Babu Banarasi Das University, Lucknow

Department of Civil Engineering

School of Engineering

Master of Technology (Structural Engineering) – Regular

Evaluation Scheme (w.e.f session 2021-22)

SEMESTER I									
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	MAS4106	Applied Mathematics	4	0	0	40	60	**100**	**4**
C	MCE4101	Advance Structure Analysis	4	0	0	40	60	**100**	**4**
C	MCE4102	Advance Concrete Structure Design	4	0	0	40	60	**100**	**4**
C	MCE4103	Theory of Elasticity and Plasticity	4	0	0	40	60	**100**	**4**
GE	GE44411/ GE44415	Generic Elective I	4	0	0	40	60	**100**	**4**
C	MCE4151	Concrete Structures Lab	0	0	2	100	0	**100**	**1**
C	MCE4152	Seminar	0	0	2	100	0	**100**	**1**
C	MCE4153	Technical Paper Writing	0	0	2	100	0	**100**	**1**
Total			**20**	**0**	**6**	**500**	**300**	**800**	**23**

Legends:

L Number of Lecture Hours per week

T Number of Tutorial Hours per week

P Number of Practical Hours per week

CIA Continuous Internal Assessment

ESE End Semester Examination

Category of Courses:

C Core Course

GE Generic Elective

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SEMESTER II									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MCE4201	Advance Steel Structure Design	4	0	0	40	60	**100**	**4**
C	MCE4202	Non Linear Analysis of Structures	4	0	0	40	60	**100**	**4**
C	MCE4203	Finite Element Analysis	4	0	0	40	60	**100**	**4**
C	MCE4204	Structural Dynamics	4	0	0	40	60	**100**	**4**
GE	GE44421/ GE44425	Generic Elective II	4	0	0	40	60	**100**	**4**
C	MCE4251	CADD Lab	0	0	2	100	0	**100**	**1**
C	MCE4252	Seminar	0	0	2	100	0	**100**	**1**
C	MCE4253	Technical Paper Presentation	0	0	2	100	0	**100**	**1**
Total			**20**	**0**	**6**	**500**	**300**	**800**	**23**

Legends:

L Number of Lecture Hours per week

T Number of Tutorial Hours per week

P Number of Practical Hours per week

CIA Continuous Internal Assessment

ESE End Semester Examination

Category of Courses:

C Core Course

GE Generic Elective

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SEMESTER III									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MCE4351	State of the art Seminar#	-	-	-	200	0	**200**	**4**
C	MCE4352	Thesis - I*	-	-	-	400	0	**400**	**16**
Total			**-**	**-**	**-**	**600**	**0**	**600**	**20**

\# Student need to perform a literature survey and will give a state-of-the-art presentation and will submit a synopsis clearly mentioning the problem statement. The presentation and synopsis will be evaluated internally within two months of the start of the semester and the result will be intimated to the students so as to proceed for thesis.

* Student will develop the workable model for the problem they have supposed in synopsis.

SEMESTER IV									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MCE4451	Thesis - II**	-	-	-	200	800	**1000**	**28**
Total			**-**	**-**	**-**	**200**	**800**	**1000**	**28**

** (a) This is in continuation with Thesis -I.

(b) The required experimental / mathematical verification of the proposed model will be done in this semester.

Legends:

L Number of Lecture Hours per week

T Number of Tutorial Hours per week

P Number of Practical Hours per week

CIA Continuous Internal Assessment

ESE End Semester Examination

Category of Courses:

C Core Course

GE Generic Elective

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Course Code	Generic Elective-I
GE44411	CAD of Structures
GE44412	Theory of Plates and Shells
GE44413	Concrete Technology
GE44414	Bridge Engineering
GE44415	Analysis of Composite Structures

Course Code	Generic Elective-II
GE44421	Tall Buildings
GE44422	Advance Retrofitting Methods
GE44423	Pre-stressed Concrete Structures
GE44424	Earthquake Resistant Design of Structures
GE44425	Design of offshore Structures

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Credit Summary Chart						
Course Category	**Semester**				**Total Credits**	**%age**
	I	**II**	**III**	**IV**		
C	19	19	20	28	86	91.48
GE	4	4			8	8.52
Total	**23**	**23**	**20**	**28**	**94**	**100**

Discipline wise Credit Summary Chart						
Course Category	**Semester**				**Total Credits**	**%age**
	I	**II**	**III**	**IV**		
Engineering Sciences	4				**4**	4.26
Professional Subject Core	13	17			**30**	31.92
Professional Subject - General Elective	4	4			**8**	8.52
Thesis, Seminar	2	2	20	28	**52**	55.32
Total	**23**	**23**	**20**	**28**	**94**	**100**

Legends:

L Number of Lecture Hours per week

T Number of Tutorial Hours per week

P Number of Practical Hours per week

CIA Continuous Internal Assessment

ESE End Semester Examination

Category of Courses:

C Core Course

GE Generic Elective

MCE4101 ADVANCE STRUCTURE ANALYSIS

Course Objective:

1. This course presents the matrix method of structural analysis. Topics included describe analysis of trusses, beams, frames and plane.
2. Illustrating transformation of co-ordinates, focus to develop the matrices of higher order, dealing with different types of ends supports.
3. To know about analysis of continuous beams by Matrix Approach.
4. To illustrate the Flexibility and Stiffness Method for Plane Frame

Learning Outcome:

1. Develop expressions for use in solving determinate and indeterminate structural engineering problems using matrix methods.
2. Analyze structural systems comprised of truss, beam and frame elements using matrix methods.
3. Generate solutions for two-dimensional and three- dimensional structural using structural software.
4. Evaluate solutions generated by structural software and compare to solutions manually.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Matrix Analysis of Structures** Introduction, Coordinate systems, Displacement and force transformation matrices, Element and structure stiffness matrices, Element and structure flexibility Matrices, Equivalent joint loads, Stiffness and flexibility approaches.	30 Hours	1
II	**Matrix Analysis of Structures with Axial Elements** Axial stiffness and flexibility, Stiffness matrices for an axial element (two DOF), plane truss element (four DOF), space truss element (six DOF), Analysis by stiffness method (two/one DOF per element), Analysis by flexibility method. **Plane Trusses**	30 Hours	1

	Analysis by stiffness and flexibility methods. Space Trusses: Analysis by stiffness method.		
III	**Matrix Analysis of Beams** Beam element stiffness (four DOF): Generation of stiffness matrix for continuous beam, dealing with internal hinges, hinged and guided-fixed end supports. **Flexibility Method for Fixed and Continuous Beams** Force transformation matrix, Element flexibility matrix, Solution procedure (including support Movements).	30 Hours	1
IV	**Matrix Analysis of Plane, Stiffness Method for Plane Frames** Element stiffness (six DOF), Generation ofStructure stiffness matrix and solution procedure, Dealing with internal hinges and various end conditions. **Flexibility Method for Plane Frames** Force transformation matrix, Element flexibility matrix, Frames with Inclined Members, Effect of Axial Load and Shear on Plastic Moment Capacity	30 Hours	1

References:

1. Devdas Menon, "Advanced Structural Analysis", Narosa Publishing House, 2009.
2. Asslam Kassimali, "Matrix Analysis of Structures", Brooks/Cole Publishing Co., USA, 1999.
3. Amin Ghali, Adam M Neville and Tom G Brown, "Structural Analysis: A Unified Classical and Matrix Approach", Sixth Edition, 2007, Chapman & Hall.
4. Devdas Menon, "Structural Analysis", Narosa Publishing House,2008.
5. William Weaver, JR. &James M. Gere, ―Matrix Analysis of Framed Structures, CBS Publisher.

MCE4102 ADVANCE CONCRETE STRUCTURE DESIGN

Course Objective:

1. The main objective is to provide students with a rational basis of the design of reinforced concrete members.
2. This course presents the fundamentals and design of reinforced concrete structures mainly Y. L. theory for slab.
3. To discuss moment capacity of different sections.
4. To illustrate the Bunker and Silos

Learning Outcome:

1. Estimate the crack width and deflection with regard to the serviceability.
2. Analyze and design a shells and folded plate roofs.
3. Analyze and design slab systems well as exposure on redistribution of moments, rotation capacity and beam-column joints.
4. Analyze and design bunkers, silos.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Yield line Theory for slabs** Nodal Forces and Two- way Slabs, Two-way Rectangular, Square, Triangular and Circular Slabs	30 Hours	1
II	**Shells and Folded Plate Roofs** Introduction, Type of shell roofs, advantages and disadvantages of shell roofs, folded plate roofs, behavior of folded plate roofs, behavior of shells, Lundgreen's Beam Theory for long shells, Design criteria for cylindrical shell roofs	30 Hours	1
III	**Moment curvature relationship concrete sections** Redistribution of moments in continuous span beams, Plastic hinge concept. Rotation capacity of sections, ultimate load analysis by Cambridge and Baker's method.	30 Hours	1

	Detailing for ductility. Beam column joints.		
IV	**Bunker and Silos** Introduction, Design of rectangular and circular bunkers, Lateral pressures as per Janssen's and Airy's Theories. Design of silos.	30 Hours	1

References:

1. Raju N.Krishna, ―Pre-Stressed concrete‖, Tata Mc Graw Hill Education (India) Private.
2. Varghese P.C.―Advance Reinforced Concrete design ,PHI Learning Private Limited.
3. Ramamrutham S.―Design of Reinforced Concrete Structures II Dhanpat Rai, New Delhi India.
4. Ashok K. Jain―Reinforced Concrete: Limit State Design‖, Nem Chand & Brothers.
5. Karve S.R. and Shah V.C, "Design of reinforced cement concrete structures using Limit State Approach", Structures Publishers.

MCE4103 THEORY OF ELASTICITY AND PLASTICITY

Course Objective:

1. To impart knowledge of Principal stresses and strains.
2. To develop analytical skills of solving problems using plain stress and plain strain.
3. To illustrate about Two Dimensional Problems.
4. To impart knowledge of engineering application of plasticity.

Learning Outcome:

After completion of the course, the students will be able to:

1. The students shall be able to demonstrate the application of plane stress and plane strain in a given situation.
2. The student will demonstrate the ability to analyze the structure using plasticity.
3. To impart the knowledge of stress-strain relations for linearly elastic solids and Torsion.
4. Student will get knowledge of engineering application of plasticity.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Analysis of Stress** Stress Tensor, Equilibrium equations in Cartesian and Polar Co-ordinate, Normal and Shearing Stresses, Transformation equations for stresses, Principal Stresses and Principal Planes, Stress Invariants, octahedral stresses, deviator and Hydrostatic stress tensor. Elementary problems of elasticity in three dimensions.	30 Hours	1
II	**Analysis of Strain** Types of strain, strain tensors, strain transformation. Principal strains, strain invariants, octahedral strains. Mohr's Circle for Strain, equations of Compatibility for Strain.	30 Hours	1
	Two dimensional problems Airy's stress function - polynomials - bi-harmonic		

III	equations - general solution of problems by displacement (warping function) force (Prandtl's stress function) Two dimensional problems in Cartesian co-ordinates, Bending of Cantilever loaded at end, Bending of beam by uniform load**.** Pure bending of curved bars, thick-walled cylinder.	30 Hours	1
IV	**Plasticity** Introduction to problems in plasticity- Physical assumption - Criterion of yielding –Rankine's theory - St. Venant's theory - Flow rule (Plastic stress-strain relationship - Elastic Plastic problems of beams in bending. Stress-strain relations plastic potential, flow rules and maximum work hypothesis.	30 Hours	1

References:

1. Dr. Sadhu Singh, ―Applied Stress Analysis, Khanna Publishers.
2. Chen W.F. and Han. D. J.,―Plasticity for structural Engineers‖, Springer-Verlag. NY.
3. Chakrabarty,―Theory of Plasticity―,Tata McGraw Hill Book Co., New Delhi, Third Edition,2006
4. Mendelson. A., ―Plasticity - Theory and Applications ‖, Krieger Pub Co., Florida, U.S.A, Second edition,1983.

MCE4151CONCRETE STRUCTURES LAB

List of Experiments:

1. To determine the Workability of concrete by various methods.
2. Design the concrete mix of different grades, as per IS: 10262.
3. To determine the compressive strength of a nominal or design mix concrete of any grade.
4. To determine the split tensile strength of concrete.
5. Nondestructive Testing - Rebound Hammer test, Ultrasonic Pulse Velocity test.

MCE4201 ADVANCED STEEL STRUCTURE DESIGN

Course Objective:

1. The objectives are to provide students with advanced knowledge of steel structural design.
2. To Understand the background to the design of steel bridges
3. To illustrate Towers, Chimneys,
4. To discuss steel rectangular and circular water tank & tubular sections.

Learning Outcome:

1. It will clear the concepts and load mechanism in plastic design.
2. It will give the exposure on different types of truss girders and plate girders bridges, their components and design principles.
3. It provides the basic knowledge of towers and their types and will also discuss analysis and design of chimneys.
4. It illustrates the design criteria, concept of analysis and design of rectangular and circular water tanks and tubular section.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Plastic Design** Introduction, Shape Factor, Plastic hinge concept - Mechanism method Application to Continuous beams and portal frames.	30 Hours	1
II	**Bridges** Introduction**,** Design of steel bridges, plate Girder Bridge and Truss girder bridge.	30 Hours	1
III	**Towers** Basic structural configurations - free standing and Guyed towers, wind loads, foundation design, Design criteria for different configurations and transmission line towers. **Chimneys** Analysis and design of steel chimneys.	30 Hours	1

IV	**Tank** Analysis and design of steel rectangular and circular water tank. **Tubular Section** Introduction, Advantages and Disadvantages, Design of circular tubular sections.	30 Hours	1

References:

1. Duggal S. K**,** –Design of Steel Structures, T. M.H. Publication
2. Arya and Ajmani, –Design of steel structures, NBC Roorkee India.
3. Ramamrutham S., –Design of steel structures, Dhanpat Rai New Delhi India
4. **Negi L. S.,** Design of Steel Structures, McGraw Hill India

MCE4202 NON-LINEAR ANALYSIS OF STRUCTURES

Course Objective:

1. To present systematic procedures for geometric and material nonlinear structural analysis.
2. To introduce and encourage the use of advanced nonlinear software.
3. To discuss about Elastic and Inelastic behavior of Plates
4. To explore the significance of common nonlinear phenomena, particularly in relation to the structural response under extreme events.

Learning Outcome:

1. Distinguish between linear and nonlinear structural analysis and the types of problem for which nonlinear structural analysis is necessary.
2. Use equilibrium paths to characterize the nonlinear structural response.
3. Understand basic incremental iterative solution procedures for tracing equilibrium paths.
4. Appreciate the fundamentals of nonlinear finite element discretization, including geometric and material nonlinearity.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction to nonlinear mechanics** Non-linear behavior, sources of non-linearity, statically determinate and indeterminate flexible bars of uniform and variable thickness 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	30 Hours	1
II	**Vibration theory and analysis of flexible members** Behavior of idealized structures, Hysteretic models and analysis of uniform and variable stiffness members under cyclic loading, Solution of simple problems involving geometric non-linearity.	30 Hours	1
III	Elastic and inelastic analysis of uniform and variable thickness plates, three-dimensional geometric non-linear analysis	30 Hours	1

IV	Nonlinear vibration and Instabilities of elastically supported beams	30 Hours	1

References:

1. Delmetor E. Firtis, ― Non Linear Mechanics‖ (CRC, Press)
2. Stein Krak,― Non Linear Modelling & Analysis of Solids &Structures ‖,(CRC Press)
3. McGuire, W., Gallagher, R., Zieman, R., ― Matrix Structural Analysis", 2nd Edition.
4. Bathe, K.J., ― Finite Element Procedures‖, Prentice-Hall, Englewood Cliffs, New Jersey.
5. Crisfield, M. A.,―Non-linear Finite Element Analysis of Solids and Structures ‖, John Wiley & Sons, Chichester, England.
6. Yang, Y.B., and Kuo, S. R., ― Theory and Analysis of Nonlinear Framed Structures‖, Prentice Hall, Englewood Cliffs, New Jersey.

MCE4203 FINITE ELEMENT ANALYSIS

Course Objective:

1. To evaluate the stress and strain parameters and their inter relations of the continuum.
2. Different application areas will be dealt with after introducing the basic aspects of the method. However, major emphasis will be on the solution of problems related to civil Engineering.
3. Develop stiffness matrices of one dimensional, two dimensional and solid elements.
4. Develop structure stiffness matrix, load vector and solve the same after applying boundary conditions.

Learning Outcome:

1. It is intended to cover the analysis methodologies for 1-D, 2-D and 3-D problems with the advantages and disadvantages clearly spelt out.
2. It gives the basic understanding of FEA, virtual work principle and iso-parametric formulation.
3. It gives the exposure of stiffness of beams, truss and frames and also CST, LST and QST and axi-symmetric element.
4. It explains the theories related to plates and shells.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction to Finite Element Analysis** Introduction, Basic Concepts of Finite Element Analysis, Introduction to Elasticity, Steps in Finite Element Analysis.	30 Hours	1
II	**Finite Element Formulation Techniques** Virtual Work and Variational Principle, Galerkin Method, Finite Element Method: Displacement Approach, Stiffness Matrix and Boundary Conditions. Element Properties: Natural Coordinates, Triangular Elements, Rectangular Elements, Lagrange and Serendipity Elements, Solid Elements, iso-parametric Formulation,	30 Hours	1

III	**Analysis of Framed Structures** Stiffness of Truss Members, Analysis of Truss, Stiffness of Beam Members, Finite Element Analysis of Continuous Beam, Plane Frame Analysis, Analysis of Grid and Space Frame FEM for Two and Three Dimensional Solids: Constant Strain Triangle, Linear Strain Triangle, Rectangular Elements, Axisymmetric Element, Finite Element Formulation of Axisymmetric Element, Finite Element Formulation for 3 Dimensional Elements	30 Hours	1
IV	**FEM for Plates and Shells** Introduction to Plate Bending Problems, 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.	30 Hours	1

References:

1. Krishnamurthy C. S., Finite Element Analysis ‖, Tata Mc Graw-Hill
2. David V. Hutton, Fundamentals of Finite Element Analysis‖, Mc Graw Hill
3. Maity D., Computer Analysis of Framed Structures", I. K. International Pvt. Ltd. New Delhi
4. Erik G. Thompson,— Introduction to the Finite Element Method: Theory, Programming and Applications‖, John Wiley

MCE4204 STRUCTURAL DYNAMICS

Course Objective:

1. 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
2. To introduce general theory of vibration and solve problems of single degree of freedom (SDOF)systems
3. To know the various mathematical modeling of various types loading conditions.
4. To introduce dynamic analysis of continuous systems.

Learning Outcome:

1. An ability to apply knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.
2. Ability to identify, formulate and solve engineering problems. This will be accomplished by having students' model, analyze and modify a vibratory structure order to achieve specified requirements.
3. Exposure on the free vibration response of MDOF and continuous systems.
4. Exposure on dynamic analysis of continuous systems.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Types of vibration and ground motions **Undamped Single Degree-of-freedom System** Introduction, Degree of Freedom, mathematical modeling of an SDOF system, D'Alembert's Principle, Solution of the differential Equation of Motion, Frequency and period, amplitude of motion. Damped Single degree-of–freedom system: Equation of motion, critically damped system, under damped system, over damped system, Logarithmic decrement.	30 Hours	1

II	**Response of SDOF system to Harmonic Excitation** Undamped Harmonic Excitation, Damped harmonic Excitation, vibration Isolation. Response of SDOF system to periodic loading: Introduction, Fourier series and Analysis, Response to the Fourier Series Loading, response of SDOF to earthquake	30 Hours	1
III	**Response to general dynamic loading** Introduction, Duhamel's Integral, Numerical evaluation of Duhamel's Integral for damped and undamped system.	30 Hours	1
IV	**Free Vibration Response of MDOF and Continuous Systems** Undamped systems and natural modes and their properties; Numerical solution for the eigenvalue problem; Solution of free vibration response for undamped systems; Free and forced vibration of continuous system. Dynamic analysis of tall and massive structures.	30 Hours	1

References:

1. Mario Paz, "Structural Dynamics", (C B S Publishers).
2. Damodarasamy S.S., Kavitha S., "Basics of structural Dynamics and Aseismic design",(PHI).
3. Pankaj Agrawal, Manish Shrikhande, "Earthquake Resistant Design of Structures" (PHI).
4. John M. Biggs, "Introduction to Structural Dynamics", McGraw-Hill Companies.
5. Anil K. Chopra, "Dynamics of Structure", Prentice Hall; 4th edition.

MCE4251 CADD LAB

List of experiments

1. Working on Structural Engineering software for Analysis and Design of Civil Structure using STAAD Pro. / SAP/ ETAB.

GE44411 COMPUTER AIDED DESIGN OF STRUCTURES

Course Objective:

1. Introduction to basic fundamentals.
2. Understand the need and concepts of design optimization.
3. Application of optimal design principles.
4. To introduce the fundamentals of AI and expert system.

Learning Outcome:

1. Illustrate drafting, design and modification using CAD.
2. Describe the basic features and operation of a computer added program and the various commands used.
3. Discuss different types of CAD software and their applications.
4. Illustrate expert system shells and exposure on principle of neural network.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction** Elements of Computer Aided Design and Its advantages. Types of hardware required for CAD works.	30 Hours	1
II	**Principals and Concepts** Principles of software design, concept of modular programming, debugging and Testing.	30 Hours	
III	**Application& Software** Computer applications in analysis and design of Civil Engineering systems. Use of software packages in the area of Structural, Geotechnical, and Environmental fields.	30 Hours	1
IV	**Artificial intelligence** Introduction, Heuristic search, knowledge based expert systems, Architecture and application of KBES, Expert system shells, Principles of neural network.	30 Hours	1

References:

1. Krishnamoorthy C.S. and Rajeev S., "Computer Aided Design", Narosa Publishing House New Delhi,1991.
2. Srivastava S. K., "Computer Aided Design: A Basic and Mathematical Approach", I.K. International Publishing House Pvt. Ltd.
3. Regalla, Srinivas Prakash, "Computer Aided Analysis and Design" I.K. International Publishing House Pvt. Ltd.

GE44412 THEORY OF PLATES AND SHELLS

Course Objective:

1. To provide an elementary knowledge of mechanics of materials and mathematics.
2. To provide a simple and comprehensive mathematical analysis of plate theories and their application to plate bending problems.
3. Give an insight into the behavior of the plate structure, maintaining a fine balance between analytical and numerical methods.
4. To provide a knowledge of the fundamentals of theory of shells and folded plates.

Learning Outcome:

1. Classify the shells and know the shell action.
2. Understand the bending theory of cylindrical shells.
3. Design and detail cylindrical shells.
4. Analyze and design doubly curved shells and to determine the properties and behavior of plates and shells.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Laterally loaded thin plates** Differential equation – Boundary conditions. Bending of plates – Simply supported rectangular plates – Navier's solution and Levy's method – Rectangular plates with various edge Conditions. Curvatures of bent plates	30 Hours	1
II	**Classification of shells** Parametric representation of a surface, the first quadratic form, Equation to the normal of a surface, Membrane theory for shells of revolution with axi-symmetric and non-symmetric loading, bending analysis of shells of revolution for axi-symmetric loadings.	30 Hours	1

III	Membrane and bending theories of cylindrical shells, theory of edge beams, doubly curved shells, membrane theory and design of hyperbolic shells, Bending theory of cylindrical shells loaded Symmetrically, Buckling of shells, Introducing to stability of shells. design applications	30 Hours	1
IV	Folded plate structures, Structural behavior, Various Types, Design of folded plates, Reinforced detailing.	30 Hours	1

References:

1. Timoshenko S.P. and Woinowsky-krieger S., Theory of plates and shells, McGraw-Hills.
2. Marti Peter, ―Theory of Structures: Fundamentals, Framed Structures, Plates and Shells, Blackwell Publishers.
3. Bhavikatti S.S., ―Theory of Plates and Shells", New Age International.

GE44413 CONCRETE TECHNOLOGY

Course Objective:

1. To study the properties of concrete making materials such as cement, aggregates and admixtures.
2. To study the properties and tests on fresh and hardened concrete.
3. To know about the special concrete.
4. To know about the application and use of fiber reinforced concrete and develop the self-compacting and high-performance concrete.

Learning Outcome:

1. Discuss the concrete ingredients and its influence at gaining strength.
2. Discuss the chemical and mineral Admixtures.
3. Design of concrete mix and grade as per IS codes.
4. Summarize the concepts of conventional concrete and its differences with other concretes like HPC, light weight, Reactive powder Concrete etc.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction to Cement** Production, composition, and properties; cement chemistry, Types of cements; special cements. Aggregates: Mineralogy, properties, test and standards. **Chemical and Mineral Admixtures** Water reducers; air Entrainers, set controllers, specialty admixtures - structure properties, and effects on concrete properties, Introduction to supplementary cementing materials and pozzolana. fly ash, blast furnace slag, silica fume, and metakaolin - their production, properties, and effects on concrete properties, Other mineral additives, Reactive and inert.	30 Hours	1

II	**Concrete Production & Fresh Concrete** Batching of ingredients; mixing, transport, and placement, Consolidation, finishing, and curing of concrete; initial and final set - significance and measurement, Workability of concrete and its Measurement.	30 Hours	1
III	**Engineering Properties of Concrete** Compressive strength and parameters affecting it, tensile strength - direct and indirect, modulus of elasticity and Poisson's ratio, Stress-strain response of concrete. Quality concepts. Definitions; principles and Standards; quality schemes. Corrosion in concrete. Thermal conductivity, thermal diffusivity, specific heat. **Dimensional Stability and Durability**: Creep and relaxation - parameters affecting; Shrinkage of concrete - types and significance, parameters affecting shrinkage; measurement of creep and shrinkage**.**	30 Hours	1
IV	**Special Concretes** Properties and applications of: High strength - high performance concrete, reactive powder concrete, Lightweight, heavyweight, and mass concrete, fiber-reinforced concrete, self-compacting concrete, shotcrete, Ready mix concrete. **Concrete Mix Design** Factors affecting mix design, design of concrete mix by BIS method using IS10262 and current American (ACI)/ British (BS) methods. Provisions in revised IS10262-2019.	30 Hours	1

References:

1. Neville, A.M., "Properties of Concrete", Pitman.
2. Brandt, A.M., "Cement Based Composites: Materials, Mechanical Properties and Performance", E & FN Spon. 1995.
3. Newman, K., "Concrete Systems in Composite Materials", EDTBY L. Holliday. Elsevier Publishing Company.1966.
4. Powers, T.C., "The Properties of Fresh Concrete", John Wiley & Sons, Inc. Mehta, P.K., "Concrete Structure, Material and Properties", Prantice Hall

GE44414 BRIDGE ENGINEERING

Course Objective:

1. To study the various bridge forms and typical loadings on the bridges.
2. To develop broad understanding of bridges.
3. Conceptual design and details of short span bridges.
4. To know about Piers, Pier caps, Abutments and bearings.

Learning Outcome:

1. Discuss the IRC standard live loads and design the deck slab type bridges.
2. Analyze the box culverts for the given loading and detail the box culverts.
3. Design and detail of T-Beam bridges.
4. Design and check the stability of piers and abutments.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Site selection, various types of bridges and their suitability. Geometric and Hydraulic design considerations, Loading and standards for highway and railway bridges.	30Hours	1
II	Design of RC bridges under concentrated loads using effective width and Pigeaud Method. Courbon's method of load distribution, Design of T-beam bridge, Design of box culverts. **Pre-stressed Concrete Girder Bridges** Advantages of pre-stressed concrete slab and girder bridges – suitable spans, design of slab and beam cross sections for given bending moment, shear– finding pre-stressing force, eccentricity.	30 Hours	1
III	**Steel Bridges** Design and detailing of plate girder, Design and detailing of box girder, Design and detailing of Truss bridges.	30 Hours	1

IV	Design of piers and pier caps, Design of Abutments and bearings. Maintenance of bridges, bridge testing for safe carrying capacity, strengthening of bridges.	30 Hours	1

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. Taylor F.W, Thomson S.E. and Smulski. E, ―Reinforced Concrete Bridges", John Wiley & Sons, New York1955.
4. IRC: 3-1983, ―Dimensions and Weights of Road Design Vehicles‖.
5. IRC:5-1998, ― Standard Specifications and Code of Practice for Road Bridges, Section I – General Features of Design (Seventh Revision).
6. IRC:6-2010, ― Standard Specifications and Code of Practice for Road Bridges, Section II – Loads and Stresses (Fifth Revision).

GE44415 ANALYSIS OF COMPOSITE STRUCTURES

Course Objective:

1. To Know about major constituents in engineering composites
2. To discuss the strength of various composite lamina types.
3. To know about failure, analysis and Design
4. To determine the failure processes of engineering composites

Learning Outcome:

1. Analyze the effects of various load or displacement boundary conditions by applying laminate analysis to composite structures.
2. Develop and use design equations for the stiffness and strength variation in composites as functions of constituent properties.
3. Understand the deformation and failure mechanisms in a composite lamina and laminate.
4. Determine the stiffness and strength of short fiber reinforced composites using the shear lag theory.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction of Composite Structures** Constituents Materials for composites-fibre and matrix. Structural application of Composites Fabrication processes.	30 Hours	1
II	**Behaviour of Composite Material** Mechanical behaviour of composites. Stress –strain relations for orthotropic materials. Lamina stress-strain relations.	30 Hours	1

III	**Failure, Analysis and Design of Laminates** Stress, vibration and buckling analysis of laminates bars beams, arches, plates and shells. Strength of Lamina, failure criteria.	30 Hours	1
IV	**Shear deformation- Laminates** Hygrothermal behavior of lamina.Shear deformation theories for laminates.	30 Hours	1

References

1. Jones R.M., Mechanics of Composite Materials ,Mc Graw Hill,Tokyo.
2. Christensen R.M., Mechanics of Composite Materials, John Wiley & Sons ,New York.
3. Agarwal B.D. and Broutman ,L.J.Analysis and performance of fibre Composite .John Wiley & Sons, New York.
4. Calcote L.R., The Analysis of Laminated Composite Structures,Van Nostrand Reinhold Co., New York.
5. Holmes, M and Just, D.J.GRP in Structural Engineering, applied Science Publishers, London.
6. Gibson R.F., Principles of Composite Material Mechanics.
7. Reddy J.N., Analysis of Composite Laminated Plates, Mc Graw Hill.

GE44421 TALL BUILDINGS

Course Objective:

1. Various methods to analyze and design the tall structure with Codal recommendations.
2. Design the shear wall system and in filled frame systems.
3. Use of IS codes for wind loading and seismic loading for tall buildings.
4. To know about effect of winds on Truss.

Learning Outcome:

1. To know the types of tall buildings according to NBC and different anticipated loads.
2. Exposure on wind effect aerodynamics and structural responses
3. Basic understanding of cause and effects of earthquake and its solution.
4. Versatile nature of shear walls and in fill walls.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction** Classification of buildings according to NBC, Types of loads, wind load and Seismic load. Design philosophy.static and dynamic approach, Structural systems and concepts, Effect of openings. Large panel construction. Foundation superstructure interaction.	30 Hours	1
II	**Wind Effect** Bluff body aerodynamics; aero-elastic phenomena; wind directionality effects; structural response and design considerations; standard provisions for wind loading.	30 Hours	1

III	**Earthquake Effect** Introduction to earthquake engineering and earthquake resistant design of buildings; earthquake motion and response; general principles and design criteria for buildings; codal provisions, seismic design of structures; dynamic analysis; effect of torsion; design of stack like structures; earthquake forces in tall buildings.	30 Hours	
IV	**Shear Wall** Shear in buildings; need and location of shear walls in tall buildings; analysis and design of shear walls. In-filled Frame Systems: Importance – Methods of analysis, Equivalent truss and frame method, Force displacement method, Effect of perforation in the in-filled frame.	30 Hours	1

References:

1. Dr. BungaleTaranath S., Reinforced Concrete Design of Tall Buildings ,CRC Press,2009
2. Bryan Stafford Smith, Tall Building Structures: Analysis and Design‖, Alex Coull,
3. Ramachandra, Design of Steel Structures– Vol.II, Standard Book House, 1750- a, NaiSarak, Delhi-6.
4. SarwarAlam Raz, Analytical methods in Structural Engineering, Wiley Eastern Private Limited, New Delhi.
5. Ghali. A.,Neville. A.M and Brown .T.G, ―Structural Analysis– Aunified classical and Matrix Approach (Fifth Edition), Span pre

GE44422 ADVANCE RETROFITTING METHODS

Course Objective:

1. To get conversant with the latest techniques with seismic retrofit of the buildings.
2. To understand the basic concept of retrofitting and its need in the present scenario of construction and strengthening of structures.
3. Various methods for the inspection of structural components.
4. To about various aspects of Retrofitting to existing Structures.

Learning Outcome:

1. It explains the evaluation and criteria of seismic hazards
2. It gives the exposure on repair Strengthening and Rehabilitations.
3. Illustrates about the repair and retrofitting of masonry structures.
4. It gives the knowledge of retrofitting of various RC buildings and bridges.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Seismic Hazard Evaluation, Methodologies for seismic evaluation, Components of seismic evaluation Methodology, seismic evaluation of RC Columns, Beams, Joints and Slabs, Nondestructive evaluation techniques, Principles of Repair and Retrofitting, Importance of repair	30 Hours	1
II	Terminology in Repair, Restoration, Strengthening and Rehabilitations, Criteria for Repair, Causes of distress	30 Hours	1
III	Restoration and Retrofitting; Repair Materials; In-situ testing methods for RC and masonry structure; Techniques of repair and retrofitting of masonry Buildings.	30 Hours	1
IV	Techniques of Repair and Retrofitting in RC buildings; Retrofitting of buildings by seismic base isolation and supplemental damping; Retrofitting of heritage structures; Retrofitting of bridges; Case studies in Retrofitting.	30 Hours	1

References:

1. XinLin Lu, Retrofitting Design for Building Structures, (CRC Press)
2. Agrawal Pankaj,Shrikhande Mainsh, Earthquake Resistant Design of Structures, (PHI Pvt.Ltd.)
3. Handbook on seismic retrofit of building, central public works department Government of India, New Delhi.
4. Handbook on repair and rehabilitation of RCC Buildings, Central public works department, Government of India, New Delhi.

GE44423 PRESTRESSED CONCRETE STRUCTURES

Course Objective:

1. To develop an understanding of the necessity of pre-stressed concrete structures and various techniques of pre-stressing.
2. Various losses encountered in the pre-tensioning and post tensioning of concrete members.
3. To design of pre-stressed concrete members for ultimate limit state and limit state of serviceability.
4. To develop an understanding of the design of flanged beams.

Learning Outcome:

1. The knowledge of evolution of various pre-stressing techniques.
2. Exposure of various losses in lieu of codal provisions.
3. Develop skills in analysis of pre-stressed concrete beams.
4. Develop skills to satisfy the serviceability and strength provisions of the Indian Standards (IS:1343-1980).

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction** Prestressing Systems, Material Properties and: Losses in prestress. Types of prestressing: pretensioning and post-tensioning, external and internal prestressing, full and partial prestressing, uniaxial and biaxial prestressing. Strength concept–Load balancing concept – Effect of loading on the tensile stresses in tendons, Advantages and disadvantages of prestressing, advantages of precast members. **Material properties** Aggregates, cement, concrete, allowable stresses, creep, shrinkage, steel, allowable stresses, Relaxation, fatigue.	30 Hours	1
II	**Losses in Pre-stress** Immediate losses, Elastic shortening, Friction and anchorage slip, Force flow diagram, Time dependent losses: creep, shrinkage, relaxation; IS Code provisions. Calculation of deflections – Short term and long term deflections, Estimation of crack width.	30 Hours	1

III	**Analysis of Members** Analysis of members under axial load. Analysis of members under flexure at service loads: stress concept, force concept, load balancing concept. Cracking moment, kern point, pressure line, and concept of limiting zone. Analysis of rectangular sections under flexure at ultimate loads: equations of equilibrium and Compatibility and constitutive models, stress block for concrete, solution procedure, minimum and maximum amount of pre-stressed reinforcement. Analysis of flanged Sections under flexure at ultimate loads. Analysis of Partially pre-stressed sections under flexure at ultimate loads.	30 Hours	1
IV	**Design of Members for Flexure** Design based on service loads: preliminary design. Final design for Type I member (no tensile stress). Final design for Type II (limited tensile stress) and TYPE III (limited cracking) members. Choice of cross section: flexural efficiency; Determination of limiting zone; post-tension in stress. Magnel's graphical method. Design for shear based on I.S. 1343 Code. Design based on ultimate loads. Detailing requirement.	30 Hours	1

References:

1. Raju. N.Krishna, Prestressed Concrete, Third Edition, Tata Mc GrawHill Co.
2. Rajagopal. N, Prestressed Concrete, Second Edition‖, Narosa Publishing House.
3. Dayarathnam P, Prestressed Concrete Structures, S. Chand Publishers.
4. Sinha, N.C .and Roy S.K, Fundamentals of Pre-stressed Concrete‖, S. Chand & Company limited.

GE44424 EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

Course Objective:

1. Understand possible causes for the movements of the plates.
2. To understand the concept of seismic loading and principles of seismic behavior of the structures.
3. Describe elastic rebound theory as it is related to seismic activity.
4. Distinguish between earthquake magnitude and earthquake damage (intensity) & Understand soil structure interaction and base isolation techniques.

Learning Outcome:

1. Occurrence of earthquake and hazards associated with it.
2. Assess seismic performance of non-structural components and building contents and identify effective measures to mitigate potential damage.
3. Basic understanding of dynamic properties of soil.
4. Mitigating the earthquake with the help of base isolation techniques.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Seismology and Seismic Response** Earth's Interior and Plate Tectonics; Causes of Earthquakes and Seismic Waves; Measurement of Earthquakes and Measurement parameters; Modification of Earthquake due to the Nature of Soil. Dynamics of Structure and Seismic Response.	30 Hours	1
II	**Earthquake Inputs** Time History Records and Frequency Contents of Ground Motion; Power Spectral Density Function of Ground Motion; Concept of Response Spectrums of Earthquake; Site Specific, Probabilistic and Uniform Hazard Spectrums; Predictive Relationships for earthquake parameters.	30 Hours	1
III	**Seismic Soil - Structure Interaction** Fundamentals of Seismic Soil-Structure Interaction; Direct Method of Analysis of Soil-Structure; Sub structuring Method of analysis of Soil- Structure Interaction	30 Hours	1

	Problem.		
IV	Base isolation for earthquake resistant design of structures: Base isolation concept, isolation systems and their modeling; linear theory of base isolation; Stability of elastomeric bearings; codal provisions for Seismic isolation, practical applications. Isolation of Non- Structures.	30 Hours	1

References:

1. Duggal S.K., Earthquake-resistant Design of Structures, Oxford University Press.
2. Agarwal Pankaj & Shrikhande Manish, Earthquake Resistant Design of Structures, PHI Publication
3. Damodarasamy S.S., Kavitha S., Basics of structural Dynamics and Aseismic design, (PHI).

GE44425 DESIGN OF OFFSHORE STRUCTURES

Course Objective:

1. Acquire knowledge and skills to carry out basic tasks regarding dimension and structural design of offshore structures.
2. Estimation of maximum forces on an offshore structure due to operational loads and conduct static and dynamic analyses of fixed platforms
3. Acquire training in the design of jacket platforms, tubular joints and concrete gravity platforms.
4. Estimate the resistance of platforms against fatigue and accidental loads

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Learning Outcome:

1. Carry out structural dynamic analysis of discrete multi – degrees systems under periodic, impulsive and stochastic excitation.
2. Carry out dynamic response analysis of 1D continuous system.
3. Assess the structural dynamic response of simple fixed offshore structures under regular and irregular wave excitation.
4. Carry out simplified fatigue strength analysis of structural components and evaluate their fatigue life cycle.

Module	Course Topics	Total Hours	Credits
I	**Introduction-Offshore Structure** Structural forms of offshore structures, loads. Introduction to structural dynamics, Vibration of bars, beams and cones with reference to soil as half-space	30 Hours	1
II	**Behavior of Structures-Wind Effect** Behaviour of concrete gravity platform as a rigid body on soil as a continuum. Wind load, Effect of size, shape and frequency.	30 Hours	1
III	**Aerodynamics - Structures** Aerodynamic admittance functions and gust factor. Spectral response due to wind for various types of structures.	30 Hours	1
IV	**Approximate Methods - Structures** Wave loads by Morison equation. Static and dynamic analysis of fixed structures. Use of approximate numerical methods.	30 Hours	1

References:

1. Graff W. J. v Introduction of Offshore Structures, Gulf Publication.
2. Clough. R. W and Penzien, J., Dynamics of structures, McGraw Hill Co.
3. Gerwick.B.C. Construction of Off shore Structures, John Wiley &Sons.