Academic Program: PG

Academic Year 2018-19

Syllabus

I & II Semester M.Tech.

COMPUTER AIDED DESIGN OF STRUCTURES

Department of Civil engineering

SHRI DHARMASTHALA MANJUNATHESHWARA COLLEGE OF ENGINEERING & TECHNOLOGY,
DHARWAD – 580 002

(An Autonomous Institution recognized by AICTE & Affiliated to VTU, Belagavi)

Ph: **0836-2447465 Fax: 0838-2464638 Web: www.sdmcet.ac.in**

SDM College of Engineering & Technology, Dharwad

It is certified that the scheme and syllabus for I &II semester M.Tech. Computer Aided Design of Structuresis recommended by Board of Studies of Civil Engineering and approved by the Academic Council, SDM College of Engineering &Technology, Dharwad. This scheme and syllabus will be in force from the academic year 2018-19 till further revision.

Principal　　　　　　　　　　Chairman BoS&HoD

COLLEGE VISION AND MISSION

VISION:

To develop competent professionals with human values

MISSION:

- To have contextually relevant curricula.
- To promote effective teaching learning practices supported by modern educational tools and techniques.
- To enhance research culture.
- To involve industrial expertise for connecting classroom content to real life situations.
- To inculcate ethics and impart soft-skills leading to overall personality development.

DEPARTMENT VISION AND MISSION

VISION:

To be a Centre of excellence, practice state-of-art civil engineering education and developing high quality engineers to serve society.

MISSION:

The stated vision can be achieved through

- Development of robust curriculum to meet the expectations of industry.
- Interactive teaching-learning process with modern educational tools.
- Establishing synergy between teaching and research.
- Networking with industry.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

The Masters Program in M.Tech(CADS) during 24 months term aims to

1. To provide proficiency in the basic principles and advanced courses of technology in Structural Engineering so that students are able to formulate, analyze and solve the societal problems for sustainable development related to structural Engineering.

2. To expose the students to the latest innovations and trends with a view to inculcate strong research orientation in structural engineering as well as in multidisciplinary streams.

3. To create a congenial environment that promotes learning, growth and imparts ability to work with inter-disciplinary groups in professional, industry and research organizations.

4. To produce Structural Engineers who integrate and build on the program's core curricular concepts in the pursuit of professional leadership, teamwork, life-long learning, and successful career advancement.

PROGRAMME OUTCOMES (PO):

PO1: An ability to independently carry out research/investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirments in the appropriate bachelor program.

Scheme of Teaching and Examination
I Semester M. Tech.

Course Code	Course Title	Teaching		Examination				
		L-T-P (Hours/Week)	Credits	CIE	Theory (SEE)		Practical (SEE)	
				Max. Marks	*Max. Marks	Duration in hours	Max. Marks	Duration in hours
18PCDSC101	Computational Structural Mechanics – Classical and FE Approach	4-0-0	4	50	100	3		
18PCDSC102	Continuum Mechanics – Classical and FE Approach	4-0-0	4	50	100	3		
18PCDSExxx	Elective-1	4-0-0	4	50	100	3		
18PCDSExxx	Elective-2	4-0-0	4	50	100	3		
18PCDSExxx	Elective-3	4-0-0	4	50	100	3		
18PCDSL104	Cad Lab – Structural Analysis	0-0-3	2	50	-	-	50	3
18PCDSL105	**Seminar	0-0-3	1	100	-	-	-	-
Total		**20-0-6**	**23**	**400**	**500**		**50**	

CIE: Continuous Internal Evaluation **SEE**: Semester End Examination

L: Lecture **T**: Tutorials **P**: Practical

***SEE** for theory courses is conducted for 100 marks and reduced to 50 marks.

****** Seminar is to be conducted every week and 2-3 students/week will present a topic from emerging areas in Computer Aided Structuralengineering preferably the contents not studied in their regular courses. The seminar shall be evaluated by 3 faculty members having specialization in StructuralEngineeringand allied areas.

Course Code	Elective Courses
18PCDSE125	Structural Dynamics -Theory & Computations
18PCDSE126	Structural Optimization - Theory & Computations
18PCDSE127	AI and Expert Systems in Structural Engineering
18PCDSE128	Action and Response of Structural Systems
18PCDSE129	Geotechnical Aspects of Foundations and Earth Retaining Structures
18PCDSE130	Numerical Methods and Programming
18PCDSE131	Composite and Smart Materials

Scheme of Teaching and Examination

II Semester M.Tech.

Course Code	Course Title	Teaching		Examination				
		L-T-P (Hours/Week)	Credits	CIE	Theory (SEE)		Practical (SEE)	
				Max. Marks	*Max. Marks	Duration in hours	Max. Marks	Duration in hours
18PCDSC201	Structural Stability Analysis - Classical and FE Approach	4-0-0	4	50	100	3		
18PCDSC202	Advanced Design of Reinforced Concrete Structural Elements	4-0-0	4	50	100	3		
18PCDSExxx	Elective-4	4-0-0	4	50	100	3		
18PCDSExxx	Elective-5	4-0-0	4	50	100	3		
18PCDSExxx	Elective-6	4-0-0	4	50	100	3		
18PCDSL204	Cad Lab - FE Analysis	0-0-3	2	50	-	-	50	3
18PCDSL205	**Seminar	0-0-3	1	100	-	-	-	-
Total		**20-0-6**	**23**	**400**	**500**		**50**	

CIE: Continuous Internal Evaluation **SEE**: Semester End Examination

L: Lecture **T**: Tutorials **P**: Practical

***SEE for theory courses is conducted for 100 marks and reduced to 50 marks.**

**** Seminar is to be conducted every week and 2-3 students/week will present a topic from emerging areas in Computer Aided Structuralengineering preferably the contents notstudied in their regular courses. The seminar shall be evaluated by 3 faculty members having specialization in StructuralEngineeringand allied areas.

Course Code	Elective Courses
18PCDSE225	Analysis of Plates - Classical and FE Approach
18PCDSE226	Reliability Analysis and Design of Structural Elements
18PCDSE227	Advanced Design of Steel Structures
18PCDSE228	Design of Stack Tower and Water Storage Structural Systems
18PCDSE229	Seismic Resistant Design of Structural Systems
18PCDSE230	Advanced Structural Dynamics
18PCDSE231	Design of Tall Structures

Detailed Syllabus

I Semester

18PCDSC101Computational Structural Mechanics–Classical and FE Approach(4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): Calculation of distribution of forces within the structure and the displaced state of the system forms the crux of design process. The objective of this course is to make students to learn computer aided methods of analysis adopted in industry for such purposes.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Apply Direct stiffness method and Analyze 2D-truss structures	3	1	
CO-2	Apply Direct stiffness method and Analyze continuous beams and 2D-frames	3	1	
CO-3	Formulate finite element method with respect to structures	3	1	
CO-4	Formulate and Apply finite element method for bar element	3	1	
CO-5	Formulate and Apply finite element method for beam element	3	1	
CO-6	Apply Knowledge of problem solving skills using computer aided methods	3	1	

POs	PO-1	PO-2	PO-3
Mapping Level	3		2

Prerequisites:

1. Strength of Materials
2. Structural Analysis I & II
3. Matrix Method of Analysis

Contents:

Module 1: Direct Stiffness Method — Trusses: Degrees of Static and Kinematic indeterminacies, Concepts of Stiffness and Flexibility, Local and Global Coordinate System,Analysis of indeterminate Trusses, with and without initial strains for different types of boundary conditions such as Fixed, Hinged, Roller, supports, support settlement.

10 Hours

Module 2: Direct Stiffness Method - Continuous Beam, 2D Frames: Analysis of Continuous beams, for different types of boundary conditions such as Fixed, Hinged, Roller, supports, support settlement. Analysis of Simple 2D Frames with and without sway, Element stiffness matrix for 3D frames and Grids

10 Hours

Module 3: Basic Concept of Finite Element Method: Concept of FEM, principle of virtual work, Principles minimum potential energy, Method of Weighted Residuals (Galerkin's)

10 Hours

Module 4: FE Analysis using Bar Elements: Derivation of Shape Function for Linear and Higher order elements using Inverse and Lagrange Interpolation formula, Element Stiffness matrix Two and Three noded elements. Examples with constant and varying cross sectional area subjected to concentrated loads, distributed body force and surface traction and Initial strains due to temperature,Isoperimetric formulation.

10 Hours

Module 5: FE Analysis using Beam Element: Derivation of Shape Function for two noded beam element, Hermitian Interpolation, Element Stiffness matrix, Consistent Nodal loads, Concept of Reduced or Lumped Loads, Examples: Cantilever and Simply Supported beams,

10 Hours

Reference Books:

[1]Rajasekaran.S, "Computational Structural Mechanics", PHI, New Delhi 2001.

[2] Reddy.C.S, "Basic Structural Analysis," TMH, New Delhi 2001

[3] Robert D Cook et al, "Concepts and Applications of Finite Element Analysis", 3rd Edition, John Wiley and Sons, New York

[4] Beaufait.F.W.etal., "Computer Methodsof StructuralAnalysis",PrenticeHall,1970.

[5] Weaver.WandGere.J.H.,Matrix, " Analysisof FramedStructures",VanNastran,1980.

[6] Rubinstein M.F, Matrix Computer Methods of Structural Analysis Prentice-Hall.

[7] Bathe.K.J, "FiniteelementproceduresinEngineeringAnalysis" .PHINewDelhi

18PCDSC102Continuum Mechanics –Classical and FE Approach(4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): To introduce students to the fundamental concepts of the mechanics of deformable bodies along with state-of-the-art computational methods in civil engineering. The range of material behavior considered includes: Finite Deformation Elasticity The delivery of topics will be made through lecture classes.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Apply knowledge of mathematics, science, and engineering by developing the Equilibrium equations		**1,2,3**	
CO-2	Formulate, analyze and solve two dimensional elasticity rectangular coordinate problems using classical approach.		**1,2,3**	
CO-3	Formulate, analyze and solve two dimensional elasticity polar coordinate problems using classical approach.		**1,2,3**	
CO-4	Formulate, analyze and solve three dimensional stress-strain problems using classical approach.		**1,2,3**	
CO-5	Formulation and implementation of Isoparametric finite element models for two and three-dimensional deforming bodies	**1,2,3**		
CO-6	Use finite element methods for solving continuum mechanics problems	**1,2,3**		
CO-7	Read and Comprehend scientific articles in the field of Computational Mechanics of deformable bodies	**1,2,3**		

POs	PO-1	PO-2	PO-3
Mapping Level	**2.43**	**2.43**	**2.43**

Prerequisites:

1. Strength of Materials
2. Structural Analysis I & II
3. Matrix Method of Analysis

Contents:

Module 1: Basic Concepts: Definition of stress and strain at a point, components of stress and strain at a point, strain displacement relations in cartesian co-ordinates, constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases, plane stress, plane strain — Definition.

10 Hours

Module 2:Two-dimensional problems in Rectangular Coordinates: Airy's stress function approach to 2-D problems of elasticity. Solution by Polynominals— End Effects, Saint — Venant's Principle — solution of some simple beam problems, including working out of displacement components.

10 Hours

Module 3: Two - dimensional problems in Polar coordinates: General equation in Polar coordinates —Strain and displacement relations, equilibrium equations - Stress distribution symmetrical about an axis — Pure bending of curved bars — Displacements for symmetrical stress distributions —Bending of a curved bar by a force at the end — The effect of a small circular hole on stress distribution in a large plate subjected to uni-axial tension and pure shear.

10 Hours

Module 4: Analysis of Stress and Strain in Three Dimensions: Introduction — Principal stresses —Determination of the principal stresses and principal planes.— Stress invariants — Determination of the maximum shearing stress- Octohedral stress components, Principal strains — strain invariants.

10 Hours

Module 5: FE approach: 2D and 3D Elements - CST, LST, Rectangular family, Tetrahedra and Hexahedra : Shape functions, Element Stiffness matrix, Equivalent Loads, Isoparametric formulation of Triangular and General quadrilateral elements, Axisymmetric elements, Gauss Quadrature.

10 Hours

Reference Books:

[1]TimoshenkoandGoodier," Theoryofelasticity" McGrawHill BookCompany,IIIEdition,1983.

[2] Valliappan.S, "ContinuumMechanicsfundamentals ",Oxfordand IBH.

[3] RobertDCooketl,"ConceptsandApplicationsofFiniteElementAnalysis",3rd Edition,JohnWileyandSons,NewYork

[4] Srinath.L.S.,"AdvancedMechanicsofSolids",TataMcGraw-HillPublishingCo. Ltd.,NewDelhi

[5]Bathe.K.J, "FiniteelementproceduresinEngineeringAnalysis".PHI.NewDelhi

[6]Zienkiewicz.O.C,"TheFiniteElementMethod",Tata-McGraw-HillPublishingCompany

[7]KrishnamoorthyC.S,"FiniteElementAnalysis",Tata-McGraw-HillPublishingCompany

18PCDSE125Structural Dynamics -Theory & Computations(4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): This course focuses on how to model single degree, multi degree of freedom systems and continuous vibratory systems for un-damped, damped forced and free vibrations. Quantification of responses of these systems is also discussed.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Evaluation of effect of structural vibrations on safety and reliability of structural systems		**1,3**	
CO-2	Develop the equations of motion for vibratory systems and solve for the free and forced response required for modeling structures for dynamic analyses.	**1,3**		
CO-3	Analyze and modify a vibratory structure order to achieve specified requirements by developing a model.		**3**	
CO-4	Emphasize the role of damping and its influence upon structural response to limit the possibility of their structures being influenced by resonance that may affect the structural safety and reliability of engineering systems.	**3**		
CO-5	Apply modal methods to calculate the forced response of SDOF and MDOF systems.	**3**		
CO-6	Analyze vibrations of the structures using finite element methods.		**3**	

POs	PO-1	PO-2	PO-3
Mapping Level	**2.5**		**2.5**

Prerequisites:

1. Strength of Materials
2. Structural Analysis I & II
3. Matrix Method of Analysis

Contents:

Module1:SingleDegreeof Freedom System: Degrees of freedom, undamped system, springs in parallel, in series. Newton's laws of motion, free body diagrams. D'Alembert's principle, solution of the differential equation of motion, frequency and period, amplitude of motion. Damped Single degree of freedom system — viscous damping, equation of motion, critically damped system, over damped system, under damped system, and logarithmic decrement. Response of single degree of freedom system to harmonic loading — undamped harmonic excitation, damped harmonic excitation, evaluation of damping at resonance, bandwidth method (Half power) to evaluate damping, response to support motion, force transmitted to the foundation, seismic instruments.

10 Hours

Module 2; Response to General Dynamic Loading:Impulsive loading and Duhamel's integral, numerical evaluation of Duhamel's integral, undamped system, numerical evaluation of Duhamel's integral, damped system. Fourier analysis and response in frequency domain — Fourier analysis, Fourier co-efficient for piece-wise liner functions, exponential form of Fourier series, discrete Fourier analysis, fast Fourier transform.

10 Hours

Module 3: Generalized Co-ordinates and Rayleigh's method: Principle of virtual work, generalized single degree of freedom system (rigid body and distributed elasticity), Rayleigh's method. Hamilton's principle.Multistory Shear Building.Free vibration — natural frequencies and normal modes. Forced motion — modal superposition method — response of a shear building to base motion. Damped motion of shear building — equations of motions — uncoupled damped equation — conditions for uncoupling. Damping.

10 Hours

Module 4 : Discretiszation of Continuous Systems: Longitudinal Vibration of a uniform rod. Transverse vibration of a pretensioned cable. Free transverse vibration of uniform beams — Rotary inertia and shear effects — The effect of axial loading. Orthogonality of normal modes. Undamped forced vibration of beams by mode superposition.

10 Hours

Module 5: Dynamic Analysis of Beams: Stiffness matrix, mass matrix (lumped and consistent); equations of motion for the discretised beam in matrix form and its solutions.

10 Hours

Reference Books:

[1]MarioPaz,"Structuraldynamics,Theoryandcomputation",2ndEdition,CBSPublisher
[2] Mukhopadyaya,"Vibration,Dynamicsandstructuralproblems,"OxfordIBHPublishers
[3] Clough,RayWandPenzienJ,"DynamicsofStructures",2ndEdition,McGraw-Hill,
[4] RoyR.Craig,AndrewJ.Kurdila,"FundamentalsofStructuralDynamics",JohnWiley&Sons

18PCDSE126Structural Optimization - Theory & Computations(4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): In this course, topics on Classical Optimization Techniques, Linear Programming, Non-Linear Programming, Stochastic Programming and Genetic Algorithms are dealt.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Classify the Optimization problems and techniques.	3	1	
CO-2	Solve the Optimization problems by Linear programming method and sketch them graphically.	3	1	
CO-3	Solve the Optimization problems by Non - Linear programming method.	3	1	
CO-4	Solve the Optimization problems by Stochastic programming method.	3	1	

POs	PO-1	PO-2	PO-3
Mapping Level	3	3	3

Contents:

Module1: ClassicalOptimizationTechniques: Engineeringapplications,Statementof optimizationproblem,Classificationofoptimizationproblems,Optimizationtechniques.Singlevariableoptimization,Multivariableoptimizationwithnoconstrains,withequalityconstraints-Lagrangemultiplier-method,constrainedvariationmethod-andwithinequalityconstraintsKuhn-Tuckerconditions.

10 Hours

Module2:LinearProgramming:
StandardformofLinearprogrammingproblem,simplexmethod,revisedsimplexMethod.

10 Hours

Module 3: Non-Linear Programming: One dimensional minimization methods, Elimination and Interpolation methods, unconstrained Optimization Techniques, Direct Search methods, Descent Methods, ConstrainedOptimizationTechniques,Directmethods, indirectmethods.

10 Hours

Module4:StochasticProgramming:Foroptimizationofdesignofstructuralelementswithrandomvariables.ApplicationProblems:OptimumDesignRC,PSC,Steelstructuralelements.Algorithmsfor optimumdesigns.

10 Hours

Module5: GeneticAlgorithms: Introduction fitnessfunctionsincludingtheeffectofconstraintscrossover,mutation.

10 Hours

Reference Books:

[1]Rao.S.S- OptimizationTheoryandApplications,WileyEasternLimited,1978.

[2]Fox.R.L. - OptimizationMethodsforEngineeringDesign", AddisonWesley,1971
[3] Stark.R.M.Nicholls.R.L.,MathematicalFoundationsforDesign",McGrawHillBookCompany.
[4]NarsingkDeo– Systemsimulationwithdigitalcomputer",Prentice-HallofIndiaPvt,Ltd.New Delhi– 1989.

18PCDSE127AI and Expert Systems in Structural Engineering (4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): Expert systems are the most mature and widely used commercial application coming out of artificial intelligence. In an expert system, the computer applies heuristics and rules in a knowledge-specific domain to render advice or make recommendations, much like a human expert would.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Use expert systems to achieve fairly high levels of performance in task areas which require a good deal of specialized knowledge and training.	3	1	
CO-2	Develop expert systems to perform tasks which are physically difficult, tedious, or expensive to have a human perform	3	1	

POs	PO-1	PO-2	PO-3
Mapping Level	2		3

Contents:

Module 1: Artificial Intelligence:

Introduction: AI - Applications fields, defining the problems - state space representation - problem characteristics - production system - production system characteristics. Knowledge Representation: Formal logic - predicate logic - logic programming - forward v/s backward reasoning - matching control knowledge.

10 Hours

Module 2: Search and Control:

Concepts - uninformed / blind search: depth first search - breadth first search - bi-directional search - informed search - heuristic graph search - generate and test - hill climbing – best-first search - AND OR graph search. Non-formal Knowledge Representation - semantic networks - frames— scripts— production systems, Programming in LISP.

10 Hours

Module 3: Expert Systems:

Their superiority over conventional software — components of an expert system — expert system life cycle-expert system development process- nature of expert knowledge — techniques of soliciting and encoding expert knowledge. Inference: Forward chaining - backward chaining - rule value approach.

10 Hours

Module 4: Uncertainty

Symbolic reasoning under uncertainty: logic for non-monotonic reasoning. Statistical reasoning:Probability and Bayes' theorem - certainty factor and rule based systems - Bayesian network –Dempster - Shafer theory.

10 Hours

Module 5; Fuzzy reasoning and Neural Networks:

Features of rule-based, network- based and frame -based expert systems — examples of expert systems in Construction Management and Structural Engineering. Expert system shells. Neural Networks: An introduction — their possible applications in Civil Engineering.

10 Hours

Reference Books:

[1]Adeli,H., "ExpertSystemsinConstructionandStructuralEngg",Chapman&Hall,NewYork
[2]PattersonD W,"ArtificialIntelligenceandExpertSystems",Prentice-Hall,NewJersey.
[3]Rich,E.andKnightK."ArtificialIntelligence",TMH,NewDelhi.
[4]Rolston, D.W.,"ArtificialIntelligenceandExpertSystems"McGrawHill,NewYork.
[5]Nilsson,N.J.,"PrincipalsofArtificialIntelligence",Narosa.,NewDelhi.

18PCDSE128Action and Response of Structural Systems(4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO):A structural system may be subjected to several combinations of actions when deployed into service. Certain important decisions such as, proper identification of structural systems, design actions on them and the recourse to the type of analysis have to be made during the design process. The focus of this course is on how to calculate the various design loads, known as actions, which are required to determine the design forces, known as 'Response" or effects of actions.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Understand the importance of appropriate code provisions	**1**	**3**	
CO-2	Familiarize with procedures for calculating action effects for different types of structures frequently encountered in practice	**1**	**3**	
CO-3	Assess the basic need, concepts and procedures of different types of analysis		**3**	
CO-4	Characterize the response of different types of structural systems for Tall buildings		**3**	

POs	PO-1	PO-2	PO-3
Mapping Level	3		2

Contents:

Module 1: IS 875 PART 1, 2, 4, 5: Sources, Nature and Magnitude, Probabilistic assessment, CharacteristicandDesignvalues.IS875PART1and2codeprovisions.Loadcombinationrulesfor design.EstimationofDLandLLonstructuralelementssuchasSlab,Beams,Columns,indifferenttypes ofstructuralsystems, Joint Loads on Trusses, Distributed load on Purlins- Numerical examples.Accidentalloads Impactandcollisions,ExplosionsandFire – Numericalexamples

10 Hours

Module2:WindLoad-IS875PART3: Buildings: NatureandMagnitude,Factorsinfluencingwind loads, Internal and External pressure distribution, Design Wind Speeds and Pressure, NumericalExamplestocalculateexternalandinternalpressurefordifferenttypesofbuildingsandregions– Flatroof,PitchedRoof,monosloperoof,Hippedroof,Signboard,Watertankonbracedandshaftstaging,MultistoryFrames.

10 Hours

Module3:SeismicLoads:IS1893:Buildings- NatureandMagnitude,Centreofmassandrigidity,CalculationofDesignSeismicForcebyStaticAnalysisMethod,DynamicAnalysisMethodLocationofCentre of Mass,LocationofCentreofStiffness, andLateralForceDistributionsas percodeprovisions.

10 Hours

Module4:VehiclesLoadsasperIRC6-2010onRoadBridges– Class70R,ClassAA,ClassA, Class B ,Tracked Vehicle, Wheeled Vehicle, Load Combinations, Impact, Wind, Water Currents, Longitudinal Forces: acceleration, breaking and frictional resistance, Centrifugal forces, temperature, Seismicforces,Snow Load,CollisionLoads.LoadCombinations-SimpleNumericalexamples

10 Hours

Module5:TypesofAnalysisandBehaviorofTallBuildings: Linear,Nonlinearbehavior,Material nonlinearity,Geometricnonlinearity,RigidandElasticSupports,FirstOrderElasticAnalysis,Second OrderElasticAnalysis,FirstorderInelasticAnalysis,SecondorderInelasticAnalysis–ConceptsandBriefdescriptions BehaviorofStructuralformsinTallbuildings–Rigidframe,BracedFrames, ShearWalls,Corewalls,Tubular,Belttruss,Outrigger

10 Hours

Reference Books:

[1]IS CodesIS875Parts (1to5), IS1893,IRC6,
[2] AnexplanatoryHandbookonIS875(PART3);WindLoadonBuildingandStructures,
[3] DocumentNo:IITK-GSDMAWind07V1.0-IITK-GSDMAProjectonBuildingCodes
[4] ExplanatoryExamplesonIndianSeismicCodeIS1893(PartI):DocumentNo:IITK- GSDMA-EQ21-V2.O-IITK-GSDMAProject onBuildingCodes

18PCDSE129 Geotechnical Aspects of Foundations and Earth Retaining Structures (4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): This course focuses on how to Plan a site investigation, classify and characterize soils for foundation design to estimate the capacity of foundations, and the settlement of the soil under the foundation load as well as computation of earth pressure and stability of different types of retaining structures.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:	Mapping to POs		
	Substantial Level (3)	Moderate Level (2)	Slight Level (1)

CO-1	Plan a subsurface exploration	**3**	**1**	
CO-2	Evaluate appropriate bearing capacity correction factors to use in design	**3**	**1**	
CO-3	Identify strategies to mitigate the effects of expansive soils on foundations	**3**	**1**	
CO-4	Select the appropriate deep foundation type for different soil profiles	**3**	**1**	
CO-5	Compute earth pressure and implement the design procedure for block foundation	**3**	**1**	

POs	**PO-1**	**PO-2**	**PO-3**
Mapping Level	**3**		**2**

Contents:

Module 1: Bearing Capacity of Soils: Generalized Bearing Capacity Equation; Field tests for Bearing Capacity and settlement estimation; Settlement of shallow foundations - Elastic and consolidation settlements; Settlement estimates from penetration tests; Settlement tolerance; Allowable bearing pressure.

10 Hours

Module 2: Design Parameters for Substructures: Factors influencing selection of depth of Foundation, Subgrade Reaction, Winkler hypothesis and Beams on Elastic Foundation Approach; Soil Line Method;Foundationson expansive soils.Geotechnical failure of foundations during earthquake — Earthquake Resistant design of Shallow foundation — Liquefaction and Remedial measures.

10 Hours

Module 3: Pile Foundations; Classification of pile foundations and general considerations of design; Ultimate load capacity of piles; Pile settlement; Analysis of single pile and pile group; laterally loaded piles and ultimate lateral resistance. Uplift resistance of piles and anchored foundations; under reamed Pile; Pile load tests; Design examples.

10 Hours

Module 4:Retaining structures: Earth pressure theories, Fill Walls, Concrete/Gravity walls, Mechanically Stabilized Earth (MSE) walls- Analysis and Design,; Sheet pile walls, internally braced excavations (struts), externally braced excavations (tieback excavations), Soil Nailing.

10 Hours

Module 5: Elements of Soil Dynamics and Design of Machine Foundations: IS 2974 Parts I to IV Machine- Foundation System , Block Foundations, Frame Foundations, Design Criteria, Tuning of Foundation, DOF of a Rigid Block Foundation, Linear Elastic Spring, Elastic Half Space Analog, Parameters influencing Dynamic Soil Parameters, Soil Mass Participation, Effect of Embedment, Soil Damping, Machine Parameters, Vibration Isolation System

10 Hours

Reference Books:

[1] Bowles J.E "Foundation Analysis and Design", McGraw Hill.

[2] Swami, S. (1999). "Soil Dynamics and Machine Foundation", Galgotia Publications Pvt Ltd, New Delhi

[3] Dr. B C Punmia, Soil Mechanics and Foundation Engineering

[4] Leonards. G.A, "Foundation Engineering", McGraw Hill.

[5] Tschebotoriff. G.P "Foundations, Retaining and Earth Structures, McGrawHill.

[6] Srinivasulu. P. and Vaidyanathan, V. (1980). "Handbook of Machine Foundations", Tata McGraw- Hill Publishing Company, New Delhi

18PCDSE130Numerical Methods and Programming(4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): An overlying goal of the course is the realization of the necessity of numerical methods and programming techniques in order to simulate technological and scientific processes.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify various mathematical problems and reformulate these in a way suitable for numerical treatment	**1,3**		
CO-2	Select a suitable numerical method for the treatment of the given problem	**1,3**		
CO-3	Motivate the choice of a method by describing its advantages and limitations	**1,3**		
CO-4	Select an algorithm leading to efficient computation, and implement this in a suitable	**1,3**		

	programming language, e.g. Matlab			
CO-5	Write well-structured programs in the programming language.	**1,3**		

POs	**PO-1**	**PO-2**	**PO-3**
Mapping Level	**3**		**3**

Prerequisites

Students taking this course shall have the knowledge of following:

1. Engineering Mathematics
2. Computer Programming

Contents:

Module 1: Solutions of linear equations: Direct method – Cramer's rule, Gauss – Elimination method- Gauss –Jordan elimination – Triangulation (LU Decomposition) method – Iterative methods Jacobi – Iteration method – Gauss – Siedel iteration, Successive over –relaxation method. Eigen values and Eigen vectors: Jacobi Method for symmetric matrices- Given's method for symmetric matrices-Householder's method for symmetric matrices-Rutishauser method of arbitrary matrices – Power method.

10 Hours

Module 2: Interpolation: Linear Interpolation - Higher order Interpolation - Lagrange Interpolation – Interpolating polynomials using finites differences- Hermite Interpolation -piece-wise and spline Interpolation

10 Hours

Module 3: Finite Difference and their Applications: Introduction- Differentiation formulas by Interpolating parabolas – Backward and forward and central differences- Derivation of Differentiation formulae using Taylor series- Boundary conditions- Beam deflection – Solution of characteristic value problems- Richardson's extrapolation- Use of unevenly spaced pivotal points- Integration formulae by interpolating parabolas-Numerical solution to spatial differential equations

10 Hours

Module 4: Numerical Differentiation: Difference methods based on undetermined coefficients- optimum choice of step length– Partial differentiation.

Numerical Integration: Method based on interpolation-method based on undetermined coefficient – Gauss – Lagrange interpolation method- Radaua integration method- composite integration method – Double integration using Trapezoidal and Simpson's method.

10 Hours

Module 5: Ordinary Differential Equation: Euler's method – Backward Euler method – Mid point method – single step method, Taylor's series method- Boundary value problems.

10 Hours

Note

1. Emphasis is on developing algorithms / flow charts and converting them into working programs.
2. Programs can be written in C / C++ / Matlab or any other programming language that The student finds suitable. In the class, C++ and/or Matlab will be used.

3. Pre-requisites: Working knowledge of C / C++ / Matlab. This shall be done during I& II Semesters through value addition courses.

Reference Books:

[1] Gerald, C.F. and Wheatley, P.O., Applied Numerical Analysis, 6ed., Pearson Education, 1999.
[2]Chapra, S.C. and Canale, R.P., Numerical Methods for Engineers with Programming and Software Applications, 3ed., Tata McGraw Hill, New Delhi, 1998.
[3] Schilling, R.J. and Harries, S.L., Applied Numerical Methods for Engineers using Matlab and C, Thomson Brooks/Cole, 2000.

18PCDSE131	**Composite and smart materials(4-0-0) 4**

Contact Hours: 50

Course Learning Objectives (CLO):A great deal of fundamental and developmental research has been made to bring composite materials in various applications such as automobile, space, medical, automotive, building construction, etc. The advent of composite materials has introduced a new dimension in application of energetic, smart and reactive materials. The objective of this course is to know the processing and application of composite and smart materials.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify and understand the basic properties and manufacturing process along with their application for different types of composites.	3	1	
CO-2	Compose and Analyze Laminated Composites	3	1	
CO-3	Failure theories of composites and Analyze Cross-ply and Angle-ply Laminates	3	1	
CO-4	Familiarize with different classes of ceramic and polymeric smart materials; development of actuators and sensors and their integration into a smart structure	3	1	
CO-5	Generate controllable force and response of a system. Monitor the response of the system.	3	1	

POs	**PO-1**	**PO-2**	**PO-3**

Mapping Level	2	3	2

Prerequisites:

1. Strength of Materials
2. Structural Analysis I & II
3. Matrix Method of Analysis

Contents:

Module1:IntroductiontoCompositematerials Classifications andapplications.Offibers, volume fraction andloaddistribution amongconstituents, minimum&criticalvolumefraction,compliance&stiffnessmatrices,coupling

10 Hours

Module2: Anisotropicelasticity Unidirectional andanisotropic lamina, thermo-mechanical properties, micro- mechanical analysis,classicalcompositelaminationtheory,Crossandangle–ply laminates,symmetric,antisymmetricandgeneralasymmetriclaminates,mechanicalcoupling,and laminatestacking

10 Hours

Module3: Analysisofsimplelaminatedstructuralelements Ply-stressandstrain,laminafailuretheories-first P lyfailure,environmentaleffects,manufacturingof composites.

10 Hours

Module4:Smartmaterials Introduction,Typesofsmartstructures, actuators&sensors,embedded&surfacemounted,piezoelectric coefficients,phasetransition,piezoelectricconstitutiverelation

10 Hours

Module5: Beammodelingwithstrainactuator,bendingextensionrelation

10 Hours

Reference Books:

[1]RobartM Jones,“Mechanics ofCompositeMaterials”,McGrawHillPublishingCo.
[2]BhagwanDAgaraval,andLawrenceJBrutman,“AnalysisandPerformanceofFiberComposites”,JohnWillyandSons.
[3]MadhujitMukhopadhyay, “Mechanics of Composite Materials and Structures”,Universities Press(2004)
[4]Lecturenoteson“SmartStructures”,by InderjithChopra,DepartmentofAerospaceEngg.,UniversityofMaryland.
[5]Crawley,EanddeLuis,J.,“Useofpiezoelectricactuatorsaselementsofintelligentstructures”,AIAA Journal,Vol.25No10, Oct1987,PP1373-1385.
[6]Crawley,EandAnderson,E.,“DetailedmodelsofPiezoceramicactuationofbeams”,Proc.Ofthe30th AIAA/ASME/ASCE/AHS/ASC- Structural dynamics and material conference, AIAA WashingtonDC,April1989.

18PCDSL104	Cad lab —Structural Analysis	(0-0-3) 2

Contact Hours: 35

Course Learning Objectives (CLO): In professional design scenario, it is very important to use industry standard software's in a Proficient manner besides knowing the theoretical concepts of structural analysis. The programming exercises helps in understanding the implementation of algorithms in to a program.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Use industry standard software in a professional set up.	**2**	**3**	
CO-2	Apply finite element modeling, specification of loads and boundary condition, performing analysis and interpretation of results for final design	**2**	**3**	
CO-3	Develop customized design automation tools	**2**	**3**	

POs	**PO-1**	**PO-2**	**PO-3**
Mapping Level		**3**	**2**

Content:

1. Structural Analysis of 2D and 3D Trusses
2. Structural Analysis of Continuous Beams using for different types of loadings and support conditions
3. Structural Analysis of 2D and 3D Rigid and Braced Frames for different types of loadings , support conditions, section orientations and stiffness variation between columns and beams, Member offsets, End release, Tension only members, Active and Inactive member specifications, Soil - Structure Interaction Problems using Winkler Springs
4. Program Development for Matrix operations- Multiplication, Transpose, Inverse, Gauss elimination and Gauss-Siedel, Cholesky methods for solution of linear system

of equations using VBA / MATLAB / C++

5. Program Development for Analysis of Trusses, Beams and Frames using VBA / MATLAB / C++

* *Exercises1to3onStructuralAnalysisusing IndustryStandardSoftwares*

Detailed Syllabus

II Semester

18PCDSC201Structural Stability Analysis - Classical and FE Approach(4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): The objective of this course is to learn buckling characteristics of various structural elements and plates by energy and FE approach. Solution to practical problems will be emphasized including integration with finite element analysis. The delivery of topics will be made through lecture classes.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Illustrate detailed treatment of buckling characteristics of various structural elements	**1**	**3**	
CO-2	Calculate critical load by elastic energy method	**1**	**3**	
CO-3	To assess different methods to solve stability problems including integration with finite element procedures	**1**	**3**	
CO-4	Calculate and analyze buckling of simply supported rectangular plate	**1**	**3**	
CO-5	Calculate and analyze buckling of	**1**	**3**	

	simply supported rectangular plate under combined bending and compression			

POs	PO-1	PO-2	PO-3
Mapping Level	3		2

Prerequisites:

1. Strength of Materials
2. Structural Analysis I & II

Contents:

Module 1: Beam column: Differential equation. Beam column subjected to (i) lateral concentrated load, (ii) several concentrated loads, (iii) continuous lateral load. Application of trigonometric series.Euler's formulation using fourth order differential equation for pinned-pinned, fixed-fixed, fixed-free and fixed- pinned columns.

10 Hours

Module 2: Buckling of frames and continuous beams: Elastic Energy method: Approximate calculation of critical loads for a cantilever. Exact critical load for hinged-hinged column using energy approach.Bucklingof bar on elastic foundation. Buckling of cantilever column under distributed loads. Determination of critical loads by successive approximation. Bars with varying cross section.Effect of shear force on critical load. Columns subjected to non-conservative follower and pulsating forces.

10 Hours

Module 3:Stability analysis by finite element approach: Derivation of shape functions for a two noded Bernoulli-Euler beam element (lateral and translational dof) —element stiffness and Element geometric stiffness matrices — Assembled stiffness and geometric stiffness matrices for a discretized column with different boundary conditions — Evaluation of critical loads for a discretized (two elements) column (both ends built-in). Algorithm to generate geometric stiffness matrix for four noded and eight nodedisoperimetric plate elements. Buckling of pin jointed frames (maximum of two active dof)-symmetrical single bay Portal frame.

10 Hours

Module 4: Buckling of simply supported rectangular plate: Buckling of uniformly compressed rectangular plate simply supported along two opposite sides perpendicular to the direction of compression and having various edge condition along the other two sides-Buckling of a Rectangular Plate Simply Supported along Two opposite sides and uniformly compressed in the Direction Parallel to Those sides.

10 Hours

Module 5: Buckling of simply supported rectangular plate —combined effects: Buckling of a Simply Supported Rectangular Plate under Combined Bending and Compression — Buckling of Rectangular Plates under the Action of Shearing Stresses — Other Cases of

Buckling of Rectangular Plates.

10 Hours

Reference Books:

[1]Stephen P. Timoshenko, James M. Gere, “Theory of Elastic Stability”, 2nd Edition, McGraw-Hill, New Delhi.

[2]Zeiglar.H,” Principles of Structural Stability”, Blasdell Publication

[3] Robert D Cook et al, “Concepts and Applications of Finite Element Analysis”, 3rd Edition, John Wiley and Sons, New York

[4]Rajashekaran.S, “Computational Structural Mechanics”, Prentice-Hall, India.

[5]RayW CloughandJPenzien,“DynamicsofStructures”,2ndEdition,McGraw-Hill,NewDelhi.

18PCDSC202Advanced Design of Reinforced Concrete Structural Elements(4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): To provide a detailed treatment of fundamental concepts for the design of RC structural elements, and to present different methods for the design of RC beams subjected to shear and torsion, Deep beams, flat slab systems including integration with finite element procedures. The course also aims at explaining the underlying theory for the provisions in IS standards.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Discuss the behavior of Reinforced Concrete Beams in Shear and Torsion.		1,3	
CO-2	Apply redistribution of moments in design of Reinforced Concrete beam.	1,3		
CO-3	Design of Reinforced Concrete Deep Beams	1,3		
CO-4	Analysis and design of compression members	1,3		
CO-5	Design of flat slabs		1,3	

POs	**PO-1**	**PO-2**	**PO-3**
Mapping Level	**2.6**		**2.6**

Prerequisites:

1. Strength of Materials
2. Structural Analysis I & II
3. Design of RC elements

Contents:

Module 1: Behavior of RC Beams in Shear and Torsion: Modes of Cracking , Shear Transfer Mechanisms , Shear Failure Modes, Critical Sections for Shear Design , Influence of Axial Force on Design Shear Strength, Shear Resistance of Web Reinforcement, Compression Field Theory, Strut-and- Tie Model. Equilibrium Torsion and Compatibility Torsion, Design Strength in Torsion, Design Torsional Strength with Torsional Reinforcement- Space Truss Analogy and Skew Bending Theory

10 Hours

Module 2: Redistribution of Moments in RC Beams: Conditions for Moment Redistribution — Final shape of redistributed bending moment diagram — Moment redistribution for a two-span continuous beam— Advantages and disadvantages of Moment redistribution — Modification of clear distance between bars in beams (for limiting crack width) with redistribution — Moment — curvature Relations of Reinforced Concrete sections . Curtailment of tension Reinforcement - code procedure — Numerical Example

10 Hours

Module 3: Design of Reinforced Concrete Deep Beams: Introduction — Minimum thickness - Steps of Designing Deep beams — design by IS 456 - Detailing of Deep beams.

10 Hours

Module 4: Behavior and Analysis of Compression Members: Effective Length Ratios of Columns in Frames, Code Charts — Numerical Examples, Short Columns - Modes of Failure in Eccentric Compression, Axial Load - Moment Interaction equation, Interaction Surface for a Biaxial Loaded Column, Concept of Equilibrium approach and application to Non rectangular columns. Slender Column: Braced and Unbraced, Design Methods as per IS 456 — Strength Reduction and Additional Moment Method

10 Hours

Module 5: Flat Slab Design: Behavior of Slab supported on Stiff ,Flexible and no beams , Equivalent Frame Concept, Proportioning of Slab Thickness, Drop Panel and Column Head, Transfer of Shear from Slab to column, Direct Design Method, Equivalent Frame Method — Design Examples. FE analysis and design of Slab Panels based on Wood-Armer equations.

10 Hours

Reference Books:

[1] S. Pillai, DevdasMenon- Reinforced concrete design 3/ED 3rd Edition

[2] Varghese. P.C., Advanced Reinforced Concrete design, prentice, Hall of India, Neevpeth.

[3] Krishna Raju — “Advanced R.C. Design”, CBSRD, 1986,

[4] Park R. and Paulay, T., Reinforced Concrete Structures, John Wiley and sons.
[5]Karve.S.R. and Shah V.L., Limit State theory and design of Reinforced Concrete, Pune VidyarthiGrihaPrakashan, Pune.

18PCDSE225Analysis of Plates - Classical and FE Approach (4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): The primary objective of this course is to learn classical methods in theory of plates pertaining to the analysis of solids. Focus will be given to the use of general relationships in the solution of plate bending problems. Solution to practical problems will be emphasized including integration with finite element analysis. The delivery of topics will be made through lecture classes.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Apply knowledge of mathematics, science, and engineering by developing the Equilibrium equations for plate element	1	3	
CO-2	Formulate, analyze and solve two dimensional plate element using strain energy approaches.	1	3	
CO-3	Formulate, analyze and solve simply supported rectangular plate element	1	3	
CO-4	Formulate Rectangular plates with different edge conditions	1	3	
CO-5	Formulate, analyze and solve circular plate	1	3	

POs	PO-1	PO-2	PO-3
Mapping Level	3		2

Prerequisites

1. Strength of Materials
2. Structural Analysis I & II

Contents:

Module 1: Pure Bending of plates: Introduction - Slope and curvature of slightly bent plates — Displacement strain relations, Strains in terms of displacements, strain-stress relations, expressions for moments. Small deflections of laterally loaded plates- stress resultants on a typical plate element, equations of equilibrium, expressions for vertical shears and boundary conditions. Strain energy in pure bending- Expression for total energy, Analysis of plates subjected to uniformly distributed load by energy method.

10 Hours

Module 2: Simply supported rectangular plates – Double Fourier series expressions for loads, Navier's solution for simply supported plate subjected to udl, patch udl, point load and hydrostatic pressure. Bending of rectangular simply supported plate subjected to a distributed moments at a pair of opposite edges.

10 Hours

Module 3: Rectangular plates with different Edge conditions: Levy's solution for rectangular plates – Analysis of rectangular plate subjected to UDL (i) two opposite edges simply supported and the other two edges clamped, (ii) three edges simply supported and one edge built-in and (iii) all edges built-in

10 Hours

Module 4: Circular Plates: Differential equation for symmetrical bending of laterally loaded circular plates — uniformly loaded circular plates with and without central cutouts, with two different boundary conditions (simply supported and clamped). Centrally loaded clamped circular plate

10 Hours

Module 5: FE approach: Finite Element Analysis of Thin Plate: Triangular Plate Bending Element, Rectangular Plate Bending Element, Finite Element Analysis of Thick Plate.

10 Hours

Reference Books:

[1]Timoshenko and Krieger, "Theory of Plates and Shells", McGraw-Hill International Book Company
[2]Chandrashekara K, "Theory of Plates", University Press
[3]SSBhavikatti, " Theory of Plates and Shells", New Age International Publishers
[4]Robert D Cook et al, "Concepts and Applications of Finite Element Analysis", 3rd Edition, John Wiley and Sons, New York
[5]Szilard. R, "Theory and analysis of plates-classical and numerical Methods"
[6]Ugural A C, "Stress in Plates and shells", McGraw-Hill International Book Company

18PCDSE226Reliability Analysis and Design of Structural Elements (4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): Assessment of safety of structures is a very important task of structural engineers. The action and response are subjected to statistical variations and are probabilistic. The primary objective of this course is to learn different methods of evaluation of safety taking into account the variation of design parameters.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Summarize concepts and techniques of reliability and probability distributions	**1,3**		
CO-2	Define safety format or failure surface for a given actions and response along with their statistics.	**1,3**		
CO-3	Compute reliability index, for the given design details	**1,3**		
CO-4	Arrive at mean value of a dominant design parameter for the target reliability index	**1,3**		
CO-5	Use simulation techniques to arrive at the statistics of design variables	**1,3**		

POs	PO-1	PO-2	PO-3
Mapping Level	**3**		**3**

Prerequisites:

1. Engineering Mathematics

Contents:

Module 1: Concept of variability: Applications of Statistical principles to deal with randomness in basic variables, statistical parameters and their significance, curve fitting, correlation and regression.

10 Hours

Module 2: Description of various probability distribution: Probability theory, binominal, Poisson, Normal, Log-normal, External distributions, Testing of Goodness of fit of distribution to the actual data using Chi-square method.

10 Hours

Module 3: Basic structural reliability: Random variables, continuous variables, discrete variable and computation of structural reliability.

10 Hours

Module 4: Reliability methods: Introduction, Basic variables and Failure surface, FOSM, Hasofer and Lind Method (AFOSM), determination of 'β' for present designs.

10 Hours

Module 5: Simulation techniques and reliability based design: Monte Carlo method, Applications, Reliability based design. Determination of partial safety factors, Safety checking formats.

10 Hours

Reference Books:

[1]Ang A.H.S and W.H. Tang, Probability concepts in Engineering planning and Design, John Wiley and sons, New York, Vol.I and II.

[2]Ranganthan R, Reliability Analysis and Design of Structures, Tata McGraw Hillpublishing Co. Ltd., New Delhi.

[3] John B. Kennedy and Adam Neville, Basic Statistical Methods for Engineers and Scientists,

[4] Harper and Row Publishers, New York. Robert E. Melchers, Structural Reliability Analysis and Prediction, Wiley

18PCDSE227Advanced Design of Steel Structures (4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): This course covers the advanced principles of the design of hot-rolled and cold-formed steel structural members. Reference is made to the IS 800 and 811 standards, explaining the underlying theory for the provisions in these standards. The objectives are to provide students with advanced knowledge of steel structural design and confidence to apply the underlying principles to solve a wide range of structural steel problems. The delivery of topics will be made through lecture classes.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Analyze and Design of Laterally unrestrained beams	1,3		
CO-2	Analyze and Design of beams subjected to torsion and bending	1,3		
CO-3	Analyze and Design of Beam-column in frames	1,3		
CO-4	Analyze and Design of Beams with web opening	1,3		
CO-5	Analyze and Design of cold formed steel sections	1,3		
CO-6	Discuss, Analyze and Design of fire resistance steel structures	1,3		

POs	PO-1	PO-2	PO-3
Mapping Level	3		3

Prerequisites:

1. Strength of Materials
2. Design of steel structures

Contents:

Module 1: Laterally Unrestrained Beams: Lateral Buckling of Beams, Factors affecting lateral stability, IS 800 code provisions, Design Approach. Lateral buckling strength of Cantilever beams, continuous beams, beams with continuous and discrete lateral restraints, Mono- symmetric and non- uniform beams — Design Examples

10 Hours

Module 2: Beams subjected to Torsion and Bending: Shear Center and Warping, Uniform and Non-Uniform torsion, Concepts, Methods of evaluating the torsional effects, IS 800 Code provisions, Design examples: Rolled and Hollow Sections.

10 Hours

Module 3: Beam- Columns in Frames: Behavior of Short and Long Beam - Columns, Effects of Slenderness Ratio and Axial Force on Modes of Failure, Biaxial bending, Strength of Beam Columns, Sway and Non-Sway Frames, Strength and Stability of rigid jointed frames, Effective Length of Columns-, Methods in IS 800 – Examples

10 Hours

Module 4: Steel Beams with Web Openings: Shape of the web openings, practical guide lines, and Force distribution and failure patterns, Analysis of beams with perforated thin and thick webs, Design of castellated beams, Vierendeel girders

10 Hours

Module 5: Cold formed steel sections and Fire resistance: Techniques and properties, Advantages, Typical profiles, Stiffened and unstiffened elements, Local buckling effects, effective section properties, IS 811 code provisions- numerical examples, beam design, column design.Fire resistance level, Period of Structural Adequacy, Properties of steel with temperature, Limiting Steel temperature, Protected and unprotected members, Fire resistance ratings- Numerical Examples.

10 Hours

Reference Books:

[1] N. Subramanian, "Design of Steel Structures", Oxford,IBH
[2]Duggal.S.K., Design of Steel structures. Tata McGraw-Hill
[3]IS 1641, 1642,1643
[4] IS 800: 2007, IS 811
[5]INSDAG Teaching Resource Chapter 11 to 20: www.steel-insdag.org

18PCDSE228Design of Stack Tower and Water Storage Structural Systems(4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): To illustrate the quintessential differences in the design of stack, tower and water storage structural systems with reference to other structural systems The delivery of topics will be made through lecture classes.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Analyze and Design of Steel Chimneys	**3**	**1**	
CO-2	Analyze and Design of Transmission line towers	**3**	**1**	
CO-3	Analyze and Design of Trestles	**3**	**1**	
CO-4	Analyze and Design of water storage structures	**3**	**1**	
CO-5	Analyze and Design of over- head	**3**	**1**	

	tanks			
CO-6	Analyze and Design of Steel Chimneys	**3**	**1**	

POs	PO-1	PO-2	PO-3
Mapping Level	**2**		**3**

Prerequisites:

1. Strength of Materials
2. Design of steel structures

Contents:

Module 1: Steel Chimneys: Lining for chimneys — breach opening — Forces acting on steel chimneys including seismic forces — Analysis Design and Detailing of RC chimneys for different load combinations. Design of thickness of steel plate — Design of base plate — Design of anchor bolts — Design of foundation.

10 Hours

Module 2: Transmission line towers of various shapes and member types: Loads on towers — Analysis and Design of Steel transmission line towers. Design of Foundations

10 Hours

Module 3: Trestles: Analysis and design of Steel Trestles for vertical and horizontal loads

10 Hours

Module 4: Water Storage structures: Properties of un-cracked section — Calculation of thickness and reinforcement for Liquid retaining structure, Design and Detailing of underground, Ground Level

10 Hours

Module 5: Overhead water tanks: Circular, Rectangular on framed and Shaft type of Staging sytems as per IS 3370 Parts 1 to 4

10 Hours

Reference Books:

[1] Ramachandra, Design of Steel structures Vol.1 and Vol. 2. Standard Publication
[2] S.K. Duggal, Design of Steel structures. Tata McGraw-Hill
[3]Vazirani&Ratwani, Steel structures, Vo1.III

[4]IS: 6533. Code of Practice for Design and Construction of steel chimneys.
[5] IS 802: Use Of Structural Steel In Overhead Transmission Line Towers — Code Of Practice - Part 1 Material, Loads And Permissible Stresses
[6]IS :4091, Code Of Practice For Design And Construction Of Foundations For Transmission Line Towers And Poles
[7] IS 3370 Part 1 to 4

18PCDSE229	Seismic Resistant Design of Structural System	(4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): In this course, topics covered on Seismic hazard assessment, Earthquake effects on structures, Concepts of earthquake resistant design of earthen, masonry and RCC buildings are dealt.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Interpret engineering seismology and Seismic hazard assessment.	**3**	**1**	
CO-2	Evaluate earthquake forces and effect of earthquake on different types of structures.	**3**	**1**	
CO-3	Differentiate the philosophy and principles of earthquake resistance design of structures.	**3**	**1**	
CO-4	Illustrate Earthquake Resistance design of masonry and RCC buildings	**3**	**1**	

POs	**PO-1**	**PO-2**	**PO-3**
Mapping Level	2		3

Contents:

Module 1: Seismic Hazard Assessment- Engineering Seismology, Definitions, Introduction to Seismic hazard , Earthquake phenomenon, Seismic tectonics and seismic zoning of India, Earthquake monitoring and seismic instrumentation, Characteristics of strong Earthquake motion, Estimation of Earthquake parameters, Microzonation.

10 Hours

Module 2: Earthquake effects on structures: Response to ground acceleration, response analysis by mode superposition, torsional response of buildings, response spectrum analysis, selection of design earthquake, earthquake response of base isolated buildings, earthquake response of inelastic structures, allowable ductility demand Response Spectra / Average response Spectra, Design Response Spectra, Evaluation of earthquake forces (IS 1893 – 2002). Effect of earthquake of on different types of structures – Lesson learnt from past earthquakes.

10 Hours

Module 3: Concepts of earthquake resistant design- Structural Systems / Types of buildings, Causes of damage, Planning consideration/Architectural Concept (IS 4326–1993) (Do's and Don'ts for protection of life and property), Philosophy and principle of earthquake resistance design, Guidelines for Earthquake Resistant design.

10 Hours

Module4: Earthquake Resistant Earthen and Masonry Buildings Earthquake Resistant low strength masonry buildings, Strength and Structural properties of masonry–Lateral load Design considerations.

10 Hours

Module5: Earthquake Resistant Design of RCCBuildings–Material properties–lateral load analysis design and detailing. Basic concepts of seismic base isolation and Seismic Isolation systems.

10 Hours

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Reference Books:

[1] Chopra, A.K.-"Dynamics of structures", Prentice-Hall of India Pvt. Ltd. New Delhi.
[2] Clough, R.W. and Penzien J. - "Dynamics of Structures", McGraw Hill Book Co. New York
[3] Biggs, M.-"An Introduction to Structural Dynamics", McGraw Hill Book Co. New York

18PCDSE230Advanced Structural Dynamics (4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): The primary objective of this course is to learn advanced methods for solving problems in vibrations. Focus will be given to the use of general relationships in the solution of linear and non-linear problems. The course also addresses other sources of vibrations such as blast and water waves.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Analyze and solve dynamic response of MDOF system	**1,3**		
CO-2	Formulate, analyze and solve non-linear structural dynamic	**1,3**		
CO-3	Define and describe random	**1,3**		

	vibration			
CO-4	Formulate, analyze and solve blast loads on structures	**1,3**		
CO-5	Define and describe water waves and analyze response of structures to water waves	**1,3**		

POs	**PO-1**	**PO-2**	**PO-3**
Mapping Level	**3**		**3**

Prerequisites:

1. Structural dynamics

Contents:

Module 1: Analysis of Dynamic Response of MDOF Systems by Direct Integration: Basic concept of direct integration methods — central difference methods - Wilson - D Method - Newmark Method — Stability and accuracy of direct integration method.

10 Hours

Module 2: Non-liner Structural Response — Classification of nonlinear analysis — Systems with nonlinear characteristics — formulation of incremental equations of equilibrium — numerical solution of nonlinear equilibrium equations for single degree freedom systems - liner acceleration step by step method, elastoplastic behavior, algorithm for the step by step solution for elastoplastic SDOF system. Newmark Method — Wilson - D - Method Response spectra — construction of a response spectrum, response spectrum for support disturbance, tripartite response spectra, response spectra for inelastic design. Non-liner Response of MDOF Systems — incremental equation of motion, Wilson-D method.

10 Hours

Module 3: Introduction to Random Vibration — Random functions, normal and Rayleigh's distribution, correlation, fourier transform, spectral analysis, spectral density function, response to random excitation.

10 Hours

Module 4: Blast Loads on Structure: Sources of Blast Loads — shock waves — sound speed and Mach numbers. Shock pressure. Determination of blast loads — defining blast loads — structure loading. Strain rate effects — approximate solution technique for SDOF systems.

10 Hours

Module 5: Basic Concepts of Water Waves — Linear wave theory — dispersion equations — wave particle velocities- wave energies. Nonlinear waves- Stokes wave theory — Conidial Wave theory — stream function wave theory. Waves transformations — Shoaling - refraction — diffraction — dissipation —breaking. Wave statistics — significant wave — short term statistics — wave spectra — long term statistics. Wave information — wave measurements — Hind casts. **Response of Structures to Water Waves:** Morrison equation, force coefficient, linearized Morrison equation, inclined cylinders — transfer lift forces. Diffraction theoryscattering problem — wave forces on vertical walls — wave forces on a low vertical wall - wave forces on a rectangular structure.

10 Hours

Reference Books:

[1]Mario Paz, "Structural Dynamics, Theory and Computation", 2nd Edition, CBS Publisher and Distributors, New Delhi.
[2]Mukopadyaya, "Vibration, Dynamics and Structural Problems," Oxford IBH Publishers
[3] Ray W Clough and J Penzien, "Dynamics of Structures", 2nd Edition, McGraw-Hill, New Delhi. 1989.
[4] Joseph W Tedesco, William G McDougal, D.Allen Ross, " Structural Dynamics Theory and Applications" Publishers Addison Wesley Longman, Inc. Menlo Park, California 94025.

18PCDSE231Design of Tall Structures(4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLO): To summarize fundamental concepts for the design of tall structure and to present the influence of different loads on the tall structure. The course also aims at explaining the underlying theory for the provisions in IS standards.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Describe tall structures and the types of load acting on tall structures.		**1**	
CO-2	Explain dispersion of Lateral Forces, flooring system, wall panel system, and multi-story box system.	**3**	**1**	
CO-3	Discuss different framing system and their comparison – drift and dynamic response of building	**3**	**1**	
CO-4	Design of tall structure by approximate method	**3**	**1**	
CO-5	Describe other latest tall structure framing system	**3**	**1**	

POs	PO-1	PO-2	PO-3
Mapping Level	**2**		**3**

Prerequisites:

1. Strength of Materials
2. Structural Analysis I & II
3. Design of RC elements

Course Contents:

Module1: Introduction to Tall Building in the Urban Context - The Tall Building and its Support Structure - Development of High Rise Building Structures - General Planning Considerations. Dead Loads – Live Loads-Construction Loads -Snow, Rain, and Ice Loads - Wind Loads-Seismic Loading – Water and Earth Pressure Loads - Loads - Loads Due to Restrained Volume Changes of Material - Impact and Dynamic Loads - Blast Loads -Combination of Loads.

10 Hours

Module2: The vertical structure plane Dispersion of Vertical Forces- Dispersion of Lateral Forces – Optimum Ground Level Space - Shear Wall Arrangement - Behavior of Shear Walls under Lateral Loading. The Floor Structure or Horizontal Building Plane Floor Framing Systems-Horizontal Bracing- Composite Floor Systems the High - Rise Building as related to assemblage Kits Skeleton Frame Systems – Load Bearing Wall Panel Systems - Panel – Frame Systems –Multi-storey Box Systems.

10 Hours

Module3: Common high-rise building structures and their behavior under load The Bearing Wall Structure- The Shear Core Structure - Rigid Frame Systems- The Wall - Beam Structure: Interspatial and Staggered Truss Systems - Frame - Shear Wall Building Systems - Flat Slab Building Structures - Shear Truss – Frame Interaction System with Rigid - Belt Trusses - Tubular Systems-Composite Buildings - Comparison of High - Rise Structural Systems Other Design Approaches Controlling Building Drift Efficient Building Forms – The Counteracting Force or Dynamic Response.

10 Hours

Module4: Approximate structural analysis and design of buildings Approximate Analysis of Bearing Wall Buildings the Cross Wall Structure - The Long Wall Structure The Rigid Frame Structure Approximate Analysis for Vertical Loading – Approximate Analysis for Lateral Loading - Approximate Design of Rigid Frame Buildings-Lateral Deformation of Rigid Frame Buildings The Rigid Frame - Shear Wall Structure – The Vierendeel Structure-The Hollow Tube Structure.

10 Hours

Module 5: Other high-rise building structure Deep - Beam Systems -High-Rise Suspension Systems – Pneumatic High -Rise Buildings - Space Frame Applied to High - Rise Buildings - Capsule Architecture.

10 Hours

Reference Books:

[1] Wolfgang Schuller - “High - rise building Structures", John Wiley and Sons, New York
[2] Bryan Stafford Smith and Alex Coull, “Tall Building Structures ", Analysis and Design, John Wiley and Sons, Inc., 1991.

[3]Coull, A. and Smith, Stafford, B. " Tall Buildings ", Pergamon Press, London, 1997.
[4]LinT.Y. and Burry D.Stotes, " Structural Concepts and Systems for Architects and Engineers ", JohnWiley, 1994.
[5] Lynn S.Beedle, "Advances in Tall Buildings", CBS Publishers and Distributors, Delhi, 1996.
[6]Taranath.B.S.,"Structural Analysis and Design of Tall Buildings", McGraw Hill,1998.

18PCDSL204Cad Lab–FE Analysis(0-0-3)2

Contact Hours: 35

Course Learning Objectives (CLO): In professional design scenario, it is very important to use industry standard software's in a Proficient manner besides knowing the theoretical concepts of structural analysis. The programming exercises helps in understanding the implementation of algorithms in to a program.

Course Outcomes (CO):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Use industry standard software in a professional set up.	2	1,3	
CO-2	Apply finite element modeling, specification of loads and boundary condition, performing analysis and interpretation of results for final design	2	1,3	
CO-3	Develop customized design automation tools	2	1,3	

POs	PO-1	PO-2	PO-3
Mapping Level	2	3	2

Content:

1. FEAnalysis of Framedstructures duetoSeismicforcesusingmodaldynamics

2. FEAnalysis ofPlaneStressandPlaneStrain Problems

3. FlexuralBehaviorofSlabPanelswithdifferentaspectratioandboundary conditions

4. FEAnalysis ofSlabpanel restingoncolumnsupports- DropPanels,Capitals

5.FEAnalysis ofSlabonGrade(Raft),Underpass,BridgeStructures

6.Programming exercises usingC/VBA/VB/MATLABfor CST,LSTand RectangularElements

* *Exercises1to5onFEAnalysis areaimedatusing IndustryStandardSoftware's*

References:

[1]Timoshenko and Krieger, "Theory of Plates and Shells", McGraw-Hill International Book Company

[2] Chopra, A.K.-"Dynamics of structures", Prentice-Hall of India Pvt. Ltd. New Delhi.

[3] Clough, R.W. and Penzien J. - "Dynamics of Structures", McGraw Hill Book Co. New York

[4] Bathe.K.J, "Finite element procedures in Engineering Analysis" .PHINew Delhi