problems - Methods of weighted residuals, approximate solution using variational method and Modified Galerkin method - continuity, compatibility, convergence aspects - Finite element concepts - General finite element solution procedure, Finite element equations using modified Galerkin method.

ELEMENT PROPERTIES

Natural Coordinates - Triangular Elements -Rectangular Elements - Lagrange and Serendipity Elements -Solid Elements - Isoparametric Formulation - Stiffness Matrix of Isoparametric Elements.

ANALYSIS OF TWO AND THREE-DIMENSIONAL SOLIDS

Constant Strain Triangle - Linear Strain Triangle - Rectangular Elements- Numerical Evaluation of Element Stiffness - Computation of Stresses, Geometric Nonlinearity and Static Condensation - Axisymmetric Element - Finite Element Formulation of Axisymmetric Element - Finite Element Formulation for 3 Dimensional Elements- Problems

Module II	**22 Hours**

ANALYSIS OF FRAMED STRUCTURES

Stiffness of Truss Member - Analysis of Truss -Stiffness of Beam Member-Finite Element Analysis of Continuous Beam - Plane Frame Analysis - Analysis of Grid and Space Frame.

ANALYSIS OF PLATES AND SHELLS AND DYNAMIC APPLICATIONS

Finite Element Analysis of Thin Plate -Finite Element Analysis of Thick Plate -Finite Element Analysis of Skew Plate - Introduction to Finite Strip Method -Finite Element Analysis of Shell - Finite Elements for Elastic Stability - Dynamic Analysis - Nonlinear, Vibration and Thermal Problems - Meshing and Solution Problems.

Course outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1 Determine the stresses and strains for 2D and 3D problems using finite element method.	Apply
CO2 Analyze framed structures using finite element method	Analyze
CO3 Analyze the plates and shells using finite element method	Analyze

Text Book(s):
T1. . Desai, Y.M., Eldho, T.L. and Shah, A.H., "Finite Element Method", Pearson Education Asia, New Delhi,2011. T2. Chandrupatla, R.T. and Belegundu, A.D., "Introduction to Finite Elements in Engineering", Prentice Hall of India, 2012.
Reference Book(s):
R1. SS. Bhavikkatti, "Introduction to Finite Element Analysis", New Age International Pvt. Ltd., New Delhi, 2005. R2. Singiresu. S. Rao, "The Finite Element Method in Engineering", Butterworth-Heinemann, India Edition, 2010.

Course Code: 24STT203	Course Title: Advanced Design of Steel Structures		
Course Category: Professional Core	Course Level: Mastery		
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:	
• To study the about the connections, analysis and design of Industrial building elements, • To study the design of cold formed steel, special structures and plastic analysis of structures.	
Module I	**22 Hours**
DESIGN OF CONNECTIONS: Types of connections – Welded and Bolted – 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 HSFG bolted connections. **ANALYSIS AND DESIGN OF INDUSTRIAL BUILDINGS**: Structural Configurations - Functional and Serviceability Requirements- Analysis and design of different types of trusses – Analysis and design of industrial buildings – Sway and non-sway frames –Gantry Girders –Earthquake resistant design of steel buildings.	
Module II	**23 Hours**

DESIGN OF LIGHT GAUGE STEEL STRUCTURES: Introduction to Direct Strength Method - Behaviour of Compression Elements - Effective width for load and deflection determination – Behaviour of Unstiffened and Stiffened Elements – Design of webs of beams – Flexural members – Lateral buckling of beams – Shear Lag – Flange Curling – Design of Compression Members – Wall Studs.

DESIGN OF SPECIAL STRUCTURES

Micro Wave Towers – Transmission line towers – Loads on towers - Shape, Sag and Tension in Uniformly loaded conductors -Analysis of towers – Design of member in towers – Design of steel water tank - Design of chimney – Design of bunkers and silos.

Course Outcome On completion of the course, the student is expected to be able to		**Cognitive Level**
CO1	Apply design principles as per IS codes for design of different types of steel connections and industrial structural elements.	Apply
CO2	Apply design principles as per IS codes for design of light gauge steel structures, special structures and composite members.	Apply

TEXT BOOKS:

1. Narayanan.R.et.al., Teaching Resource on Structural steel Design,
2. INSDAG, Ministry of Steel Publishing, 2000.
3. Subramanian. N, Design of Steel Structures, Oxford University Press, 2016.
4. S.K. Duggal, Limit State Design of Steel Structures, McGraw Hill Book Company, 2017

REFERENCES:

1. L.S.Jayagopal, D.Tensing, Design of Steel Structures, Vikas Publishing, 2015
2. Dayaratnam, Design of Steel Structures, S. Chand & Company Ltd.,2012
3. S.Ramchandra and Virendra Gehlot,'Design of Steel Structures', Vol.-II, Scientific Publication, New Delhi,2010.
4. INSDAG, 'Teaching Resource for Structural Steel Design', Kolkotta, Version-II
5. Wie Wen Yu, Design of Cold-Formed Steel Structures, McGraw Hill Book Company, 2019

Course Code: 24STL201		Course Title: Design Studio	
Course Category: Core		Course Level: Practice	
L:T:P(Hours/Week) 0:0 :3	Credits: 1.5	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The students will be able to analysis and design various structural elements using software.

List of Exercises:

Analysis of Structures using Software

1. Analysis of pin jointed plane trusses.
2. Analysis of Rigid jointed plane frames.
3. Plane stress analysis of CST and four nodded isoparametric elements.

Design of Reinforced concrete structures using software

4. Design and detailing of slabs and beams.
5. Design and detailing of short and slender columns.
6. Design and detailing of reinforced concrete retaining wall (cantilever type).
7. Design and detailing of different types of foundations.

Design of steel structures using software

8. Design of steel structural elements (Beams and Columns)
9. Design of Purlins and elements of truss.
10. Design of steel towers.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Analyse the truss, frame and other elements using software.	Analyse
CO2: Analyse and design the various structural components in steel and concrete using software.	Analyse

Reference Book(s):

R1. Design Studio Laboratory Manual of Civil Engineering Department, MCET, Pollachi.

Reference Book(s):

R1. Design Studio Laboratory Manual of Civil Engineering Department, MCET, Pollachi.

Course Code: 24SHA201		Course Title: TEACHING AND LEARNING IN ENGINEERING (Common to all PG Programmes)	
Course Category: Audit Course		Course Level: Introductory	
L:T:P(Hours/Week) 0:0:4	Credits: -	Total Contact Hours: 30	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on an outcome-based approach, employing active learning methods in lecture/practical/tutorial sessions. Assessments will be conducted using rubrics, focusing on higher-order thinking skills.

Module I **15 Hours**

Outcome Based Approach

Outcome based Education- Need & Approach- Washington accord- Graduate attributes- Learning outcomes –Blooms Taxonomy.

Active Learning Methods

Design and Delivery plan for lectures/practical/tutorial sessions-Need for Active learning methods-Active learning strategies- Benefits of Active learning Methods.

Module II **15Hours**

Assessments

Assessments- types of assessments-need for rubrics, Types of rubrics- Assessment using rubrics.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Use outcome based approach in teaching courses in engineering Programmes.	Apply
CO 2: Conduct lecture/practical/tutorial sessions using active learning methods.	Apply
CO 3: Conduct higher order assessments by using rubrics.	Apply

Reference Book(s):

1. William G. Spady and Francis Aldrine A. Uy (2014). Outcome-Based Education: Critical Issues and Answers, ISBN: 978-971-0167-41-8, Maxcor Publishing House, Inc.
2. Dr. William G. Spady, WajidHussain, Joan Largo, Dr. Francis Uy (2018). Beyond Outcomes Accreditation: Exploring the Power of 'Real' OBE Practices.
3. Richard M. Felder, Rebecca Brent (2016), Teaching and Learning STEM: A Practical Guide, John Wiley & Sons Inc.

ELECTIVES

Course Code: 24STE001	Course Title: Advanced Concrete Technology		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) - 3:0:0	Credits: 3	Total Contact Hours:45	Max Marks: 100

Course Objectives:

To study the properties of materials in concrete, mix design, tests, strength and durability properties concrete and also about special concretes.

Module I	22 Hours

Fundamentals of Concrete:

Properties of materials used in concrete – types and properties of admixtures, effects of admixtures on fresh and hardened concrete - measurement of workability by quantitative empirical methods – concrete properties: setting and hardening - mix design for various concrete.

Properties of Fresh and Hardened Concrete:

Process of manufacturing, transporting, placing and curing of concrete. Tests on fresh & hardened concrete - elastic behavior in concrete - creep, shrinkage and thermal properties of concrete - failure modes in concrete

Module II	23 Hours

Durability of concrete: Classification of causes of concrete deterioration – permeability of concrete – durability concept: pore structure and transport process - alkali-aggregate reactivity. assessment of durability properties of concrete - non-destructive testing of concrete.

Special Concrete:

Properties and applications of Light weight concrete – Polymer concrete – Geo polymer concrete - Cellular concrete – Aerated & foamed concrete - high strength concrete - high performance concrete - fiber reinforced concrete - High density concrete – Self healing concrete – Recycled concrete

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply knowledge on various materials needed for concrete manufacture and to do mix design as per IS code.	Apply
CO 2: Explain various tests on fresh and hardened concrete to get knowledge on strength and durability properties of concrete.	Apply
CO 3: Apply knowledge on selection of various special concrete for different structures.	Apply
Reference Book(s):	
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.	

Course Code: 24STE002		Course Title: HEALTH MONITORING OF STRUCTURES	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge structural health monitoring for structures and understand the conditional assessment & techniques for strengthening and retrofitting of structures.

Module I **22 Hours**

Introduction of Structural Health Monitoring

Need of Structural Health Monitoring – Concept of SHM – SHM & Biomimetic Comparison of SHM with NDT – Types & Components of SHM – Procedure of SHM – Objectives & Operational Evaluations of SHM – Advantages of SHM

Instrumentations & Sensors for SHM

Basics of Instrumentations & Measurements – Classifications – Input-Output Configurations of Instruments – Static & Dynamic Characteristics – Functions. Various Types of Electromechanical, Electronics & Digital Instruments for SHM. Data Acquisition Systems: Types, Hardware & its Components.

Basics of Sensors – Transducers & Actuators – Classification of Sensors – Characteristics & Working Principles of Various Types of Sensors like Strain Gauges – LVDT – Accelerometers Concept of Smart Materials & Smart Structures with SHM – Basics of Smart Materials like Piezoelectric – Shape Memory Alloys – ER & MR Fluids etc

Module II **23 Hours**

Methods of SHM : Methodologies and Monitoring Principles – Local & Global Techniques for SHM – Static & Dynamic Field Testing – Short & Long-Term Monitoring – Active & Passive Monitoring. Vibration Based SHM Techniques - Use & Demonstration of Dynamic Properties of Structures for Damage Detection & SHM – Ambient Vibration Test – Acoustic Emission Technique – Electromechanical Impedance Technique – Wave Propagation Based Techniques – Fibre Optics Based Techniques – Remote & Wireless SHM Techniques – IoT Application in SHM – Artificial Intelligence & Machine Learning in SHM

Structural Assessment & Retrofitting of Structures: Structural Assessment & Need for retrofitting – Health assessment of structures – structural damages & failures – Principles of structural assessment – Classification & levels of assessment – Current scenario of infrastructure through case studies

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Adopt a proper health monitoring technique and suggest solution for the problems identified in the structures.	Apply
CO 2: Analyze the various health monitoring system and apply to the real time problems.	Analyse
CO 3: Propose a research project focused on developing innovative ways to monitor the health of aging infrastructure. Outline your research objectives, methodology, and expected outcomes.	Apply

Text Book(s):

T1. Daniel Balageas, Claus - Peter Fritzen, Alfredo Guemes, "Structural Health Monitoring", 1st Edition, ISTE Publishing Ltd., U.K. 2006.

T2. Douglas E "Health Monitoring of Structural Materials and Components Methods with Applications", 1st Edition, Wiley Publisher, 2007.

T3. J. P. Ou, H. Li and Z. D. Duan "Structural Health Monitoring and Intelligent Infrastructure", Vol1, Taylor and Francis Group, London, UK, 2006.

Reference Book(s):

R1. Victor Giurglutiu, "Structural Health Monitoring with Wafer Active Sensors", Academic Press Inc, 2007.

R2. Hand book on "Repair and Rehabilitation of RCC Buildings", Director General, CPWD, Govt. of India, 2002.

Web References:

1. https://research.csiro.au/data61/structural-health-monitoring
2. https://beanair.com/conditioning-monitoring-system.html
3. https://www.hindawi.com/journals/ace/2010/724962/
4. https://www.ndt.net/events/NDTCanada2014/app/content/Slides/40_Tamutus.pdf
5. https://cpwd.gov.in/Units/FinalDraftHandbook_Apr2007.pdf

Course Code: 24STE003		Course Title: FRACTURE MECHANISM IN CONCRETE STRUCTURES	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course aims to impart the knowledge on fracture types and micro mechanism, energy concepts in crack and mechanism of linear elastic and elastic plastic fractures.

Module I	23 Hours

INTRODUCTION TO FRACTURE MECHANISM

Ductile and brittle fractures - Conventional design practices - Need for fracture mechanics in design - Micromechanics of various types of fracture - Mode I, II and III cracks - Crack detection methods.

ENERGY RELEASE RATE AND RESISTANCE OF CRACK

Stress concentration concepts - Griffith's theory and Irwin's modification - Energy release rate - Change in compliance and strain energy approaches - Crack resistance curves - Plane stress and plane strain cases - Crack stability and instability conditions.

Module II	22 Hours

LINEAR ELASTIC FRACTURE AND ELASTIC PLASTIC FRACTURE MECHANICS

Linear Elastic Fracture Mechanics (LEFM), Conditions for validity of LEFM - Stress field around crack tip in Mode I, II and III cracks - Stress intensity parameter - Formulations under complex loads - Relation between stress intensity parameter and energy release rate - Crack tip plastic zone - Analysis of plastic zone size by conventional yield theories - Irwin's correction - Relevant and scope of elastic plastic fracture mechanics, J-Integral, Path independence, Stress-Strain relation.

CRACK TIP OPENING DISPLACEMENT AND FATIGUE

Introduction - Relationship between CTOD, KI, GI for small scale yielding - Equivalence between CTOD and J; S-N curve - crack initiation and propagation - effect of overload - variable amplitude fatigue load.

Course Outcomes	**Cognitive Level**
At the end of this course - students will be able to:	
CO1 Identify the fracture mechanism and apply suitable method for crack detection.	Apply
CO2 Understand the energy concepts in cracks.	Understand
CO3 Categorize the relevance and scope of elastic fracture and elastic plastic fracture mechanics and Recognize concepts in crack initiation and propagation under fatigue Loading	Apply

Text Book(s):

T1. . .T.L. Anderson, Fracture mechanics: Fundamentals and Applications, 4th Edition. CRC Press, Taylors & Francis, 2017.

T2. Shah, S.P., Swartz, S.E., and Ouyang, C., Fracture Mechanics of Concrete: Applications of Fracture Mechanics to Concrete, Rock, and Other Quasi-brittle Materials, John Wiley and Sons, 1994.

Reference Book(s):

R1. K. Ramesh, E-Book, Engineering Fracture Mechanics (With Troubleshooting and searching, multimedia facilities) by, IIT, Madras.

R2. ACI 446.1 R-91, Fracture Mechanics of Concrete: Concepts, Models and Determination of Material Properties, American Concrete Institute.

<table>
<tr><td colspan="2">Course Code: 24STE004</td><td colspan="2">Course Title: Structural Optimization</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week) 3:0 :0</td><td>Credits: 3</td><td>Total Contact Hours: 45</td><td>Max Marks: 100</td></tr>
<tr><td colspan="4">Course Objectives:
The course is intended to impart knowledge on concept of optimization, linear programming and non-linear programming. Solve problem on dynamic programming in optimization and practical structures subjected to dynamic loading.</td></tr>
<tr><td colspan="3">Module I</td><td>25 Hours</td></tr>
<tr><td colspan="4">Introduction to Optimization: Engineering application of Optimization – Statement of an optimization problem - Optimal Problem formulation – Classification of optimization problems. Active constraint - Global and Local minima. Standard form of a linear programming – Geometry of linear programming – Simplex method – Basic solution – computation maximization and minimization – Dual relations – Dual simplex method – revised simplex method - One dimensional minimization methods – Dichotomous search – Fibonacci method – Golden section method – Interpolation methods. Unconstrained optimization techniques – Cauchy’s steepest descent method – Davidon Fletcher powell method.</td></tr>
<tr><td colspan="3">Module II</td><td>20 Hours</td></tr>
</table>

Bellman's principle of optimality - Representation of a multistage decision problem – Concept of sub-optimization problems using classical and tabular methods – Linear programming as a case of dynamic programming - Methods of optimal design of structural elements – Minimum weight design for truss members – Fully stressed design – Optimization principles to design of R.C members.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Identify, formulate and solve engineering problems by linear and non-linear programming by applying the knowledge of optimization techniques.	Apply
CO 2: Apply the engineering knowledge to understand the concept of dynamic programming and design various structural elements.	Apply
CO 3: Prepare a case study on any of the optimization technique followed in engineering members.	Apply
Text Book(s):	
T1. Rao, S.S. "Engineering Optimization: Theory and Practice", 4th Edition, Wiley Eastern (P) Ltd., 2013. T2. Belegundu A. D., Chandrupatla T. R., Optimization Concepts and Applications in Engineering, 2nd Edition, Cambridge University Press, Delhi, 2011.	
Reference Book(s):	
R1. Kalyanmoy Deb, Optimization for Engineering Design Algorithms and Examples, Prentice Hall, 2012 R2. J.S.Arora, "Introduction to Optimum Design", McGraw –Hill Book Company, 2011. R3. Iyengar. N.G.R and Gupta. S.K, "Structural Design Optimization", Affiliated East West Press Ltd, New Delhi, 1997	

Course Code: 24STE005		Course Title: STRUCTURAL STABILITY	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to expose the students to the buckling of different structural elements such as beam, column, frames, & plates and also to know about the torsional and lateral buckling.

Module I	22 Hours

Buckling of Columns

States of equilibrium – concept of equilibrium, energy, imperfection and vibration approaches to stability analysis. Governing equation for column buckling – 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.

Buckling of Beam-Columns and Frames

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.

Module II	**23 Hours**

Torsional and Lateral Buckling

Torsional buckling – Combined Torsional and flexural buckling - Local buckling - Buckling of Open Sections - Lateral buckling of beams – pure bending of simply supported and cantilever beams.

Buckling of Plates

Governing differential equation - Buckling of thin plates with various edge conditions - Analysis by equilibrium and energy approach – Finite difference method.

Inelastic Buckling

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Derive the buckling load on column, beam – columns and frames by various approaches.	Apply
CO 2: Derive the equation for buckling of thin walled members, plates and inelastic buckling.	Apply
CO 3: Prepare a report on real-world structural failure by identifying the causes of instability, and propose alternative design strategies that could have prevented the failure.	Apply

Reference Book(s):

R1. Timoshenko, S., and Gere., Theory of Elastic Stability, McGraw Hill Book Company, 1963.

R2. Chajes, A. Principles of Structures Stability Theory, Prentice Hall, 1974.

R3. Ashwini Kumar, Stability Theory of Structures, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1995.

R3. Iyenger.N.G.R., Structural stability of columns and plates, Affiliated East West Press,1986.

R5. Gambhir, Stability Analysis and Design of Structures, Springer, New York

Course Code: 24STE006		**Course Title: Advanced Composite Materials for Structures**	
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3:0 :0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks: 100**

Course Objectives:

The course is intended to impart knowledge on the concept of composite materials, analyse the mechanical properties of composite laminae, behavior of glass-fibre laminates and design the GRP box beams.

Module I	**25 Hours**

Requirements of structural materials – Influence of natural materials in structural form – Nature of structural materials – Homogeneous and composite materials – Assumptions and idealization – stress-strain relation – Isotropic and orthotropic laminae – Macro mechanical analysis of composite laminae, introduction, assumptions and limitations – Stiffness characteristics of glass reinforced laminae – Stress-strain relationships in continuous and discontinuous fiber laminae – Strength characteristics of glass reinforced laminae – Stiffness characteristics of laminated composites – Behaviour of laminated beams and plates – Strength analysis and failure criteria, Effect of inter laminar structures – Glass reinforced composites – Continuously reinforced laminates – unidirectional and multi directionally continuously reinforced laminates – Stiffness and strength properties.

Module II	**20 Hours**

Adhesive, mechanical, combinational, transformed sections short and long term strength and stiffness properties – Temperature and fire effects – Structural joints – Experimental behavior – Effect on beam performance – Modulus of Elasticity, compressive strength – I value – Prevention of compression buckling failure – Behavior under long term loading – Design of stressed skinned roof structure.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Analyze the mechanical behavior of composite laminae by using the concept of composite materials	Analyze
CO 2: Apply the concept of composite laminates to design structural elements	Apply
CO 3 : Design GRP box beams by using the concept of composite laminates and the behavior of glass-fibre laminates	Apply
CO 4: Propose a research project on developing a composite structural element.	Apply

Text Book(s):

T1. R Fangueiro, Fibrous and Composite Materials for Civil Engineering Applications, Woodhead Publishing Ltd, 2011

T2. Madhujit Mukhop, Mechanics of Composite Materials and Structures, Universities press, 2004.

Reference Book(s):

R1. Holmes. M and Just D.J., GRP in Structural Engineering, Narosa Puublications, New Delhi, 2008.

R2. Robert M Jones, Mechanics of Composite Materials, McGraw Hill Publishing Co., 2002.

R3. Bhagwan D Agarvalm, and Lawrence J Brutman, Analysis and Performance of Fiber Composites, John Willy and Sons, 2004.

Course Code: 24STE008		Course Title: THEORY OF PLATES AND SHELLS	
Course Category:		Course Level:	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to expose the students to understand the deformation of plates, classification of shells and numerical approaches to solve plates and shells.

Module I	23 Hours

Symmetrical Bending of Plates

Equation of equilibrium and deformation of plates – Bending of rectangular plates and circular plates – Post buckling behaviour.

Numerical Methods

Energy method – Finite difference and Finite element methods – Plate bending problems – Principles of design of folded plates

Module II	22 Hours

Shells

Shell surfaces - Classification of shell surfaces – Surfaces of revolution – Δ-forms of surfaces – Characteristics of shell surfaces – Surfaces and its related aspects – Curvatures of a surface – Curves and related aspects.

Structural Behaviour of Shell

Structural behaviour and various relations – Equilibrium equations – Stress-strain relationships – Equilibrium equations for thin shell elements in membrane state – Curvilinear coordinate system – Shells of revolution – Strain-displacement relations for cylindrical shells.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Derive the differential equation for bending of thin plate, rectangular, circular and folded thin plates.	Apply
CO 2: Derive the equilibrium equations for shells.	Apply
CO 3: Prepare a report on identifying the causes of failure, the role of plate and shell behavior in the failure, and suggest design improvements.	Apply

Text Book(s):

T1. Chandrashekahara, K. Theory of plates, University Press (India) Ltd., Hyderabad, 2001.

T2. Reddy J N, “Theory and Analysis of Elastic Plates and Shells”, McGraw Hill Book Company, 2006.

T3. Timoshenko. S. P, and Krieger S. W. Theory of Plates and Shells, McGraw Hill Book Company, New York, 2003.

Reference Book(s):

R1. Ventsel E and Krauthammer T, “Thin Plates and Shells”, Marcel Dekker, Inc., 2001.

R2. Ugural A, “Stresses in Plates and Shells”, McGraw Hill, 1999.

R3. Gould P. L, “Analysis of Shells and Plates”, Springer-Verlag, 1988.

R4. Dym C. L, “Introduction to the Theory of Shells”, Hempshire Publishing Corp., 1990.

Course Code: 24STE009	Course Title: DISASTER MITIGATION AND MANAGEMENT		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge of causes of various disaster and its impact, concept of Disaster Management Cycle and Framework and Applications of Science and Technology for Disaster Management & Mitigation.

Module I	22 Hours

Introduction

Concepts of Disaster and its types – Hazard – Vulnerability – Risk – Capacity – Disaster and Development – disaster management.

Consequences and Control of Disasters

Geological, Hydro-Meteorological, Biological, Technological and Man- made Disasters – Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters.

Disaster Management Cycle and Framework

Disaster Management Cycle – Paradigm Shift in Disaster Management – Pre-Disaster Risk Assessment and Analysis – Risk Mapping – zonation and Micro zonation – Prevention and Mitigation of Disasters – Early Warning System: Preparedness – Capacity Development – Awareness During Disaster Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Damage and Needs Assessment – Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment – IDNDR – Yokohama Strategy – Hyogo Framework of Action

Module II	23 Hours

Disaster Management in India

Disaster Profile of India – Mega Disasters of India and Lessons Learnt – Disaster Management Act 2005 – Institutional and Financial Mechanism – National Policy on Disaster Management – National Guidelines and Plans on Disaster Management – Role of Government – Non-Government and Inter-Governmental Agencies

Applications of Science and Technology for Disaster Management & Mitigation

Geo-informatics in Disaster Management – Disaster Communication System – Land Use Planning and Development Regulations – Structural and Non Structural Mitigation of Disasters – S&T Institutions for Disaster Management in India

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Analyze the consequences, trends, and emerging risks associated with disasters to evaluate global disaster trends through the case studies of disasters, identify lessons learned, and propose innovative solutions for disaster risk reduction and management.	Apply
CO 2: Apply geo-informatics tools to mitigate disaster risks effectively and evaluate the role of science and technology in disaster management and recovery.	Analyse
CO3: Propose a case study analysis of a recent disaster event and assess the strengths and weaknesses of the disaster management response. Identify lessons learned and recommendations for future improvement.	Apply

Text Book(s):

T1. S.C. Sharma," Disaster Management" Khanna Publishing, 2nd edition, 2022.

T2. Damon P Coppola, "Introduction to International Disaster Management" BH Publishers, 4th edition, 2021.

T3. Manual on "Natural disaster management in India", M C Gupta, NIDM, New Delhi.

Reference Book(s):

R1. Disaster Management Act, Publisher by Govt. of India.

R2. National Disaster Management Policy, GoI.

Web References:

1. https://ndma.gov.in/
2. https://www.newbedford-ma.gov/emergency-management/emergencies-disasters/mitigation/
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7152083/
4. https://www.asdma.gov.in/pdf/publication/undp/disaster_management_in_india.pdf

Course Code: 24STE010		Course Title: RETROFITTING AND REHABILITATION OF STRUCTURES	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course aims to impart the knowledge on assessing the structural defects, selecting the proper repair materials and various retrofitting techniques.

Module I	22 Hours

MAINTENANCE AND REPAIR ASSESSMENT

Need for rehabilitation of structures - Service life behaviour - importance of Maintenance - causes and effects of deterioration - Different types of cracks, causes and effects due to Environment, Fire and Earthquake - Mechanism of steel corrosion in concrete and quantification of corrosion damage - Non-destructive Testing Techniques**.**

REPAIR MATERIALS AND SPECIAL CONCRETES

Repair materials-Various repair materials, Criteria for material selection, Methodology of selection, Special mortars and concretes- Polymer Concrete and Grouting materials- Bonding agents-Latex emulsions, Epoxy bonding agents, Protective coatings-Protective coatings for Concrete and Steel, FRP sheets.

Module II	23 Hours

STRUCTURAL PROTECTION METHODS

Concrete protection methods – reinforcement protection methods- cathodic protection – Sacrificial anode - Corrosion protection techniques – Corrosion inhibitors, concrete coatings- Corrosion resistant steels, Coatings to reinforcement

REPAIR, RETROFITTING AND DEMOLITION OF STRUCTURES

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

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1 Assess the structural health and select suitable repair and retrofitting technique.	Apply
CO2 Adopt specific materials required for repair and retrofitting of structures.	Apply
CO3 Apply the techniques for repair, retrofitting and protection of existing structures.	Apply
CO4 Prepare a detailed case study report on structural defects of existing structures and suggest suitable repair and retrofitting measures.	Apply

Text Book(s):

T1. Ravishankar.K., Krishnamoorthy. T.S, Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures, Allied Publishers, 2004.

T2. Varghese, P.C., "Maintenance Repair and Rehabilitation and Minor Works of Building", 1st Edition, Prentice Hall India, 2014.

Reference Book(s):

R1. Hand Book on "Repair and Rehabilitation of RCC Buildings-Director General Works CPWD", Govt of India, New Delhi,2002.

R2. Hand Book on "Seismic Retrofit of Buildings",CPWD and Indian Buildings Congress, Narosa Publishers, 2008.

Web References:

1. https://onlinecourses.nptel.ac.in/noc22_ce20/preview
2. cpwd.gov.in/Units/handbook.pdf

Course Code: 24STE010		Course Title: GREEN BUILDING TECHNOLOGY	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge about green building technologies and their application in sustainable construction and development.

Module I	25 Hours

Introduction to Green Buildings: Definition of green buildings and sustainable development – typical features of green buildings – benefits of green buildings towards sustainable development. Green building rating systems: GRIHA – IGBC – LEED – overview of the criteria as per these rating systems.

Site selection and planning: Criteria for site selection – preservation of landscape – soil erosion control – minimizing urban heat island effect – maximize comfort by proper orientation of building facades, day lighting, ventilation, etc.

Water conservation and efficiency: Rainwater harvesting methods for roof & non-roof – reducing landscape water demand by proper irrigation systems – water efficient plumbing systems – water metering – waste water treatment – recycle and reuse systems.

Energy Efficiency: Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy

Methods to reduce operational energy: Energy efficient building envelopes – efficient lighting technologies – energy efficient appliances for heating and air-conditioning systems in buildings – zero ozone depleting potential (ODP) materials – wind and solar energy harvesting – energy metering and monitoring – concept of net zero buildings

Module II	20 Hours

Building materials: Methods to reduce embodied energy in building materials: Use of local building materials – Use of natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks – use of materials with recycled content such as blended cements, pozzolana cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste – Reuse of waste and salvaged materials

Waste Management: Handling of construction waste materials – separation of household waste – on-site and off-site organic waste management

Indoor Environmental Quality for Occupant Comfort and Wellbeing: Daylighting – air ventilation – exhaust systems – low VOC paints – materials & adhesives – building acoustics – Codes related to green buildings: NBC – ECBC – ASHRAE – UPC etc.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Analyse site selection criteria for green buildings, considering landscape preservation and Assess strategies for enhancing energy efficiency in green buildings.	Analyse
CO 2: Analyze the environmental impact of building materials and apply methods to reduce embodied energy, promoting the reuse of waste materials and importance of indoor environmental quality for occupant comfort and well-being.	Apply
CO 3: Compare and evaluate the criteria used by green building rating systems to assess the sustainability and environmental performance of buildings.	Analyse
CO 4: Investigate the role of green building technology in mitigating climate change. Discuss how green buildings contribute to reducing carbon emissions and improving resilience to climate-related challenges.	Analyse

Text Book(s):

T1. Indian Green Building Council, “Introduction to Green Building and Built Environment” BS Publications, 2023.

T2. GRIHA version 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment.

T3. Charles J. Kibert, “Sustainable Construction - Green Building Design and Delivery”, John Wiley & Sons, New York, 2008.

Reference Book(s):

R1. Sustainable Building Design Manual, Vol.1 and 2, TERI, New Delhi, 2004.

R2. K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao “Alternative building materials and technologies “ New age international publishers, 2007.

R3. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, Indian Green Building Council Publishers, 2013.

Web References:

1. https://archive.nptel.ac.in/courses/105/102/105102195/
2. https://onlinecourses.nptel.ac.in/noc19_ce40/preview
3. https://www.igi-global.com/chapter/green-building-technologies/284812

Course Code: 24STE011		Course Title: RETROFITTING AND REHABILITATION OF STRUCTURES	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course aims to impart the knowledge on assessing the structural defects, selecting the proper repair materials and various retrofitting techniques.

Module I	22 Hours

MAINTENANCE AND REPAIR ASSESSMENT

Need for rehabilitation of structures - Service life behaviour - importance of Maintenance - causes and effects of deterioration - Different types of cracks, causes and effects due to Environment, Fire and Earthquake - Mechanism of steel corrosion in concrete and quantification of corrosion damage - Non-destructive Testing Techniques**.**

REPAIR MATERIALS AND SPECIAL CONCRETES

Repair materials-Various repair materials, Criteria for material selection, Methodology of selection, Special mortars and concretes- Polymer Concrete and Grouting materials- Bonding agents-Latex emulsions, Epoxy bonding agents, Protective coatings-Protective coatings for Concrete and Steel, FRP sheets.

Module II	23 Hours

STRUCTURAL PROTECTION METHODS

Concrete protection methods – reinforcement protection methods- cathodic protection – Sacrificial anode - Corrosion protection techniques – Corrosion inhibitors, concrete coatings- Corrosion resistant steels, Coatings to reinforcement

REPAIR, RETROFITTING AND DEMOLITION OF STRUCTURES

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

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1 Assess the structural health and select suitable repair and retrofitting technique.	Apply
CO2 Adopt specific materials required for repair and retrofitting of structures.	Apply
CO3 Apply the techniques for repair, retrofitting and protection of existing structures.	Apply
CO4 Prepare a detailed case study report on structural defects of existing structures and suggest suitable repair and retrofitting measures.	Apply

Text Book(s):

T1. Ravishankar.K., Krishnamoorthy. T.S, Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures, Allied Publishers, 2004.

T2. Varghese, P.C., "Maintenance Repair and Rehabilitation and Minor Works of Building", 1st Edition, Prentice Hall India, 2014.

Reference Book(s):

R1. Hand Book on "Repair and Rehabilitation of RCC Buildings-Director General Works CPWD", Govt of India, New Delhi,2002.

R2. Hand Book on "Seismic Retrofit of Buildings",CPWD and Indian Buildings Congress, Narosa Publishers, 2008.

Web References:

3. https://onlinecourses.nptel.ac.in/noc22_ce20/preview
4. cpwd.gov.in/Units/handbook.pdf

Course Code: 24STE012		Course Title: Design of Industrial Structures	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to expose the students to the planning and functional requirements of industrial building. It also includes design if various industrial structures.

Module I	23 Hours

Planning and Functional Requirements

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.

Industrial Buildings

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

Module II	22 Hours

Power Plant Structures

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

Transmission Line Structures and Chimneys

Analysis and design of steel monopoles, transmission line towers – Sag and Tension calculations, Methods of tower testing – Design of self-supporting and guyed chimney, Design of Chimney bases.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Develop the concept of planning, analyse and design of industrial structures.	Apply
CO2: Analyse & design of power plant structures, transmission line structures and chimneys.	Apply
CO3: Propose a report on redesigning any existing industrial building for a new purpose considering current codes and standards.	Apply

Text Books:

T1. Jurgen Axel Adam, Katharria Hausmann, Frank Juttner, Klauss Daniel, Industrial Buildings: A Design Manual, Birkhauser Publishers, 2004.

T2. Santhakumar A.R. and Murthy S.S., Transmission Line Structures, Tata McGraw Hill,1992.

T3. Swami saran, Analysis & Design of substructures, Limit state Design second Edition.2018.

Course Code: 24STE013		Course Title: Design of Bridges	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0 : 0	Credits:3	Total Contact Hours:45	Max Marks:100

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

Module I **22 Hours**

Introduction : Selection of Site and Initial Decision Process - Classification of Bridges- General Features of Design- Standard Loading for Bridge Design as per different codes - Road Bridges – Railway Bridges

Design of Short Span Bridges: Design Codes - Working Stress Method- Limit State Method of Design–Selection of main bridge parameters, design methodologies -Choices of superstructure types - Orthotropic plate theory, load distribution techniques.

Module II **23 Hours**

Design of Long Span Bridges: Analysis and Design of RCC solid slab culverts -Design of RCC Tee beam and slab bridges - Design principles of continuous girder bridges, box girder bridges, balanced cantilever bridges – Arch bridges – Box culverts – Segmental bridges– Design principles only Design of bridge bearings and substructure

Design of Special Bridges: Design principles of PSC bridges – PSC girders –Design principles of steel bridges - Plate girder bridges – Box girder bridges – Truss bridges – Vertical and Horizontal stiffeners.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Design an RC solid slab culvert bridge and Tee Beam and Slab bridge	Apply
CO 2: Design the bridge bearings and substructure	Apply
CO 3: Evaluate the design principles of PSC bridges, box girder bridges, truss bridges	Evaluate

Text Book(s):

T1. N. Krishna Raju, Design of Bridges, Oxford & IBH publisher, 2019.

Reference Book(s):

R1. T.R. Jagadeesh, M. A. Jayaram, Design of Bridge Structures, PHI Learning,2009.

R2. N. Krishna Raju, Design of Prestressed Concrete Bridges, CBS publisher, 2010.

<table>
<tr><td colspan="2">Course Code: 24STE014</td><td colspan="2">Course Title: Design of Sub-Structures</td></tr>
<tr><td colspan="2">Course Category:
Professional Electives</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3:0:0</td><td>Credits: 3</td><td>Total Contact Hours:</td><td>Max Marks: 100</td></tr>
<tr><td colspan="4">Course Objectives:
The course is intended to impart knowledge on design of shallow foundations, deep foundations, well foundations, machine foundations and special foundations.</td></tr>
<tr><td colspan="3">Module I</td><td>22 Hours</td></tr>
<tr><td colspan="4">Shallow Foundations
Subsoil exploration methods - In-situ testing of soils - Classification of foundations - General requirement of foundations - Selection of foundations Bearing capacity of soil. Structural design of isolated footings, strip footings, combined footings.
Deep Foundations
Types of pile foundations – load carrying capacity - pile load test – structural design of straight piles –configuration of piles- Pile groups: Bearing capacity, settlement, uplift capacity, load distribution between piles different shapes of piles cap – structural design of pile cap. Type of</td></tr>
<tr><td colspan="3">Module II</td><td>23 Hours</td></tr>
</table>

Well Foundations

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

Machine Foundations

Introduction to machine foundation - 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.

Special Foundations

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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Understand the principles of subsoil exploration and the design concepts of foundations.	Understand
CO 2: Determine the bearing capacity of soil and load carrying capacity of piles.	Apply
CO 3: Design of reinforced concrete shallow foundations, pile foundations, well foundations, and machine foundations.	Apply
CO 4: Prepare a report of design of special foundation for different structures on different soil conditions.	Apply

Text Book(s):

T1. Bowles .J.E., "Foundation Analysis and Design", McGraw Hill Publishing co., New York, 1997.

T2. Braja. M. Das Principles of Foundation Engineering", PWS Publishing Company.

Reference Book(s):

R1. Tomlinson. M.J, "Foundation Design and Construction", Longman, Sixth Edition, New Delhi, 1995.

R2. Swamy Saran," Analysis and Design of substructures", Oxford and IBH Publishing Co. Pvt. Ltd., 2006.

R3. Varghese.P.C, "Design of Reinforced Concrete Foundations" – PHI learning private limited, New Delhi - 2009.

Web References:

1. https://onlinecourses.nptel.ac.in/noc22_ce32

2.https://freevideolectures.com/course/3269/advanced-foundation-engineering

3. https://archive.nptel.ac.in/courses/105/104/105104162

Course Code: 24STE015		Course Title: Earthquake Resistant Structures	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3:0 :0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on concepts of engineering seismology, ground motion, capacity based design, code provisions for seismic analysis and design of RC structures, modern concepts of retrofitting of structures.

Module I	23 Hours

Elements of seismology - causes of earthquakes, seismic waves, magnitude, intensity and energy release – Indian seismology - Ground Motion parameters - Behaviour of Building during past earthquakes - Principles of earthquake resistant design - Response Spectrum Theory – Design spectrum – Design principles, Capacity based design, Strong column – weak beam concept - Code Provisions of Design of Buildings as per IS1893 and IS4326 – Behaviour and Design of Masonry Structures as Per IS 13827 and IS13828 - Methods of Seismic Analysis: Equivalent static analysis – Response Spectrum method – Time history method – Pushover Analysis.

Module II	22 Hours

Ductile detailing of reinforcement in RC Buildings as per IS 13920 - Concept of ductility – lateral force resisting systems - Earthquake Resistant Design for multi storey RC frames, shear wall, braced frames - Base isolation technique, Active and passive control devices - Seismic retro-fitting strategies for RC and masonry buildings - Soil Liquefaction.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the codal provisions for earthquake resistant design & detailing understanding the response of the structures to dynamic loads and capacity design.	Apply
CO 2: Apply the concept of ductility to design RC elements as per code provision.	Apply
CO 3: Utilize the modern concepts on strengthening and retrofitting of structures under earthquake loading.	Apply

CO 4: Prepare and present an earthquake resistant design for multi storey RC frames based on the given zone conditions.	Apply

Text Book(s):

T1. Chopra A.K., Dynamics of Structures - Theory and Applications of Earthquake Engineering, N J Pearson Education inc., 2017

T2. Pankaj Agarwal and Manish Shrikhande., (2010), Earthquake resistant design of structures, Prentice-Hall India Pvt. Ltd., New Delhi.

Reference Book(s):

R1. Duggal S.K., Earthquake Resistant Design of Structures, Prentice Hall of India, New Delhi, 2013.

R2. IS: 1893:2016 (Part 1), Criteria for earthquake resistant design of structures.

R3. IS: 13920: 2016, Ductile detailing of reinforced concrete structures subjected to seismic forces

Web References:

1. https://swayam.gov.in/nd1_noc20_ce52/
2. https://onlinecourses.nptel.ac.in/noc24_ce96/