SEM-I

Core Course 1 Structural Dynamics

Course Code	Course Name
PC-MST101	Structural Dynamics

Course pre-requisites	

Course Objectives

The objectives of this course are

1. Dynamic load, difference between static load and dynamic load and different types of dynamic load.
2. Free vibration analysis of SDOF systems, concept of damping and dynamic analysis of SDOF system to different dynamic loads including ground motion.
3. Frequency domain analysis.
4. Dynamic degrees of freedom, Calculation of frequencies and mode shapes for lumped mass MDOF systems, analysis of MDOF systems subject to dynamic loads using modal analysis.
5. Analysis of system with distributed mass.

Course Outcomes

At the end of the course the students shall be able to,

1. Distinguish between static and dynamic loads; understand different types of dynamic loads
2. Understand the elements of single degrees of freedom, concept of damping and free and forced vibrations; able to find the frequency and free vibration response of single degree of freedom (including generalized single degree of freedom) system for different types of dynamic loads including ground motion in time domain.
3. Find the frequencies and mode shape for various types of multiple degrees of freedom lumped mass structures and carry out the dynamic (Damped and un-damped) for different types of dynamic loads including ground motion in time domain.
4. Carry out the dynamic analysis of systems with distributed mass.
5. Able to apply Fourier series in analysis of systems subjected to periodic loads and will understand the frequency domain analysis.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** Introduction to structural dynamics, definition of basic problem in Dynamics, static v/s dynamic loads, different types of dynamic loads	02
2	**Single degree of Freedom (SDOF) systems** Un-damped free vibration of SDOF system, natural frequency and period of vibration, damping in structures, viscous damping and Coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, logarithmic decrement, computation of	10

	damping. Forced vibration, response to harmonic forces, periodic loading, dynamic load factors, and response of structure subjected to general dynamic load, Duhamel's integral, numerical evaluation of dynamic response of SDOF systems subjected to different types of dynamic loads. Numerical methods of evaluation of dynamic response of structures. Distributed mass system idealized as SDOF system, use of Rayleigh's method, response of SDOF system subjected to ground motion.	
3	Use of Fourier Series for periodic forces, introduction to vibration isolation, and transmissibility. **Introduction to frequency domain analysis**, response of structure in frequency domain subjected to general periodic and non-periodic /impulsive forces of short duration, use of complex frequency response function, Fourier Response Integral, Discrete Fourier Transforms, Fast Fourier Transforms.	03
4	**Generalized Single-Degree of Freedom System:** Generalized properties, assemblages of rigid bodies, systems with distributed mass and elasticity, expressions for generalized system Properties.	07
5	**Free vibration of Lumped mass multi degree of freedom (MDOF) system:** Coupled and uncoupled systems, direct determination of frequencies of vibration and mode shapes, orthogonality principle, vibration of MDOF systems with initial conditions, approximate methods of determination of natural frequencies of vibration and mode shapes-vector iteration methods, energy methods and use of Lagrange's method in writing equations of motion	04
6	**Forced vibration of Lumped mass multi degree of freedom (MDOF) system:** Decoupling of equations of motion, modal equation of motion, concept of modal mass and modal stiffness, forced vibration of MDOF system, modal analysis, and application to beams and multi storey frames with rigid girders subjected to lateral dynamic loads.	07
7	**Structure with distributed mass system:** Use of partial differential equation, free vibration analysis of single span beams with various boundary conditions, determination of frequencies of vibration and mode shapes, forced vibration of single span beams subjected to the action of specified dynamic loads	03
TOTAL		36

Text Books

1. Dynamics of Structures by Clough & Penzien, McGraw-Hill, Computers & Structures, CBS Publishers, 2015
2. Dynamics of Structures: Theory & Applications to Earthquake Engineering by Anil K Chopra, Prentice Hall of India

Reference Books

1. Structural Dynamics by Mario Paz, Springer India, CBS Publishers, 2004
1. Introduction to Structural Dynamics by John M Biggs, CBS Publishers,2014
2. Basic Structural Dynamics by James C Anderson &FarzadNaeim, John Wiley & Sons
3. Fundamentals of Structural Dynamics by Roy R Craig & Andrew J Kurdia, Wiley
4. Mechanical Vibrations by Den P Hartog, McGraw-Hill
5. Dynamics of Structures by Jagmohan L Humar, 3rd Edition, CRC Press,
6. Passive Energy Dissipation Systems in Structural Engineering by Soong T T&Dargush G F, Wiley
7. Introduction to Structural Motion Control by Connor J J, Prentice Hall, NJ
8. Active Structural Control by Soong T T, Wiley, NY & Longman Scientific & Technical, England
9. Random Vibrations by N.C.Nigam
10. Structural Dynamics by Meriowich
11. Structural Damping: Applications in Seismic Response Modification by Zach Liang, George C Lee, Gary F Dargush&Jianwei Song, CRC Press
12. MATLAB: An Introduction with Applications by Amos Gilat, Wiley India

Core Course II Advanced theory of structures

Course Code	Course Name
PC-MST102	Advanced theory of structures

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To learn the force method of analysis of indeterminate structures
2. To understand displacement method of analysis of indeterminate structures
3. To understand the behaviour of curved beams
4. To understand the concept of beams on elastic foundations

Course Outcomes

Upon successful completion of the course, students should be able to

1. Use the force method for analysis of indeterminate structures
2. Use the displacement method for analysis of indeterminate structures
3. To determine stresses developed in curved beams
4. To analyze beams resting on elastic foundations

Course Content

Module No.	*Details*	*Hrs.*
1	**Review of the concepts :** Basic concepts of structural analysis; Principle of virtual work.	02
2	**Matrix method of analysis of structures – Stiffness approach:** Introduction, Stiffness coefficients, member stiffness matrix, energy concept, transformation of system forces and displacements to element forces and displacements, transformation of element stiffness matrix to system stiffness matrix, effect of support settlement and temperature changes, spring supports. Consideration of Shear effects, Consideration of torsional effects for thin-walled member including torsional bending; Static condensation. Symmetry considerations in structures.	06
3	**Application of stiffness matrix method:** Application to beams, pin jointed plane frames, rigid jointed plane frames and grid structures. Basic concepts associated with computer implementation of stiffness method	06
4	**Matrix method of analysis of structures – flexibility approach:** Introduction, flexibility coefficients, member flexibility matrix, transformation of element flexibility matrix to system flexibility matrix, effect of support settlement and temperature changes, application to beams, pin jointed plane frames, rigid jointed plane frames and grid structures.	06
5	**Analysis of curved beams loaded perpendicular to their plane:**	06

	Introduction, force developed at a section in a curved beam, sign conventions, torsion factor, analysis of beams curved in plan, circular arc cantilever, semi-circular beam fixed at two ends and subjected to central concentrated load, semi-circular beam subjected to udl and simply supported by three columns spaced equally, circular ring beam. Torsional analysis- Calculation of moments and forces	
6	**Curved beams with loading in their plane:** Circumferential and radial stresses, neutral axis, analysis of crane hooks of different cross sections and chain links.	06
7	**Beams on elastic foundations:** Infinite beam subjected to concentrated load, beam supported on equally spaced discrete elastic supports, Infinite beam subjected to distributed load, semi-infinite beam subjected to concentrated load at its end and near its end, short beams.	04

Text Books

1. Aslam Kassimali (2012), "Matrix Analysis of Structures", Cenage Learning
2. C. S. Reddy (2009), "Basic Structural Analysis", Tata McGraw, 779 pages
3. Pandit Gupta (2001), "Matrix structural Analysis", Tata McGraw-Hill Education, ISBN 0070667358, 602 pages
4. Arthur P. Boresi, Richard J. Smith, "Advanced Mechanics of Materials", Willey, 681 pages
5. Meghre A.S, Deshmukh S.K (2016), "Matrix Method Of Structural Analysis ", Charotar Publishing House, 552 pages

Reference Books

1. Gere Weaver(1980), "Matrix Structural Analysis", Van Nostrand Reinhold Company, ISBN 0442257732, 492 pages

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Elective-I Analysis of Composite Structures

Course Code	Course Name
EC-MST103	Analysis of Composite Structures

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To introduce the general set of composite materials
2. To show the advantages of composites over metals
3. To explain the fabrication processes
4. To analyze the structural mechanics of composite materials.
5. To explain the deformation and failure of composite materials under the influence of different loads.
6. To know the effect of hygro-thermal environment on composite materials.

Course Outcomes

Upon successful completion of the course, students should be able

1. The use of composite materials in real structures.
2. Composite material: classification, characterization, fabrication techniques.
3. Structural mechanics of composite materials: Calculation of strength and stresses.
4. De lamination, knowledge about inters laminar stresses.
5. Environmental effect on composite materials.

Course Content

Module No.	*Details*	*Hrs.*
1	Polymer matrix composites in structures. Fibre sand polymeric matrix materials. Fabrication processes.	06
2	Introduction to anisotropic elasticity. Unidirectional composites.	05
3	Micromechanics Interfaces and inter phases in polymer composites. Laminates and lamination theory.	06
4	De lamination in composites. Inter laminar stresses and free edge effects. Stress and failure analysis of laminated composites.	06
5	Hygro thermal and environmental effects.	04
6	Experimental characterization of composites.	04
7	Introduction to metal matrix, ceramic matrix and carbon-carbon composites. Intelligent composites, design approach.	05

Text Books

1. Jones R. M. (1975), “Mechanics of Composite Materials”, McGraw Hill Kogakusha, Tokyo, ISBN 0070853479, 355 pages
2. Agarwal B. D. and Broutman L. J. (1990), “Analysis and Performance of Fibre composites”, John Wiley & Sons, New York., ISBN 0471625728, 741 pages

3. Kaw A. K, "Mechanics of Composite Materials", CRC Press
4. Mukhopadhyay M (2005), "Mechanics of Composite Materials & Structures", Universities Press

Reference Books

1. Christensen R. M. (1991), "Mechanics of Composite Materials" Krieger Publishing Company, ISBN 0894645013, 348 pages
2. Calcote L. R. (1969), "The analysis of Laminated Composite Structures", Van Nostrand Reinhold Co., New York, ISBN 0442156286, 222 pages
3. Holmes M. and Just D. J. (1985), "GRP in structural Engineering", Applied Science Publishers, London. ISBN 0853342326, 298 pages
4. Gibson R. F. (17-Oct-2011), "Principles of Composite Material Mechanics", CRC Press, ISBN 1439850054, 683 pages
5. Reddy J. N., "Analysis of Composite Laminated Plates", McGraw Hill.

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Elective-I Advanced Foundation Engineering

Course Code	Course Name
EC-MST104	Advanced Foundation Engineering

Course pre-requisites	

Course Objectives

The objectives of this course are

1. The design of foundation requires the consideration of many essential factors with regard to soil data, geology of the site, land use patterns, ground conditions and the type of structure to be built.
2. A detailed understanding of the field situation is also very important apart from theoretical knowledge of the course. This course seeks to provide an overview of the essential features of foundation design.
3. The different aspects of foundation engineering ranging from soil exploration to the design of different types of foundation, including the ground improvement measures to be taken for poor soil conditions have been covered in this course.

Course Outcomes

Upon successful completion of the course, students should have

1. An ability to apply knowledge of mathematics, science and engineering
2. An ability to design and conduct experiments, as well as to analyze and interpret data
3. An ability to identify, formulate and solve engineering problems
4. An ability to use the techniques, skills and modern engineering tools

Course Content

Module No.	*Details*	*Hrs.*
1	**Review of fundamentals of soil mechanics:** Soil, soil formation , soil profiles , weight volume relationship, soil classification, Indian standard method of soil classification, concept of total stress, effective stress and pore water pressure. One dimensional consolidation, Terzaghi's theory, derivation of equation. Determination of a_v, m_v, c_c, c_v from laboratory test , determination of p_c by various methods, field consolidation curve, secondary consolidation, quassi- pre consolidation , three-dimensional consolidation, practical applications.	07
2	**Shear strength** Coulomb's law of shear strength , Mohr's Coulomb's criteria of failure, shear strength and shear strain behavior of sandy and clayey soils under undrained , drained and consolidated drained conditions, concept of progressive failure , critical void ratio, practical applications. Estimation of stresses in soils, Boussinesque and Westergard theories, Newmark Chart, practical applications	06

3	**Sub-surface ground geotechnical investigations** Direct methods of explorations, influence of type of soils, type of foundations, etc. on the programme of exploration, lateral extent and depth of exploration, bore log details, profiles of soil in various directions, indirect methods, and practical applications.	05
4	**Bearing capacity of shallow foundations**: Type of shallow foundations, gross load and net load , gross and net ultimate bearing capacity, safe bearing capacity, and allowable bearing pressure, modes of failure, criteria of failure , Terzhagi, Meyerhof, bearing capacity in shear, compressibility (including critical rigidity index) criteria, factor of safety. Bearing capacity of clay and sand in settlement, settlement analysis for clay, normally and over consolidated soils, settlement analysis of sand, Schemertmann method, and practical applications.	06
5	**Pile foundations**: Axially loaded piles, necessity of piles, types of piles, static and dynamic resistance of piles, pile load carrying capacity using dynamic pile formulae and their limitations, pile load carrying capacity using Terzhaghi, Meyerhof, Berznatsv, Vesic, Indian standard 2911 (part -1 & part-2) method, settlement of pile in clay, group of piles, load carrying capacity for sand and clay soils, group efficiency, group settlements, practical applications.	06
6	**Ground improvements**: Various methods, sand drains, stone columns, stabilization, grouting, reinforced earth, geotextiles, diaphragm walls,	04
7	**Caissons & cofferdams.**	02

Reference Books

1. Taylor D.W. (2013), “Fundamentals of Soil Mechanics”, Asia publications Bombay, ISBN 1258768925, 714 pages
2. Karl terzaghi, (1996),” Soil Mechanics in Engineering Practice”, John Wiley & Sons, ISBN 0471086584, 549 Pages
3. Joseph E Bowles, (1997),” Foundation Analysis and Design”, McGraw-Hill, ISBN 0071188444, 1175 Pages
4. Dr. Alam Singh, “Soil Mechanics and Foundation Engineering Vol. 1, & 2”, Standard Book House
5. Dr.Alam Singh, “Geotechnical Application”, Standard Book House.
6. Reddy J. N., “Analysis of Composite Laminated Plates”, McGraw Hill.

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Elective-I Design of Pre-Stressed Concrete Structures

Course Code	Course Name
EC-MST105	Design of Pre-Stressed Concrete Structures

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To understand prestress force and its effect in structural members, prestressing systems and industrial applications.
2. To understand the materials which can be used for prestressed structure. To understand the concept of deflections due to prestressing force along with other forces
3. To understand the concept of composite structures and concordancy of cables.
4. To understand the design concept using prestressing force and familiarize with IS-1343.

Course Outcomes

Upon successful completion of the course, students should be able to

1. To understand the concept of prestressing, its types and methods, and behavior of prestressed structural members
2. To analyse the losses in prestressed sections
3. To analyse and design simple prestressed flexural members and their end zones
4. To analyse and understand the behavior of prestressed composite sections and indeterminate members
5. To understand the application of IS codal clauses for analysis and design of prestressed structures

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction to basic concepts and general principles of pre-stressed concrete, materials used in prestressed concrete and methods and techniques of prestressing, prestressing systems.	02
2	Analysis of prestressed concrete sections for flexure considering loading stages, computational of sectional properties, critical sections under working loads for pretensioned and post tensioned members, load balancing method of analysis of prestressed concrete beams, losses in prestress, application to simply supported beams and slabs, concept of debonding of cables in pre tensioned units.	08
3	Design philosophy of prestressed concrete sections, permissible stresses in concrete and steel, design approaches using working stress method as per IS 1343 – 2012, limit state of collapse – flexure and shear as applied to prestressed concrete beams, kern points, choice and efficiency of sections, cable profile and layouts, cable zone, deflection of prestressed concrete sections.	08

4	End zone stresses in prestresses concrete members, pretension transfer bond, transmission length, end block of post tensioned members.	05
5	Design of simply supported pre-tensioned and post tensioned slabs and beams. Design of bridge girders subjected to IRC loadings.	05
6	Analysis and design of composite prestressed concrete structures, concept and behavior of long term creep and relaxation of prestressed members.	04
7	Introduction to application of prestressing to continuous beams, linear transformation and concordancy of cables.	04

Text Books

1. T. Y. Lin, "Design of Prestressed Concrete Structures", John Wiley Publishers
2. N. Krishna Raju, "Prestressed Concrete", Tata McGraw Hill
3. Y. Guyon, "Prestressed Concrete", Contractors Record Ltd.
4. R. H. Evans & E. W. Bennette, "Prestressed Concrete", McGraw Hill Book Co.

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Elective-I Advanced Concrete Technology

Course Code	Course Name
EC-MST106	Advanced Concrete Technology

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To expose the students to advancement in concrete technology.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Test materials used in concrete per IS code
2. Design the concrete mix using IS code method
3. Determine the properties of fresh and hardened concrete, ensure quality control and acceptance criteria
4. Decide suitability of special concretes for specific applications and to decide suitability of recycling & re-use of industrial waste material.
5. Select and use suitable repair techniques

Course Content

Module No.	*Details*	*Hrs.*
1	Review of properties of cement, their physical and chemical properties, special purpose cements, Classification and properties of aggregates, soundness of aggregates, alkali aggregate reaction, thermal properties of aggregates, Importance of shape and Surface area and grading, gap graded and aggregates.	02
2	Admixtures & construction chemicals, Use of Fly Ash, Silica Fumes, Metakaolin& GGBS in concrete Rheological behavior of concrete, requirements of workability of concrete, Durability & Effect of environmental conditions, Strength & maturity of hardened concrete, Impact, Dynamic and fatigue behaviour of concrete, shrinkage and creep of concrete, behaviour of concrete under fire.	07
3	Permeability and Durability of concrete, Parameters of durability of concrete, chemical attack on concrete, Production of concrete; batching mixing, transportation, placing, compaction of concrete. Special methods of concreting and curing, Hot weather and cold weather concreting, Guniting (Shotcreting).	07
4	Concrete mix design, Basic considerations and choice a mix proportions, various methods of mix designs including IS Code method.	05
5	Quality control and quality assurance of concrete, Acceptance	05

	criteria, Quality management in concrete construction, Inspection and testing of concrete. Non-destructive testing of concrete, core test and load test.	
6	Special concrete such as high strength, Lightweight, heavy weight, vacuum processed concrete, Mass concrete, high performance concrete, Pumpable concrete, Self-Compacting concrete, Air entrained concrete, Ferro cement, fiber reinforced concrete, Polymer impregnated concrete. Jet concrete.	04
7	Recycling & re-use of industrial waste material. Deterioration and repair technology of concrete, Distress and type of repairs, crack sealing techniques.	06

Text Books

1. Gambhir M.L., "Concrete Technology", Tata McGraw Hill, 2nd Edition, 1995.

2. M.S.Shetty, "M.S.Shetty", S.Chand& Company New Delhi, 2005.

3. P.KumarMehata, Paulo & J.M. Monteiro, "Concrete microstructure, properties & materials", Prentice Hall INC &Mcgraw Hill USA.

4. Short &Kenniburg, "Light Weight Concrete", Asia Publishing House, Bombay, 1963.

5. Orchard D.F, "Concrete Technology -Vol I. & II", Applied Science Publishers, 4th Edition, 1979.

6. Neville A.M., J.J.Brook, "Properties of Concrete", Addison Wesley, 1999.

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Elective-II Non Linear Analysis

Course Code	Course Name
EC-MST114	Non Linear Analysis

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To introduce the students to the concepts of plastic analysis of steel structures including continuous beams, single/multiple span rigid jointed portal frames and single bay gable frames.
2. To introduce the students to the concepts of elastic stability of structures.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Find the shape factor, determine the collapse load of single and multiple span beams, pin jointed frames, single/multiple span rigid jointed portal frames and single bay gable frames.
2. Find the fully plastic moment of a section under the effect of axial force and shear force.
3. Determine buckling loads of prismatic, non-prismatic members, beam-columns, single bay single storey portal frames.
4. Analyse thin walled open cross sections for torsional buckling, combined buckling due to torsion and flexure and analyse the beams for lateral buckling.

Course Content

Module No.	*Details*	*Hrs.*
1	Plastic Analysis: Concepts of plastic analysis of steel structures, stress strain relations. Shape factor- Plastic modulus, plastic hinge, fully plastic moment, moment curvature relations. Use of statistical and mechanism methods for calculation of collapse load, Lower and upper bound theorems, various types of failure mechanisms.	05
2	Collapse load analysis of pin jointed frames, Determination of collapse load – Single and multiple span beams carrying various types of loads, single/multiple span rigid jointed portal frames and single bay gable frames.	07
3	Effect of axial force and shear force on the fully plastic moment of a section. Design of beams and single span rigid jointed frames subjected to a system of proportionate loading as per Indian code provisions.	07
4	Elastic stability: Geometric Non linearity –Basic Concepts. Elastic buckling of bars with various end conditions, Euler's formula, buckling of non-prismatic members, use of energy method and finite difference method for evaluation of critical load analysis of single storey members.	07
5	Analysis of beam-columns, buckling of continuous beams. Buckling of single bay single storey portal frames. P-delta Analysis.	05
6	Torsional buckling: Pure torsion of thin walled open cross section, warping and warping rigidity, Torsional buckling of columns, combined buckling of	05

	members under torsion and flexure.	
7	Lateral buckling of beams, lateral buckling of beams in pure bending, lateral torsional buckling of cantilever and S.S. beams.	03
Term Work		
There is no Term Work for this Course		

Text Books

1. Lord Baker & Jacques Heyman (1980), "Plastic Design of Steel frames", Cambridge University Press, ISBN-0521297788, 238 pages.
2. Michael. R, Horne & B. G. Neal (2014), "Plastic Theory of Structures", Elsevier, ISBN9781483188454, 188 pages.
3. Alexander Chajes (1974), "Principles of Structural Stability Theory", Prentice Hall, ISBN-9780137099641, 336 pages.
4. NGR Iyengar (2007), "Elastic Stability of Structural Elements", Macmillan, 440 pages.
5. M. L. Gambhir (2004), "Stability Analysis & Design of Structures", Springer Science & Business Media, 535 pages.

Reference Books

1. Lynn. S. Beedle (1997), "Plastic Design of Steel Frames", John Wiley & Sons, Australia Limited, ISBN-978047109862, 406 pages.
2. Stephen Timoshenko & James. M. Gere, "Theory of Elastic Stability", Tata McGraw Hill
3. Chai H Yoo & Subg Lee (2011), "Stability of Structures: Principles & Applications", Elsevier, 536 pages.
4. George Simites & Dewey H Hodges (2006), "Fundamentals of Structural Stability", Butterworth-Heineman, 480 pages.

Sr. No.	Examination	Module
1	T-I	1 and 2
2	T-II	3, 4 and Part of 5
3	End Sem	1 to 7

Elective-II Numerical Methods

Course Code	Course Name
EC-MST115	Numerical Methods

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To master basic Programming fundamentals, Fundamentals of numerical methods
2. Determine errors present in numerical solutions to engineering problems.
3. Utilize programming logic, structure and syntax to develop multifunctional algorithms to solve engineering problems
4. Identify and classify the numerical problem to be solved.
5. Choose the most appropriate numerical method for its solution based on characteristics of the problem
6. Understand the characteristics of the method to correctly interpret the results.

Course Outcomes

Upon successful completion of the course, students should have an ability of

1. Root finding; solutions for nonlinear algebraic equations
2. Solving sets of linear equations
3. Interpolation and curve fitting models
4. Numerical Differentiation and Integration
5. Understand fundamentals of numerical methods.

Course Content

Module No.	*Details*	*Hrs.*
1	Programming fundamentals, Fundamentals of numerical methods, Error analysis;	06
2	Curve fitting, Interpolation and extrapolation	04
3	Differentiation and integration	05
4	Solution of nonlinear algebraic and transcendental equations	06
5	Elements of matrix algebra	05
6	Solution of systems of linear equations, Eigen value problems, differential equations.	06
7	Computer oriented algorithms; Numerical solution of different problems.	04

Reference Books

1. J.H. Wilkinson (1965), "The Algebraic Eigenvalue Problem", Oxford University Press, ISBN 0198534183,608 pages
2. K.E. Atkinson (1989), "An Introduction to Numerical Analysis", J. Wiley and Sons, ISBN0471624896, 712 pages

3. G.E. Golub and C.F. Van Loan (1989), "Matrix Computations", Johns Hopkins University Press, ISBN 1421407949, 756 pages.

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Elective-II Structural Optimization

Course Code	Course Name
EC-MST116	Structural Optimization

Course pre-requisites	

Course Objectives
The objectives of this course are 1. The objective of this course is to introduce the concepts of design optimization and review major conventional and modern optimization methods used in structural optimization applications.

Course Outcomes
Upon successful completion of the course, students should be able 1. To find the best solutions from which a designer or a decision maker can derive a maximum benefit from the available resources.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction to optimization:** Historical development, engineering applications of optimizations	03
2	**Classical optimization technique:** Single variable optimization. Multivariable optimization with no constraints, multivariable optimization with equality and quality constraints	04
3	**Linear programming:** Simple method- simplex algorithm **Non-linear programming:** One dimensional methods-elimination methods- unrestricted search- exoustive search- Fibonacci method-golden section method –interpolation method –quadratic & cubic interpolation method-direct root method	09
4	**Non-linear programming:** Unconstrained optimization technique –direct search methods – random search, univariable and pattern search methods-descent methods-gradient of a function-steepost descent method –fletcher – reeves conjugate gradient method, quasi newton methods, dividon Fletcher powells variable metric method **Non-linear programming:** Constrained optimization techniques –direct method – method of physible direction- indirect method- transformation techniques – basic approach in the penalty function method – interior and exterior penalty function methods	10

5	Introduction to dynamic programming	03
6	Introduction to CPM and PERT	03
7	Applications of the above methods to some structural problems	04

Reference Books

1. Rao S. S. (2009), "Optimization – Theory and Applications", John Wiley & Sons, ISBN 0470183527, 813 pages
2. Gass S.I (2003), "Linear Programming", McGraw Hill Book.Co, ISBN 0486432847, 532 pages
3. SrinathL.S(2001),"PERT and CPM - Principles and Applications", Affiliated East-West Press (Pvt.) Ltd, ISBN 8185336202.
4. Wagner H.M, (1975), "Principles of Operation Research", Prentice Hall of India, ISBN 0137095929, 1039 pages

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Advanced Design of Steel Structures

Course Code	Course Name
EC-MST117	Advanced Design of Steel Structures

Course pre-requisites	Design of steel structures

Course Objectives

The objectives of this course are

1. To develop clear understanding of concepts, and practical knowledge of modern Civil Engineering techniques for design of steel structures.
2. Use of various relevant IS codes for designing steel structures.
3. To encourage students and faculty to interact with industry, alumni and other reputed institutes for purpose of better understanding of industry requirements
4. To deal with social, environmental and economic issues

Course Outcomes

Upon successful completion of the course, students should be able

1. To understand the design concept of different types of moment resistant connections
2. To understand the analysis and design concept of round tubular structures
3. To understand the design concept of different type of steel water tank
4. To understand the design concept of lattice tower and steel chimney
5. To understand the design concept of gantry girder
6. Use of various relevant IS codes for designing steel structures

Course Content

Module No.	*Details*	*Hrs.*
1	Moment Resistant Beam End Connections: Design of moment resistant bolted and welded beam end connections.	04
2	Round Tubular Structural Members Properties of steel tubes, design of tension and compression members, design of welded connections, design of flexural members, analysis and design of tubular trusses including purlins	06

	and supports.	
3	Elevated Steel Tanks: Loads acting on tanks including wind and earthquake, design of circular tanks with conical bottom, supporting ring beam, staging for circular tanks including design of columns and base plate.	06
4	Design of rectangular steel tanks including design of staging, columns and base plate	04
5	Gantry Girder: Loads acting on gantry girder. Analysis and design of gantry girder.	06
6	Lattice Tower: Different configurations of lattice towers, loads acting on lattice towers, analysis and design of lattice tower including welded or bolted connections for members.	04
7	Steel Chimney: Forces acting on chimney, design of self-supporting welded chimney and its components including design of base.	06

Text Books

1. Design of steel structures: Subramanian, Oxford Press.
2. Design of steel structures: Negi L.S., Tata McGraw Hill
3. Design of steel structures: Kazimi S.M. A. & Jindal R.S., Prentice Hall of India.
4. Design of steel structures: Krishnamachar B.S, &Ajitha Sinha D.
5. Design of steel structures: Arya and Ajmani, New Chand & Bros.
6. Design of steel structures, Vol I & II: Ramchandran, Standard Book House, New Delhi.
7. Design of steel structures: Dayaratnam, Wheeler Publication, New Delhi
8. Comprehensive design of steel structures: Punamia, A.K. Jain &Arun Kumar Jain, LaxmiPublicalions Pvt. Ltd.
9. Design of steel structures: I C Sayal&Salinder Singh, Standard Publishers & Distributors.

Reference Books

1. Steel structures, Controlling behaviour through design: R. Englekirk, Wiley
2. Design of steel structures: Breslar, Lin and Scalzi, John Willey, New York.
3. Design of steel structures: Mac. Ginely T.
4. Structural steel work: Reynolds TJ., Kent L.E. &Lazenby, D.W., English University Press.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Elective-III Advanced Solid Mechanics

Course Code	Course Name
EC-MST125	Advanced Solid Mechanics

Course pre-requisites	

Course Objectives

The objectives of this course are

1. This course will expand on the basic principles established in Solid Mechanics.
2. Methods of three-dimensional stress and strain analysis will be extended to allow the student to obtain solutions using analytical and/or numerical methods. These will include the analyses of principal stresses and strains, three dimensional Mohr's circles, strain gauge experimentation and failure criteria.
3. In addition, this unit will focus on plastic deformation of solids, including the analysis of residual stresses.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Define stress/strain correlations for an engineering problem
2. Derive governing differential equations to solve engineering problem
3. Establish links between theoretical and practical applications; identify problems and formulate solution strategies

Course Content

Module No.	*Details*	*Hrs.*
1	**Revision:** Stress transformation and strain transformation at a point in an elastic body, 3-D Problems, rigid body translation and rotation of an element in space. Generalized Hook's law, separation of elastic strain rigid body displacement for a general displacement field u,v,w. Principal stresses and strains.	07
2	**Two dimensional problems in elasticity:** Plain stress and Plain strain problems. Differential equations of equilibrium and compatibility equations. Boundary conditions, stress functions.	04
3	**Problems in rectangular coordinates:** Polynomial solutions, cantilever loaded at the end, simply supported beam under uniformly distributed load, linear loading.	03

4	**Two dimensional problems in polar coordinates:** Stress distribution symmetrical about an axis, pure bending of curved bars, displacement for symmetrically loaded cases, bending of curved bars by forces at end. Effect of a circular hole in a plate under in-plane loading. Concentrated load at a point of a straight boundary. Stresses in circular disk. Forces acting on the end of	07

	wedge.and friction plate selection	
5	**Three dimensional problems in elasticity:** Differential equation of equilibrium in 3D, condition of compatibility determination of displacement, principle of superposition, uniqueness theorem, problems of rods under axial stress bar under its own weight pure bending of prismatic rods, torsion of prismatic bars of elliptical rectangular triangular and other sections. Membrane analogy-torsion of narrow rectangular bars .torsion of hollow shafts and thin tube.	07
6	**Bending of prismatic bars as a problem of elasticity in 3D:** Bending of cantilever stress functions circular and rectangular section non-symmetrical cross section shear centre for different cross section of bars calculation of deflection.	04
7	**Energy theorems**: Application of complimentary energy theorems to the problems of elasticity. **Introduction to plasticity:** Criterion of yielding strain hardening rules of plastic flow different stress-strain relation. Total strain theory, theorem of limit analysis, elasto-plastic bending of members.	04

Text Books

1. C.K.Wang (December 1963) , "Applied Elasticity", MCGRAW-HILL INC.,US, ISBN 0070681252, 537 pages
2. Timoshenko (1970), "Theory of Elasticity", McGraw-Hill Publishing Company, ISBN 0070858055,608 pages
3. Shames I. H (1964), "Mechanics of Deformable Solids", Prentice Hall India
4. Srinath L. S (2009)," Advanced mechanics of solids", Tata McGraw-Hill Education, ISBN 0070139881, 504 pages
5. Mohammad Ameen (January 2008), "Computational Elasticity: Theory of Elasticity, Finite and Boundary Element Methods" Alpha Science International Ltd, ISBN: 978-1842654491,532 pages

Reference Books

1. J. Chakrabarti (2006), "Theory of plasticity", Elsevier/Butterworth-Heinemann, ISBN 0750666382, 882 pages
2. Timoshenko S (2004), "Strength of Materials Vol – I & II", CBS Publishers & Distributors, ISBN 8123910304 ,298 pages
3. Boresi A. P (2002)," Advanced mechanics of materials", John Wiley & Sons, ISBN 0471438812,681 pages

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Core Lab-I Advanced Concrete Lab

Course Code	Course Name
PC-MST151	Advanced Concrete Lab

Course pre-requisites	

Course Outcomes
Upon successful completion of the course, students should be able to 1. Design high grade concrete and study the parameters affecting its performance. 2. Conduct Non Destructive Tests on existing concrete structures. 3. Apply engineering principles to understand behaviour of structural/ elements

Course Content	
Practical No.	***Details***
1	Mix design of high strength concrete
2	Stress-Strain curve of high strength concrete
3	Cube compressive strength, cylindrical comp. strength of concrete and relation between them.
4	Split tensile strength and Modulus of rupture
5	A. Flexural strength of beam. B. Shear strength of beam C. Torsional strength of beam.
6	Effect of cyclic loading of steel
7	Non-Destructive Tests A. Study of Rebound Hammer test on concrete B. Ultrasonic Pulse Velocity test on Concrete C. Study of half-cell Potentiometer and measurement of corrosion in RCC. D. Core removal from concrete structure and compression testing E. Carbonation Test on concrete
Report on experiments performed as detailed above shall be submitted as laboratory work	

Core Lab-II Numerical Analysis Lab

Course Code	Course Name
PC-MST152	Numerical Analysis Lab

Course pre-requisites	

Course Outcomes
Upon successful completion of the course, students should be able to 1. Find Roots of non-linear equations by Bisection method and Newton's method. 2. Do curve fitting by least square approximations 3. Solve the system of Linear Equations using Gauss - Elimination/ Gauss - Seidal Iteration/ Gauss - Jorden Method 4. Integrate Numerically Using Trapezoidal and Simpson's Rules 5. Find Numerical Solution of Ordinary Differential Equations by Euler's Method, Runge- Kutta Method.

Course Content	
Practical No.	***Details (Atleast 8 to be performed)***
1	Find the Roots of Non-Linear Equation Using Bisection Method
2	Find the Roots of Non-Linear Equation Using Newton's Method
3	Curve Fitting by Least Square Approximations.
4	Solve the System of Linear Equations Using Gauss - Elimination Method
5	Solve the System of Linear Equations Using Gauss - Seidal Iteration Method
6	Solve the System of Linear Equations Using Gauss - Jorden Method.
7	Integrate numerically using Trapezoidal Rule.
8	Integrate numerically using Simpson's Rules.
9	Numerical Solution of Ordinary Differential Equations By Euler's Method
10	Numerical Solution of Ordinary Differential Equations By Range- Kutta Method
Report on experiments performed as detailed above shall be submitted as laboratory work	

MLC-Research Methodology & IPR

Course Code	Course Name
MC-PG01	Research Methodology & IPR

Course pre-requisites	

Course Objectives

The objectives of this course are

1. Understand research problem formulation
2. Analyze research related information
3. Follow research ethics

Course Outcomes

Upon successful completion of the course, students should be able to

1. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
2. Understand that when IPR would take such important place in growth of individuals & nation, it is needless to emphasise the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
3. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Course Content

Module No.	*Details*	*Hrs.*
1	**Meaning of research problem**. Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	03
2	**Effective literature studies approaches, analysis** Plagiarism, Research ethics	03
3	**Effective technical writing, how to write report, Paper** Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	03
4	**Nature of Intellectual Property** Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	03

5	**Patent Rights:** Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications	03
6	**New Developments in IPR** Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	03

Text Books

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 6

Audit- Project Planning & Management

Course Code	Course Name
AU-PG 01	Project Planning And Management

Course pre-requisites	Basics of structural analysis and design, surveying, soil mechanics, hydraulics, construction materials and practices, working of organizations

Rationale
The purpose of this course is to provide a sound understanding of the roles and responsibilities of civil and structural engineers in industry with an emphasis on engineering projects. In this context the course will provide a thorough insight into what to expect and what is expected of a fresh civil and structural engineer. The course will establish the application and importance of academic knowledge in industrial practice. Appreciation of the strong links between academics and practice will promote a positive approach and attitude thus enhancing employment opportunities

Course Objectives
The objectives of this course are 1. Understand the roles and responsibilities of civil and structural engineer in practice. 2. Understand the important activities and the sequence in which they are to be carried out 3. Learn the importance of accuracy and correctness in work and how this is achieved. 4. Understand the skills required by a civil and structural engineer
Course Outcomes
Upon successful completion of the course, students should be able to 1. Have a clear understanding of the stages and activities in project execution 2. Draw upon the academic knowledge gained in college to achieve efficiency in actual practice. 3. Appreciate the developments in Civil and Structural engineering and the continuous up gradation of knowledge and skills. 4. Approach industry with enthusiasm, motivation, confidence and a strong pride in the profession

Course Content

Module No.	***Details***	***Hrs.***
1	**Introduction and Early work** • Roles and challenges of the Civil and structural engineer • Planning and scheduling for a project • Budget and Cost control • Surveying activity for a project	06

	• Geotechnical Investigation for a project	
2	**Basic Design of a Project** • Plot Layout Planning, • Construction strategy • Tendering and Contract strategy for a project • Design basis for the project • Important codes, specifications and standards Site Development	06
3	**Global design** • Important engineering principles and concepts • Preliminary structural analysis and design • Quantity and cost estimation and monitoring • Piling in a project • Material Estimation for ordering • Construction strategy for a project.	06
4	**Detailed Design** • Detailed computer analysis and design of structures, • Statutory approvals and permits • 3D computer modelling and interaction with other engineering disciplines. • Design reviews and Change management 2D Detailed construction drawings for Reinforced concrete, Steel and Architecture	06
5	**Construction Stage** • Steel fabrication drawings and concrete bar bending schedules • Construction management • Safety and Quality Control • Present and future trends in Civil and Structural engineering Essential skills required by a Civil and Structural engineer	06

Audit - English for Research Paper Writing

Course Code	Course Name
AU-PG02	English For Research Paper Writing

Course pre-requisites	

Course Objectives
Upon successful completion of the course, students should be able to 1. Understand that how to improve your writing skills and level of readability. 2. Learn about what to write in each section. 3. Understand the skills needed when writing a Title

Course Content		
Module No.	***Details***	***Hrs.***
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	03
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts	03
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	03
4	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an introduction, skills needed when writing a Review of the Literature	03
5	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	03
6	Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.	03

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

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 6

SEM-II

Core Course III: Finite Element Analysis

Course Code	Course Name
PC-MST201	Finite Element Analysis

Course pre-requisites	Advanced Solid Mechanics

Course Objectives

The objectives of this course are

1. To understand mathematical modelling and numerical formulation of engineering problems.
2. To learn about concepts of elements and their properties.
3. To understand finite element methods and its application for solution of structural mechanics problems.
4. To understand finite element methods and its application for solution of non-linear and dynamics problems

Course Outcomes

Upon successful completion of the course, students should be able to

1. Formulate the numerical models for engineering problems.
2. Use appropriate element for solution of problem by finite element modeling.
3. Solve non-linear and dynamics problems using finite element approach.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** Mathematical Modeling of Engineering Problems, Types of governing equations, Solution methodologies, numerical modeling, approximate method of analysis – method of point collocation, method of collocation by sub region, method of least squares, Galerkin's method, Rayleigh-Ritz method	05
2	**Finite Element Method:** General Steps in FEM, Direct approach, variational approach, energy approach and weighted residual approach.	06
3	**Finite Elements and Interpolation Functions:** Interpolation functions, one two and three dimensional elements – linear, quadratic, Cubic and Lagrangian Interpolation function, Isoparametric elements, Serendipity elements Shape Functions, Sub-Parametric and super parametric elements,Infinite elements	06
4	**One Dimensional Finite Elements:** Linear spring, Truss element, Space truss, Beam Element.	04

	Application to analysis of beams, trusses, plane frames and grids Multilinear springs, compression and tension only springs.	
5	**Two Dimensional Finite Elements:** Two dimensional stress analysis, CST element for plane stress and plane strain, triangular elements for axi-symmetric analysis, rectangular elements, isoparametric formulation	05
6	**Introduction to Non-Linear Analysis:** Geometric Non-Linearity-Geometric Stiffness of an Axial Element. Stability of Bar- Spring System. General Formulation of Geometrically Non Linear Problem. Geometric Stiffness of Beam-Column and Triangular Elements. Non-Linear Material Behavior. Non- Linear Spring- Elasto Plastic Analysis by FEM- Elasto Plastic Analysis of a truss- Two Dimensional Element Formulations- General Formulation of a physically Non-Linear Problem	05
7	**Introduction to Dynamic Analysis by FEM:** Formulation of Inertial Properties- Lumped Mass vs Consistent Mass Matrices –Condensation and Assembly of Mass Matrices- Formulation of Damping Properties- Free Vibration, Steady – State and Transient Response Analysis for Simple Problems.	05
TOTAL		36

Text Books

1. Desai Y.M, Eldho T.I, Shah A.H (2011) ,"Finite Element Method With Applications in Engineering ", Pearson Education India , ISBN 8131724646 , 492 pages
2. Krishnamoorthy C.S, (1994), "Finite Element Analysis", Tata McGraw Hill, ISBN 0074622102, 710pages
3. William B. Bickford, (1990),"First Course in The Finite Element Method", ISBN 0256079730, 649 pages
4. Rajshekaran S. (2008), "Finite Element Analysis", Wheeler publishing, ISBN 8121923149, 630 pages

Reference Books

1. O. C. Zienkiewicz,K. Morgan (2000), "Finite Elements and Approximation", Dover publications, ISBN 0486453014, 352 Pages
2. J.N. Reddy, (2008), "Non linear Finite Element Analysis", Oxford University Press, ISBN 0195692039,
3. Cook R.D., Malkus D.S. and Plesha,(2001), "Concepts and Applications of Finite Element Analysis", John Wiley & Sons (Asia) PvtLtd.ISBN0471356050, 736 pages.
4. Weaver W and Johnston P.R., "Finite Element for Structural Analysis", Prentice Hall

Core Course IV: Earthquake Engineering

Course Code	Course Name
EC-MST 202	Earthquake Engineering

Course pre-requisites	Structural Dynamics

Course Objectives

The objectives of this course are

1. The importance of the earthquake engineering.
2. Basics of earthquake engineering : causes of earthquake, types of earthquakes, seismic waves, structure of earth, and measurement of earthquake.
3. Concept of Response Spectrum: ground motion parameters, response spectrum, characteristics of response spectrum, and methods of construction of response spectrum.
4. Analysis of the structure subjected to earthquake ground motion. Provisions of IS 1893-2016 and calculation of earthquake loads
5. Importance of ductility in earthquake resistant design of structures and provisions of IS 13920 (2016)
6. Practical knowledge by conducting some basic experiments in structural dynamics.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Describe earthquake phenomenon, their causes and effects on structures
2. Apply knowledge of structural dynamics in evaluation of structural response to earthquake ground motion
3. Characterize the ground motion in the form of response spectra and construct response spectra and evaluate the structural response to earthquake ground motion using response spectra
4. Carry out Seismic analysis of structure, incorporating the provision of IS -1893-2016; and IS 13920- 2016

Course Content

Module No.	*Details*	*Hrs.*
1	**Review of Structural dynamics:** Review of dynamic analysis of SDOF and MDOF systems subjected to various types of dynamic loads including earthquake ground motion.	02
2	**Seismological background:** Seismicity of a region, earthquake faults and waves, structure of earth, plate tectonics, elastic-rebound theory of earthquake, intensity and magnitude of earthquake, measurement of ground motion, seismogram, earthquake frequency, local site effects, seismo-tectonics and Seismicity of India. Effect of near-field and far-field earthquake ground motions.	04

3	**Characterization of ground motion:** Earthquake response spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration, response spectrum shapes, deformation, pseudo-velocity, pseudo-acceleration response spectra. peak structural response from the response spectrum, response spectrum characteristics, construction of site-specific response spectra.	05
4	**Deterministic earthquake response:** Types of earthquake excitation, lumped SDOF elastic systems. translational excitation, lumped MDOF elastic systems, systems with distributed mass and elasticity, translational excitation, time history analysis, multi storied buildings with symmetric plans, multi storied buildings with unsymmetric plans, torsional response of unsymmetric plan building, distributed - parameter elastic systems, translational excitation, combining maximum modal responses using mean square response of a single mode, SRSS and CQC combination of modal responses. **Earthquake response of inelastic buildings:** Allowable ductility and ductility demand, building with weak or soft storey.	07
5	**I. S. code method of seismic analysis:** Equivalent static method and its limitation, response spectrum method, IS 1893-2016 provisions for seismic analysis of buildings and water towers, seismic evaluation and retrofitting, types of structural system used in building to resist earthquake loads.	07
6	**Seismic Design Considerations for RC Buildings:** Choice of earthquake resisting systems for low-rise, medium-rise and high-rise buildings, Principles of member design, ductile detailing, Earthquake Resistant Design of beams and columns, Design of Beam-Column Joints, Design of Shear Walls with ductile detailing, Drift and lateral stability criteria.	06
7	**Seismic Design Considerations for Steel Structures:** Performance of steel structures in the past earthquakes, Design philosophy for steel structures, Capacity design concept, Ductility of steel buildings, Seismic design and detailing of Moment Resistant Frames (MRFs); Beams and columns, Panel Zones and Connections, Seismic design and detailing of Concentric Brace Frames (CBFs)	05

Text Books
1. Dynamics of Structures by Anil K Chopra, Prentice Hall of India 2. Structural Dynamics of Earthquake Engineering: Theory & Application using MATHEMATICA & MATLAB by S Rajasekaran, Woodhead Publishing Ltd. 3. Earthquake Resistance Design & Risk Reduction by David Dowrick, Wiley India 4. Seismic Analysis of Structures by T K Dutta, John Wiley & Sons (Asia) Pvt.Ltd 5. Seismic design of RC buildings : Theory and Practice by S.N.Manohar, S.N.Madhekar ,Springer (2015) 6. Earthquake Resistant Design of Structures by Manish Shrikhande, Pankaj Agrawal 7. I.S. Codes No. 1893, 4326, 13920 (All latest codes)
Reference Books
1. Fundamentals of Earthquake Engineering by N M Newmarks& E Rosenblueth, Prentice Hall 2. Earthquake Spectra & Design by N M Newmarks & W J Hall, Earthquake EngineeringResearch Institute, Berkeley, California 3. Dynamics of Structures by Clough &Penzien, McGraw-Hill, Computers & Structures 4. Fundamentals of Earthquake Engineering by Amr S Elnashai & Luigi Di Sarno, WileyIndia 5. Fundamentals of Earthquake Resistant Construction by Ellis L Krinitzsky, James P Gould & Peter H Edinger, Wiley India 6. Elementary Seismology by C R Richter, W.H. Freeman & Company, San Francisco

Sr.No.	Examination	Module
1	T-I	Module 1 and 2
2	T-II	Module 3 and 4
3	End Sem	Module 1 to 7

Elective IV Bridge Engineering

Course Code	Course Name
EC-MST203	Bridge Engineering

Course pre-requisites	Design of Prestressed Concrete Structure

Course Objectives

The objectives of this course are

1. To understand Bridge types
2. To learn IRC Loading criteria
3. To understand fundamentals of Bridge design
4. To understand fundamentals of Bridge design
5. To understand the principles of long span bridge design

Course Outcomes

Upon successful completion of the course, students should be able to

1. Understand the different loadings on Bridges and the components of different types of Bridges
2. Understand the behaviour and suitability of various bridge types
3. Analyse the different types of bridges and design their various components
4. Understand the different construction methods for bridge construction and their impact on bridge design

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction:** Classification and components of bridges, historical perspective, layout and planning, investigations for bridges, choice of type of the bridges, conceptual bridge design, bridge aesthetics. Bridge appurtenances.	05
2	**Loads on bridges:** Loading standards for highway and railway bridges (IRC, IRS)	05
3	Analysis and design of RC and PSC bridge decks: Slab culvert bridges, slab-and-beam bridges, load distribution in slabs and beams, bow-string girder bridges, behavior of skew bridge decks	05
4	Behavior, analysis and design of RC and PSC box-girder bridge decks.	05
5	Behavior, analysis and design of steel bridge decks: girder bridges, truss bridges, arch bridges, composite construction	05
6	Design of bearings, substructure and foundations – piers and abutments of different types, shallow and deep foundations – design and constructional aspects	05

7	Modern methods of construction of concrete, steel and composite bridges, their impact on analysis and design, construction stage analysis. Introduction to analysis and design of long span bridges: suspension and cable stayed bridges, balanced cantilever construction, segmental construction.	06

Text Books

1. Raju N. K (1988), "Design of Bridges", Oxford and IBH Publishing, ISBN 8120417410.
2. Victor D. J (2007), "Essentials of Bridge Engineering" , Oxford & IDH, ISBN 8120417178, 495 pages.
3. T.R Jagdeesh& M.A Jayaram,(2009), " Design of Bridge Structures", Prentice Hall India Private Ltd. New Delhi, 360 pages

Reference Books

1. Ponnuswamy S (2008), "Bridge engineering", Tata McGraw-Hill Education, ISBN 0070656959, 747 pages
2. Raina V.K(1994), " ConcreteBridge Practice", Tata McGraw Hill, ISBN 0074623621, 756 pages
3. Tomlinson M.J (2001), "Foundation Design And Construction " , Prentice Hall , ISBN 0130311801, 584 pages
4. FIB recommendations.

Elective IV Analysis of Offshore Structures

Course Code	Course Name
EC-MST204	Analysis of Offshore Structures

Course pre-requisites	

Course Objectives
The objectives of this course are to understand wave and ocean structure interaction under various types of Hydrodynamic and aerodynamic loading
Course Outcomes
Upon successful completion of the course, students should be able 1. Wave generation process 2. Design aspects of ocean and coastal structure. 3. Short and long term statistics of wind, wave 4. Different types of offshore structures 5. Codes of Practices for design of ocean structures

Course Content

Module No.	*Details*	*Hrs.*
1	Wave Mechanics: Wave generation process, small and finite amplitude wave theories.	05
2	Types of offshore structures, planning and design aspects, Loads and structural forms of different types of offshore structures.	05
3	Wave loads regular and random, loads due to wind, tides and currents. Operational environment. Wind forces: Wave forces on vertical, inclined cylinders, structures – current forces and use of Morison equation.	05
4	Short and long term statistics of wind; static wind load; effect of size, shape and frequency; Aerodynamic admittance function and gust factor, spectral response due to wind for various types of structures;	05
5	Static and dynamic analysis of fixed structures.	06
6	Different types of offshore structures, foundation modeling, structural modeling, Static method of analysis, Foundation analysis, Dynamics analysis of offshore structures, Design of platforms, Jacket tower and mooring cables and pipe lines	05
7	Codes of Practices (latest versions) such as API R-2A, bureau Veritas	05
TOTAL		36

Reference Books

1. Brebbia C.A. and Walker (1978): Dynamic Analysis of offshore structures", Newness butterworth, London, 1978.
2. Sarpakaya T. and Isaacson M.(1981): Mechanics of Wave Forces on Offshore Structures", Van NostrandRainhold, NewYork, 1981.
3. Hallam M.G., Heaf N.J. and Wootton, L.R. (1978): "Dynamics of Marine Structures", CIRIA Publicartions, Underwater Engg. Group, London, 1978.
4. Graff W.J. (1981): "Introduction to Offshore Structures", Gulf Publishing Co., Houston, Texas, 1981.
5. Clough R.W. and Penzien J. (1992): "Dynamics of Structures", IInd Edition, McGraw hill, 1992.
6. Simiu E. and Scanlan R.H. (1978): wind effects on Structures", Wiley,New York, 1978.
7. Codes of Practices (latest versions) such as API R-2A, bureau Veritas etc.

Elective IV- Deterioration, Instrumentation and Rehabilitation of Structures

Course Code	Course Name
EC-MST205	Structural Instrumentation and Rehabilitation of Structures

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To impart knowledge on laboratory / field testing of Civil Engineering Structures.
2. To expose students to state-of-the-art Instrumentation for Structural analysis results and techniques for Rehabilitation of RC, Steel and Masonry structures.
3. To inculcate aptitude for quality control and strengthening of civil structures.

Course Outcomes

Upon successful completion of the course, students shall be able to

1. Present methods of laboratory / field testing of Civil Engineering Structures.
2. Identify cracks in buildings: causes and remedial measures.
3. Identify and apply the techniques for rehabilitation / strengthening of RC, Steel and Masonry structures.

Course Content

Module No.	*Details*	*Hrs.*
1	Study of various transducers, Principle of their working, displacement, velocity, acceleration etc, strain gauge & piezoelectric type of transducers.	10
2	Strain measurements, strain gauges (static and dynamic), calculation of stresses and loads from measurements of strains and deflections.	04
3	Special concrete constructions: fibre reinforced concrete; fibre wrapping, Special concrete like lightweight concrete, ferro cement, fly ash concrete, High performance concrete, concrete admixtures.	05
4	Corrosion of steel and concrete: Theory and prevention	05
5	Cracks in buildings: causes and remedial measures.	05
6	Techniques for Rehabilitation of RC, Steel and Masonry structures	05
7	Non-destructive testing of concrete, steel structures, Various NDT tests, codal provisions, Proof Load testing.	06
TOTAL		36

Reference Books

1. Singh, Sadhu; Experimental Stress Analysis, Khanna Publishers.
2. Soisson, H.E.; Instrumentation in Industry; John Willey & Sons; NY; 1975
3. Boomfield, J.P.; Corrosion of Steel in Concrete; E& FN SPON; 1997
4. Ganesan, T.P.; Model Analysis of Structures; University Press; 2000
5. IS: 13935; Repair and Seismic Strengthening of Bulidings- Guidelines; Bureau of Indian Standard; New Delhi; 1993
6. SP: 25; Causes and Prevention of Cracks in Buildings; Bureau of Indian Standard; New Delhi; 1984

Elective V Advanced Design of Concrete Structures

Course Code	Course Name
EC-MST214	Advanced Design of Concrete Structures

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To introduce the students to different design philosophies applied to reinforced concrete structures.
2. To introduce the students to the design of special reinforced concrete structures.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Analyse the structure using the concept of limit design, analyse slabs using yield line analysis and design various RCC elements using ultimate load method and limit state method.
2. Design special reinforced concrete structures such as silos and bunkers, folded plate roofs, circular cylindrical shell roofs etc.

Course Content

Module No.	*Details*	*Hrs.*
1	**Ultimate Load analysis of concrete structures:** Stress strain characteristics of concrete and reinforcing steel, review of elastic theory and ultimate strength theory, Whitney's rectangular stress block, analysis and design of singly and doubly rectangular and tee sections.	04
2	**Concept of limit design:** Introduction to the concept of limit design. Moment curvature relationship of reinforced concrete sections, rotation capacity of sections, ultimate load analysis by Cambridge and Baker's method. Application to continuous beams and simple rectangular portal frames.	06
3	**Yield line analysis:** Yield line analysis of slabs, virtual work and equilibrium method. Application to orthotropically reinforced rectangular slabs with various boundary conditions under uniformly distributed loads.	05
4	**Reinforced concrete design by limit state method:** Review of limit state method as per IS 456:2000. Limit state collapse in flexure, direct compression, compression with bending, shear and torsion, limit state of serviceability for deflection and cracking, applications to beam-slab system of typical residential, office, industrial floors and rectangular portal frames and gable ended frames.	05
5	**Design of different slab systems:** Analysis and Design of Two-way Slab System without Beams (Flat Plate and Flat Slabs), Two-way Slabs with Beams.	05
6	**Silos and bunkers:** Lateral pressure as per Janssen's and Airy's theories, design consideration for square, rectangular and circular shapes, design of hoppers and supporting structures.	05
7	**Large span roofs:** Analysis of Folded plate roofs- Whitney's method,	06

	Simpson's method. Circular cylindrical shell roofs- beam theory of cylindrical shells.	

Term Work

There is no Term Work for this Course

Text Books

6. G. S. Ramaswamy, (2005), "Design and Construction of Concrete Shell Roofs ", CBS Publishers & Distributors, ISBN 8123909905.

7. Karve S.R. and Shah V. C (1994), "Design of Reinforced Cement Concrete Structures using Limit State Approach", Structures Publishers, ASIN B007I29ARC.

8. Krishna Raju (2016), Advanced Reinforced Concrete Design (IS : 456-2000) , CBS Publishers & Distributors, ISBN: 9788123929606, 8123929609, 488 Pages.

Reference Books

5. V. Ramkrishnan & P. D. Arthur (1964), "Ultimate Strength Design for Structural Concrete", Wheeler Publishing Co, Pitman, 264 pages.
6. P. C. Verghese, (2005), "Advanced Reinforced Concrete Design", PHI Publishers, ISBN-10: 812032787X, 560 pages.

Sr. No.	Examination	Module
1	T-I	1, 2 and part 3
2	T-II	Part 3, 4 and 5
3	End Sem	1 to 7

Elective V Theory of Plates

Course Code	Course Name
EC-MST215	Theory of Plates

Course pre-requisites	

Course Objectives

The objective of this course is to enable students to acquire the analytical and numerical methods needed for the solution of different types of plates and thin slabs.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Express various types of loadings on a plate in terms of Fourier series.
2. Apply the Navier and Levy solutions for rectangular plates with different boundary conditions and loading.
3. Obtain solutions for circular plates.
4. Use finite difference methods to obtain plate deflections and moments, and also apply available finite-element programs to plate problems.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction**: Introduction to theory of plates with small and large deflections, distinction between plate and shell action.	03
2	**Pure bending of thin plates**: Curvature at a point, circle of curvature, moment curvature relationships, relationship between twisting moment and twist of surface.	05
3	**Classical plate theory**: Classical Small-Deflection Theory of Thin Plates, Plate Equation in Cartesian Coordinate System, Boundary Conditions of Kirchhoff's Plate Theory	05
4	**Symmetrical bending of thin circular plates with small deflections under axi-symmetrical transverse loads:** Differential Equation of Circular Plates, Circular plates different support conditions, plates with overhangs, plates with coaxial circular opening. Circular plates subjected to different loads.	06
5	**Small deflection theory for laterally loaded thin rectangular plates**: Rigorous Solution of Plate Equation, Rectangular plates subjected to transverse load, Transverse shears and bending moments, corner effects	06
6	**Series solutions of governing differential equation:** Various	05

	support conditions, Navier's and Levi's solution for uniformly distributed , uniformly varying load and concentrated loads	
7	**Numerical technique for solution of plate equations:** Use of numerical techniques for the solution of plates, concept of influence surface; study of simply supported plate with continuous edge moments,	06
TOTAL		36

Text Books
1. D Timoshenko, (1989), ''Theory of Plates and Shells", McGraw-Hill, 580 pages 2. Varadan T.K and Bhaskar K, "Analysis of Plates Theory and Problems", Narosa Publishing House, ISBN 8173192561, 198 pages 3. N.K. Bairagi(1984)," Plate Analysis", Khanna Publishers, 310 pages 4. Bhavikatti (2015), "Thoery of Plates & Shells", New Age International
Reference Books
1. R.Szilard(1974), "Theory and Analysis of Plates, "John Wiley & Sons, ISBN 0471429899,1024 pages

Elective V Reliability Based Civil Engineering Design

Course Code	Course Name
EC-MST216	Reliability Based Civil Engineering Design

Course pre-requisites	

Course Objectives

The objectives of this course are

1. Random variables, probability and statistics, Monte Carlo simulation, Variation reduction techniques
2. Concept of failure of a structure
3. Reliability based design , Application of reliability analysis to structural members and structural systems

Course Outcomes

Upon successful completion of the course, students should be able

1. Determine probability distributions, correlation between random variables
2. Use Monte Carlo simulation, variation reduction techniques and find different reliability indices
3. Perform Reliability based design and Apply reliability based analysis to structural members and structural systems

Course Content

Module No.	*Details*	*Hrs.*
1	**Revision:** General introduction to structural safety and reliability and reliability. Concept of uncertainty in reliability-based analysis and design. Course outline.	10
2	• Random variables. • Probability axioms and probability functions. • Conditional probability. • Common probability distributions. • Correlation between random variables. • Random vectors and functions of random variables	04
3	• . Monte Carlo simulation, Variation reduction techniques.	05
4	• Concept of failure of a structure. • Reduced variable space and basic definition of reliability index. • First order second moment index. • Hasofer-Lind reliability index.	06

	• Rackwitz-Fiessler reliability index.	
5	• Reliability-based design code and its development. • Load and resistance factor design format. • Calibration of partial safety factors. • Uncertainty models for load and resistance.	05
6	• Second order reliability method. • Bayesian approach. • Response surface approach. • Time-varying reliability. • Summary.	06
7	Application of reliability analysis to structural members and structural systems	06
TOTAL		36

Text Books

1. Srinath L., Raghavan. M., Ingaiah K., Gargesha G, Pant B. and Ramachandra K., Experimental Stress Analysis, Tata McGraw Hill Company, New Delhi, 1984.
2. Dally J. W. and Riley W. F., Experimental Stress Analysis, McGraw Hill Book Co. 1977.

Reference Books

1. Ang, A.H.S. & Tang, W.H. (1975), "Probability Concepts in Engineering Planning and Design: Volume 1 - Basic Principles", Wiley, New York, ISBN 3857480939
2. Benjamin, J.R. & Cornel, C.A. (1970), "Probability, Statistics and Decision for Civil Engineers", McGraw-Hill, New York, 684 pages
3. Ellingwood, B. et al.(1980), "Development of a Probability Based Load Criterion for American National Standard A58", US Department of Commerce, Special Publication NBS-577.
4. Ranganathan R. (1990), "Reliability Analysis and Design of Structures", McGraw-Hill, New Delhi, ISBN 0074603140, 354 pages

Elective V Theory of Shells

Course Code	Course Name
EC-MST217	Theory of Shells

Course pre-requisites	

Course Objectives

The objective of this course is to enable students to acquire the analytical and numerical methods needed for the solution of different types of shells

Course Outcomes

Upon successful completion of the course, students should be able to

1. Understand the force flow in shell structures and be able to manually calculate stresses, deformations and buckling loads of elementary shell shapes.
2. Understand the scientific approach to deriving and solving the governing differential equations and will be able to make, interpret and check analyses of shell structures.

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction to structural behavior of thin shells, membrane and bending actions.	04
2	**Mathematical representation of a shell surface:** Principal curvatures, Gauss curvature. Classification of Shells	05
3	**Membrane theory of thin shells:** Stress resultants, application to cylindrical shell under symmetric loads and surfaces of revolution under axi-symmetric loads	05
4	**Bending theory of open circular cylindrical shells:** With special emphasis to approximate theories of Finsterwalder and Schorer theories: Introduction to DKJ Flugge and other exact theories: Different boundary conditions for single and multiple shells.	05
5	**Bending theory of closed cylindrical shell:** Stiffness coefficients at free edges along radial and rotational directions; Bending theory of spherical shells. Geckeler's approximations, Stiffness coefficients	05
6	**Moment theory of shells of revolution:** Introduction, Governing equations, Shells of revolutions under axisymmetrical loads, Approximate method for solutions of governing equations.	06
7	**Approximate theories of shell analysis and their application:** Introduction, the semi membrane theory of cylindrical shells, The	06

	Donnel-Mushtari Vlasov theory of thin shells, Theory of shallow shells, Edge effects.	
TOTAL		36

Reference Books
1. Stephen Timoshenko, S. Woinowsky-Krieger (2003), "Theory of Plates and Shells", Textbook Publishers, ISBN 0758184093, 580 Pages 2. R. Chandrashekara, (1987), "Analysis of Thin Concrete Shells", McGraw Hill Book Co, ISBN 0074515683, 288 Pages 3. Ramaswamy G.S., (1984), "Design and Construction of Concrete Shell Roofs", Krieger Pub Co; ISBN 0898740010, 745 Pages 4. N.K. Bairagi, (1990), "Shell Analysis", Khanna Publishers, Delhi , 5. V.V. Novozhilov, (1970), "Thin Shells", Kluwer Academic Publisher, ISBN 900164550X, 429 Pages 6. Bhavikatti (2015), "Theory of Plates & Shells", New Age International

Elective V Soil-Structure Interaction (Online Course)

Course Code	Course Name
EC-MST218	Soil Structure Interaction

Course pre-requisites	Soil Mechanics and Foundation Engineering

Course Objectives	
The course will focus on the different soil-structure interaction models for shallow foundation under various loading conditions and subgrade characteristics. Piles under uplift and lateral loading conditions will also be discussed.	
Course Outcomes	
Beams and plates on elastic foundation problems & different foundation models and their solution with the help of Finite Difference Method (FDM) will be discussed. The application of foundation models in real life problems will also be discussed.	
Course Content	
	Details
1	Introduction, critical study of conventional methods of shallow foundation design: bearing capacity and settlement calculation.
2	Critical study of conventional methods of shallow foundation design (continued), contact pressure and soil-structure interaction for shallow foundation, concept of subgrade modulus, determination of subgrade modulus, parameters influencing subgrade modulus.
3	Determination of subgrade modulus and parameters influencing subgrade modulus (continued). Different foundation models (such as one-parameter, two-parameter models etc.) with linear and non linear stress-strain characteristics.
4	Time-dependent response, Beams on Elastic Foundation, infinite beam.
5	Infinite beam (continued), infinite beam subjected to various loading conditions, semi-infinite beam.
6	Semi-infinite beam (continued), beams with finite length.
7	Beams with finite length and various end conditions, continuity among the foundation soil layers
8	Continuity among the foundation soil layers (continued), beams on two-parameter soil medium (infinite and finite beam), beam with variable EI and subgrade modulus.
9	Plates on Elastic Foundation (rectangular and circular), plates on two-parameter soil medium, use of Finite Difference Method (FDM) for soil structure interaction problems
10	Use of Finite Difference Method (FDM) for soil structure interaction problems (continued), computer programs based solution of different interaction problems such as beams, plates, application of foundation models in real life problem.
11	Group action of pile, Elastic Analysis, settlement of pile group under compressive load by Interaction Factor Approach, negative skin friction
12	Laterally loaded piles, Reese and Matlock's generalized solution, displacement of pile group under lateral load by Interaction Factor Approach, Uplift capacity of piles and anchors.
Reference Books	

1. Analytical and Computer Methods in Foundation, Bowels J.E,. McGraw Hill Book Co., New York, 1974

2. Numerical Methods in Geotechnical Engineering, Desai C.S. and Christain J.T., McGraw Hill Book Co., New York

3. Selvaduraim A. P. S., 1979, 'Elastic Analysis of Soil-Foundation Interaction', Elsevier Scientific, Amsterdam

4. Hetenyi, 1979, "Beams on Elastic Foundation" The University of Michigan Press

5. Woodward, J. and Tomlinson, M. 1994, "Pile Design and Construction Practice" Chapman & Hall

6. Poulos, H.G. and Davis, E.H. 1980, "Pile Foundation Analysis and Design" Rainbow-Bridge Book Co./ John Wiley & Sons

Course: Core Lab III-MODEL TESTING LAB

Course Code	Course Name
PC-MST253	Model Testing Lab
Course Outcomes	
Upon successful completion of this course, students will be able to : 1. Understand the response of structures 2. Conduct model testing for static loading 3. Conduct model testing for free and forced vibrations	

Practicals	
Experiment No.	***Details***
1	Strains and deflection of beams and frame model
2	Load test on plates
3	Natural frequency and Damping of frames -Time domain
4	Natural Frequency and damping of frames – Frequency domain
5	Response Analysis of Frames subjected to ground motion
6	Vibration characteristics of RC beams
Report on experiments performed as detailed above shall be submitted as laboratory work	

Course: Core Lab IV- Structural Engineering LAB

Course Code	Course Name
PC-MST254	STRUCTURAL Engineering LAB

Course pre-requisites	

Course Outcomes
Upon successful completion of this course, students will be able to : 1. Design structure using Latest relevant IS codes. 2. Design structure using latest relevant software.
Practicals
1. Design and Detailed drawing of complete structure by student using relevant Software as well as Latest IS codes.

.

AUDIT-Disaster Management

Course Code	Course Name
AU-PG 03	Disaster Management

Course pre-requisites	

Course Objectives

The objectives of this course are

1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.	04
2	**Repercussions of Disasters and Hazards** Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.	04
3	**Disaster Prone Areas in India** Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.	04
4	**Disaster Preparedness and Management** Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.	04
5	**Risk Assessment** Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk	04

	Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.	
6	**Disaster Mitigation** Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.	04

Reference Books
1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company. 2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi. 3. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi.

Sr.No.	Examination	Module
1	T-I	Module 1 and 2
2	T-II	Module 3 and 4
3	End Sem	Module 1 to 6

AUDIT-Stress Management by Yoga

Course Code	Course Name
AU-PG 04	Stress Management By Yoga

Course pre-requisites	

Course Objectives
The objectives of this course are 1. To achieve overall health of body and mind 2. To overcome stress
Course Outcomes
Upon successful completion of the course, students should be able 1. Develop healthy mind in a healthy body thus improving social health also 2. Improve efficiency

Course Content

Module No.	*Details*	*Hrs.*
1	Definitions of Eight parts of yog. (Ashtanga)	08
2	Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	08
3	Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects-Types of pranayama	08

Reference Books

1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama
3. (Publication Department), Kolkata

Sr. No.	Examination	Module
1	T-I	Module 1
2	T-II	Module 2
3	End Sem	Module 1 to 3

Open Elective I: Business Analytics

Course Code	Course Name
OE-PG01	Business Analytics

Course pre-requisites	

Course Objectives

The objectives of this course are

1. Student will be able to have a comprehensive understanding of business analytics methods

Course Content

Module No.	*Details*	*Hrs.*
1	Business Analysis: Overview of Business Analysis, Overview of Requirements, Role of the Business Analyst. Stakeholders: the project team, management, and the front line, Handling Stakeholder Conflicts.	07
2	Life Cycles: Systems Development Life Cycles, Project Life Cycles, Product Life Cycles, Requirement Life Cycles.	08
3	Forming Requirements: Overview of Requirements, Attributes of Good Requirements, Types of Requirements, Requirement Sources, Gathering Requirements from Stakeholders, Common Requirements Documents.	09
4	Transforming Requirements: Stakeholder Needs Analysis, Decomposition Analysis, Additive/Subtractive Analysis, Gap Analysis, Notations (UML & BPMN), Flowcharts, Swim Lane Flowcharts, Entity-Relationship Diagrams, State-Transition Diagrams, Data Flow Diagrams, Use Case Modeling, Business Process Modeling	10
5	Finalizing Requirements: Presenting Requirements, Socializing Requirements and Gaining Acceptance, Prioritizing Requirements. Managing Requirements Assets: Change Control, Requirements Tools	10
6	Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data Journalism.	04

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

Sr.No.	Examination	Module
1	T-I	Module 1 and 2
2	T-II	Module 3 and 4
3	End Sem	Module 1 to 6

Open Elective II: Industrial Safety

Course Code	Course Name
OE-PG02	Industrial Safety Engineering (Online Course)

Course pre-requisites	-

Course Content	
No.	***Details***
1	Introduction, key concepts, terminologies, and safety quantification, safety by design
2	Hazard identification techniques (e.g., HAZOP, FMEA, etc.)
3	Fault tree and event tree analysis (qualitative & quantitative)
4	Bow-tie and quantitative risk assessment (QRA)
5	Safety function deployment
6	Safety vs reliability – quantification of basic events (repair to failure, repair-failure-repair, and combined processes)
7	Safety vs reliability – quantification of basic events (contd.)
8	Systems safety quantification (e.g., truth tables, structure functions, minimal cut sets)
9	Human error analysis and safety
10	Accident investigation and analysis
11	Application of virtual reality
12	OSHAS 18001 and OSHMS
Reference Books	
1. Probabilistic Risk Assessment for Engineering and Scientists, Komamoto and Henley, IEEE Press, 1995. Industrial Accident Prevention, Heinrich et al., McGraw Hill, 1980. Techniques for safety management - A systems approach, Petersen D, ASSE 1998.	

*Forecasting the safe remaining useful life of infrastructure (remaining life analysis)

Open Elective III: Operational Research

Course Code	Course Name
OE-PG03	Operational Research

Course pre-requisites	

Course Outcomes

Upon successful completion of the course, students should be able

1. To apply the dynamic programming to solve problems of discreet and continuous variables.
2. To apply the concept of non-linear programming.
3. To carry out sensitivity analysis.
4. To model the real world problem and simulate it.

Course Content

Module No.	*Details*	*Hrs.*
1	Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models	
2	Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming	
3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.	
4	Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.	
5	Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	

Reference Books

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

Sr.No.	Examination	Module
1	T-I	Module 1 and 2
2	T-II	Module 3 and 4
3	End Sem	Module 1 to 5

Open Elective IV: Cost Management of Engineering Projects

Course Code	Course Name
OE-PG04	Cost Management of Engineering Projects

Course pre-requisites	

Course Content		
Module No.	***Details***	***Hrs.***
1	Introduction and Overview of the Strategic Cost Management Process	
2	Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.	
3	Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process	
4	Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.	
5	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	

Reference Books
1. Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi 2. Charles T. Horngren and George Foster, Advanced Management Accounting 3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting 4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher 5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Sr.No.	Examination	Module
1	T-I	Module 1 and 2
2	T-II	Module 3 and 4
3	End Sem	Module 1 to 5

SEM-III

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2022-23

Value added course:- Advanced Earthquake Resistant Design of Structures

Course Code	Course Name
VA-MST01	Advanced Earthquake Resistant Design of Structures

Course pre-requisites	Structural Dynamics, Earthquake Engineering

Course Objectives

The course deals with special provisions and requirements of structures for their safety against earthquake induced forces.

Course Outcomes

Upon successful completion of the course, students should be able to

1. understand the different philosophies and concepts of performance based seismic engineering
2. analyse and estimate the non-linear properties of structural elements
3. understand the concept of and perform non-linear static and dynamic analysis for seismic performance
4. understand the concept of seismic control devices

Course Content

Module No.	*Details*	*Hrs.*
1.	**Concepts of Earthquake Resistant Design**: Force based vs. displacement-based design, performance-based design, seismic input characteristics and their effect on seismic design, study of ASCE 41	4
2.	**Modelling for Performance Based Design**: Back-bone curve, Idealized component models, estimation and modelling of stiffness, strength and ductility of RC, and steel structures	5
3.	**Methods for non-linear seismic analysis of Structures** Nonlinear static and dynamic analysis methods : NLSPA, NLTH (selection and scaling of time histories –ASCE-41, PEER database)	5
4.	**Direct Displacement-Based Design**: Structure performance objectives, performance levels (structural and NSE) and limit states; P-Delta effects; Torsion; Capacity design for direct displacement-based design.	10
5.	**Performance-Based Design:** Structural and non-structural performance, quantification of performance	3
6.	Performance evaluation of structures, services and equipment(NSEs)	3
7.	Introduction to passive, active and semi-active control systems.	6

Text Books and Reference Books

1. Paulay, T. and Priestley, M.J.N. “Seismic Design of Reinforced Concrete and Masonry Buildings,” John Wiley & Sons.
2. Skinner, R., Robinson ,W.H., McVerry ,G.H., “An Introduction to Seismic Isolation”, John Wiley and Sons.
3. George G. Penelis and Andreas J. Kappos, “Earthquake Resistant Concrete Structures,” E & FN Spon.
4. FEMA-356, “Pre-standard and Commentary for the Seismic

Rehabilitation of Buildings," Federal Emergency management Agency.
5. ASCE 41
6. FEMA-450, "NEHRP Recommended provisions for Seismic Regulations for New Buildings and Other Structures," Federal Emergency management Agency.
7. Priestley, M.J.N., Calvi, G.M. and Kowalsky, M.J., "Displacement- Based Seismic Design of Structures," IUSS Press.

Sr.No.	Examination	Module
1	T-I	Module 1 and 2
2	T-II	Module 3 and 4
3	End Sem	Module 1 to 7

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2022-23

Dissertation phase -I

Seminar on Literature Review

The project work extends through the third and fourth semester. The project work is defined based on the interest of the students to specialize in a particular area. Students are expected to carry out independent research work on the chosen topic and submit a thesis for evaluation? The work at this stage may involve review of literature, laboratory experimental work, development of software, development of model, case study, field data collection and analysis etc. On completion of the work the student shall prepare a report and will give a Seminar on the report.

Dissertation Seminars Stage I

Student shall finalize a theme, related to construction engineering and/or management area for the dissertation work. Student shall prepare a report on the theme outlining importance of the theme of the study, objective, scope of work, methodology, and a review of literature published in the relevant area. The student shall present seminars on this report.

SEM-IV

Dissertation Phase -II

Seminar (Pre –Synopsis)

Student shall study the problem of dissertation in the light of outcome of Stage I and Stage II seminars. On completion of data collection, analysis, and inferencing the student shall prepare an interim report and shall present a seminar on the work done, before the submission of Synopsis to the University.

Dissertation and Viva Voce

On finalization of the dissertation student shall submit the dissertation report to the University. The student shall have to appear for a Viva-voce examination for the dissertation.