POOJYA DODDAPPA APPA COLLEGE OF ENGINEERING, KALABURAGI

Scheme of Teaching and Examinations – 2024

M.Tech. STRUCTURAL ENGINEERING COURSE CIVIL ENGINEERING DEPARTMENT

Choice Based Credit System (CBCS) and Outcome-Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical/Seminar	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	BSC/PCC	24MAT11	Computational Methods	03	00	00	03	50	50	100	3
2	IPCC/PCC/PBLC	24PSE12	Special Concrete	03	02	00	03	50	50	100	4
3	PCC	24 PSE 13	Structural Dynamics	03	00	02	03	50	50	100	4
4	PCC	24 PSE 14	Theory of Elasticity and Plasticity	02	00	02	03	50	50	100	3
5	PCC	24 PSE 15	Advanced Design of RCC Structures	02	00	02	03	50	50	100	3
6	PCCL	24 PSE L16	Advanced Structural Engineering Lab	01	02	00	03	50	50	100	2
7	PCCL	24 PSE L17	Software based Lab-1	01	02	00	03	50	50	100	2
8	PCC	**24SEM18**	Technical Seminar	00	01	01	03	100	---	100	1
9	NCMC	24RMI19	Research Methodology and IPR (**Online**)	Online courses (online.vtu.ac.in)							PP
				15	**07**	**07**	**24**	**450**	**350**	**800**	**22**

Note: **BSC**-Basic Science Courses, **PCC**: Professional core.**IPCC**-Integrated Professional Core Courses,**NCMC**- None Credit MandatoryCourse, **PCCL**-Professional Core Course lab

AUD/AEC –Audit Course / Ability Enhancement Course, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities**(Hours are for Interaction between faculty and students)**PBLC**: Project Based Learning Course

Integrated Professional Core Course (IPCC): Refers to a Professional Theory Core Course Integrated with practicals of the same course. The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

Project Based Learning Course (PBLC): Project Based Learning Courseis a professional core Course only students have to complete a project out of learning from the course and SEE will be viva voce on project work.

Skill development activities:Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).
2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3. Involve in case studies and field visits/ fieldwork.
4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in modeling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7. Work on different software/s (tools) to simulate, analyse and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Students and the course instructor/s to be involved either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of

the course teacher can take up relevant technical –activities that will enhance their skills. The prepared report shall be evaluated for CIE marks.

24RMI19-Research Methodology and IPR- None Credit Mandatory Course (NCMC) if students have not studied this course in their undergraduate program then he /she has to take this course at **http://online.vtu.ac.in** and qualifying in this course is compulsory before completion of the minimum duration of the program (Two years), however, this course will not be considered for vertical progression.

Technical Seminar: Students have to finalize the technical topic for the seminar in consultation with a faculty mentor, Preparation of the seminar report, and presentation slides to be presented at the end of the semester.

Proposed Syllabus for I Semester M.Tech.

(Structural Engineering)

COMPUTATIONAL METHODS

SubjectCode: 24MAT11	Credits:03	
CIE:50Marks	SEE:50Marks	SEE:03Hrs.
Hours/Week: 3 Hrs Theory		TotalHours:42

Course Learning Objectives: This course will enable the students:

- To enhance the problem-solving skills of engineering students using an extremely powerful problem-solving tool namely numerical method.
- To understand the system of equations, non-linearities and complicated geometries that are not uncommon in engineering practice and that are often impossible to solve analytically.

Course content:

Module-I

Linear Algebra:Solution of System of Linear Algebraic equations by triangularization method: Crout's method,Cholesky method, Partitions method, Gauss Jacobi, Gauss- Sidel's method and Power method for eigen values and eigen vectors.(RBT Levels:L1&L2) **[8 hours]**

Module-II

Roots of equations: Muller method, Graeffe's root squaring method. Numerical solution of ordinary differential equation by Picards method of successive approximation, first order simultaneous equation by Picard and Runge-Kutta method. Second order equation by Picard's method.

.(RBT Levels:L2&L3) **[8 hours]**

Module-III

Partial Differential Equations: Numerical solution of one-dimensional wave equation, Heat equation, (Schmidt's explicit formula) & Laplace equation (Gauss-Seidel process) by finite difference schemes. Illustrative examples on each method.

.(RBT Levels:L2&L3) **[8 hours]**

Module-IV

Probability distribution: Random variables, probability mass and probability distribution function, Probability distributions: Binomial, Normal and Gaussian distributions& examples.

.(RBT Levels:L2&L3) **[8 hours]**

Module-V

Sampling Theory: Testing of hypothesis: t-distribution test, Chi square test and F-test. Analysis of Variance (ANOVA):one way classification, Design of experiments, RBD.

.(RBT Levels:L2&L3) **[8 hours]**

Course Outcomes:

At the end of this course, students will be able to:

CO1. Acquire the idea of significant figures, types of errors during numerical computation.

CO2. Learn various numerical methods to solve system of linear deferential equations

CO3. Analyze and solve PDE's related to wave equation arising in vibration analysis

CO4. Describe the basic notions of discrete and continuous probability distributions

CO5. Understand statistical and probabilistic concepts required to test the hypothesis and designing the experiments using RBD.

.Reference Books:

1.S.S .Shastry, Introductory Methods of Numerical Analysis , PHI, 2005.

2.David C. Lay, "Linear Algebra and its applications", 3rdEdition , Pearson Education, 2002.

3.T.Veerarajan "Probability, Statistics and Random Process", 3rd Edition, Tata Mc-Graw Hill Co.,2016

4.Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2ndEdition,PHI, 2011

5.B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers,44Th Ed,2017

6.E.Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley,2015.

SPECIAL CONCRETE

SubjectCode: 24PSE12	Credits:04	
CIE:50Marks	SEE:50Marks	SEE:03Hrs.
Hours/Week: 3 Hrs. + 2 Hrs. Practical		TotalHours:56

Courseobjectives:

This course will enable the students to

1. Behaviour of concrete under uniaxial compression and tension, Biaxial, triaxial stress
2. Properties, behavior under different type of loading and Design of Ferrocement
3. Learning mix prorprtion and behaviour of FRC under tension, compression and bending
4. Evaluate the properties of high density concrete and light weight concrete
5. Design of concrete by packing density method

MODULE-I

Behavior of concrete under uniaxial compression,Uniaxial tension,Biaxial,triaxial stress and Fracture mechanics approach for failure criteria testing of existing structure.Core testing,NDTtests – rebound hammer and UPSV. **10Hours**

MODULE-II

Ferro cement: Materials and mechanical properties, strength and behavior in tension, Compression, flexure and cracking. Durability of Ferrocement, prestressed Ferrocement,lightweight Ferrocement,design o fFerro cementin flexure. **10Hours**

MODULE-III

Fiber reinforced concrete: materials, mix properties, fiber content-distribution, orientation and interfacial bond, fiber concrete properties in fresh state,strength and behavior in tension,compression and bending.

12Hours

MODULE-IV

High density concrete: Materials, placement method, properties in wet and hardened state, use of high density concrete as radiation shields.

Lightweight concrete: Classification, properties of light-weight concrete, strength and durability, design of lightweight concrete mixes.

Polymer concrete composting admixtures in concrete, polymer impregnated concrete. Geo-polymer concrete, materials, fresh and hardened state properties.

Self-Compacting Concrete (SCC): Materials, fresh and hardened state properties. Mix design of SCC

14Hours

MODULE-V

Design of concrete by packing Density method, Design of High strength concrete, reactive powder concrete,modern concrete chemicals. Bacterial concrete. **10Hours**

CO	Course Outcome(CO)	BL
CO1	Evaluate the fracture mechanics approach for failure of concrete	C3
CO2	Design of ferrocement in flexure	C3
CO3	Evaluate the behaviour of FRC under tension,compression and bending	C4
CO4	Design of light weight concrete and SCC	C4
CO5	Design of high strength concrete	C4

Extent of teaching: Itisclearlydefinedinthesyllabus.

Schemeof SEE:i) Two questions are to be set fromeach module.

ii)Totalfivequestionsaretobeansweredbyselectingminimumonequestionfromeachmodule.

ReferenceBooks:

1. PaulandRama,**"FerrocementLFIC"**,AIT,Bangkok
2. ShortAandVKinniburgN**"Lightweightconcrete"**.
3. NevileA.M**"Propertiesofconcrete"**ELBSEditionLondon.
4. ShahSP**"SpecialConcrete"**ProceedingsofseminarUniversityofIllinois,1973.

STRUCTURAL DYNAMICS

SubjectCode: 24PSE13	Credits:04	
CIE:50Marks	SEE:50Marks	SEE:03Hrs.
Hours/Week: 3Hrs.(Theory)+2Hrs. SDA		TotalHours:56

Course objectives:

To enable students to acquire the knowledge in the fallowing topics:

1. To attain the knowledge of effect of vibrations & earthquake force on the structures.
2. To attain the knowledge of rotating unbalance, Duhamel's integral, DLF, SDOF.
3. To attain the knowledge of free vibration of MDOF, natural frequencies, shear buildings modeled as MDOF.
4. To attain the knowledge of forced vibration of MDOF, response of shear building to base motion, base isolation.
5. To attain the knowledge of continuous systems, dynamic analysis of beams, lumped mass and consistent mass formulation

MODULE-I

Introduction: Objectives,types of dynamic problems,degree of freedom, D'Alemberts principle, principle of virtual displacement and Hamilton's principle. Single degree of freedom systems**.** Un-damped and damped free vibrations; force vibration- response to harmonic loading. **12Hours**

MODULE-II

Support motion,evaluation of damping,vibration isolation,transmissibility,response to periodic forces.Numerical methods applied to SDOF,Direct integration and Duhamel Integral. **10 Hours**

MODULE-III

Multi degree freedom systems-Natural modes – Orthogonality conditions,Modal analysis -free and forced vibration with or without damping. **10 Hours**

MODULE-IV

ApproximateMethod: Rayleigh'smethod,Dunkarly'smethod,Stodola'smethod,Rayleigh-Ritzmethod,

12Hours

MODULE-V

Continuous system– Free longitudinal vibration of bars,flexural vibration of beams with different end conditions - forced vibration-response of beams under moving loads.

Response to earthquake– Techniques for analyzing earthquake response-design principles of earthquake resistant structures. **12Hours**

Course Outcomes: On completion of this course, students are able to:		
CO		**BL**
CO1:	Explain the terminology associated with earthquake And the basic concepts of SDOF System and its response to harmonic loads.	C2
CO2:	Explain Duhamel's integral vibration isolation and analyze SDOF subjected to general system of load,harmonic base excitation	C2
CO3:	Analyze MDO Fsystem subjected to free vibration,	C3

CO4	Determine the response of shea rbuilding to forced vibration,basemotionand Harmonic forced excitation.	C2
CO5	Analyze beams by dynamic approach using technique of lumped mass and consistent mass formulation.	C3

Extentofteaching: Itisclearlydefinedinthesyllabus.

SchemeofSEE:i)Twoquestionsaretobesetfromeachmodule

ii)Totalfivequestionsaretobeansweredbyselectingminimum onequestionfromeachmodule.

ReferenceBooks:

1. M.Mukhopadhay**"Vibrations,DynamicsandStructuralSystems"**Oxford andIBH publishing Co. Pvt.Ltd. New Delhi
2. AnilK.Chopra**"DynamicsofStructures(TheoryandApplications to Earthquake Engineering)"** Prentice ball ofIndia Private limited,New Delhi
3. Mario Paz **"Structural Dynamics (Theory and ComputationsecondEdition)"**CBS Publishers and Distributors,New Delhi
4. R.W.CloughandY.Pengiln–**"DynamicsofStructures"**,McgrawHill

THEORY OF ELASTICITY AND PLASTICITY

SubjectCode: 22PSE14	Credits:03	
CIE:50Marks	SEE:50Marks	SEE:03Hrs.
Hours/Week: 2 Hrs.+2Hrs. SDA		TotalHours:42

Course objectives:

1.Generalized Hooke's law and strain-displacement relations, Equations of equilibrium and compatibility for two dimensional problems in rectangular & polar co ordinates

2.Plane stress and plane strain problems, measurement of surface strains and strain rosettes, stalk polynomial.

3.Analysis of two-dimensional problems in rectangular and polar coordinates

MODULE-I

Stress and strain at a point,Lame's Constants,Generalized Hook's Law, Strain- displacement relations. Differential equations of equilibrium,boundary conditions, Compatibility equations for 2D & 3D cases, ,Stress polynomials, St.Venant's principle, Airy's stress function,Numerical Problems. **08 Hours**

MODULE-II

Plane stress and plane strain, Evaluation of stress in-varients and principal stresses for a given stress matrix in 3D, Two-dimensional problems in rectangular coordinates,bending of a cantilever beam subjected to end load, effect of shear deformation in beams, simply supported beam subjected to UDL. **10 Hours**

MODULE-III

Two-dimensional problems in polar coordinates, strain-displacement relations,equations of equilibrium,compatibility equation,stress function.Problems. **08 Hours**

MODULE-IV

Stress distribution symmetrical about an axis,Lame'sproblem,Effect of circular hole in an infinite plate-highstress concentration factors.

Torsion: stress function, torsion of circular, elliptical and equilateral triangular sections. **08 Hours**

MODULE-V

Plasticity : General concept – yield criteria – flow laws for perfectly plastic and strain hardening material – simple applications. Theories of failure,Problems on theories of failure. **08 Hours**

Course Outcomes:

At the end of this course, students will be able to:

CO1. Achieve knowledge of design and development of problem solving skills

CO2. Design the principles of stress-strian behaviour of continuum equations

CO3. Design and develop analytical skills

CO4. Achieve knowledge of stress concentration factors and torsional effect.

CO5. Comprehend the concepts of elasticity and plasticity.

Extentofteaching: Itisclearlydefinedinthesyllabus.

Schemeof SEE:i)Two questionare to be set from each module.

ii)Totalfivequestionsaretobeansweredbyselectingminimumonequestionfromeachmodule.

TEXTBOOKS:

1. Timoshenko. S.P. and Goodier.J.N. – **"Theory of Elasticity"**International Students' Edition, McGraw Hill Book Co. Inc., NewDelhi.
2. Wang.P.C.-**"AppliedElasticity"**
3. Sadhu singh – **"Theory of Plasticity"**

REFERENCEBOOKS:

1. Valliappan.C-**"ContinuumMechanicsFundamentals"**,OxfordandIBHPublishingCo.Ltd.,NewDelhi.
2. Srinath.L.S. – **"Advanced Mechanics of Solids"**, Tata McGrawHillPublicationsCo.Ltd.,NewDelhi.
3. Venkataraman andPatel- **"Structural Mechanics withIntroduction to Elastity and Plasticity"**, McGraw Hill BookInc.,NewYork.

ADVANCED DESIGN OF RCC STRUCTURES

SubjectCode: 22PSE15	Credits:03	
CIE:50Marks	SEE:50Marks	SEE:03Hrs.
Hours/Week: 2 Hrs. + 2 Hrs SDA		TotalHours:42

Course objectives:

To enable the students to acquire the knowledge in the following topics

1.Understand the design procedure of cantilever & counterfort retaining walls

2.Understand the design procedure o circular & rectangular water tanks resting on ground.

3.Understand the design procedure of slab type & beam type combined footings.

4.Understand the base concept of yield line theory for the design of different shapes of RCC slabs. Understand the design concept of grid floors & flat slabs.

5.Understand the design procedure for continuous beams & single bay & single storey RC frames

MODULE-I

Yield Line Method : Introduction,basic ideas of yield line theory,location of yield lines for standard cases,internal forces in yield lines,methods of yield line analysis (equilibrium approach & by virtual work principle),yield analysis of one way &two-way rectangular slab, circular slab &rectangular slab supported on three edges & design of one way &two-way rectangular slabs. **08 Hours**

MODULE-II

Design of Grid Floor and Flat Slabs: Introduction,analysis & design of grid floors by approximate & plate theory, design of flat slabs. **10Hours**

MODULE-III

Design of Continuous Beams and Portal Frames: Introduction ,effective span, and calculation of BM & SF, redistribution of moments,designofcontinuousbeamsbylimitstatemethod,designofsinglebay,single story portal frame (hinged & fixed)for given analyzed data,reinforcement detailing. **08 Hours**

MODULE-IV

Design of silos and bunkers. Design principles of chimney (Only theory). **08 Hours**

MODULE-V

Design of Beams Curved in Plan : Design of circular, semi circular & segmental (circular type) type of curved beams for point load & UDL.

Art of dealing earthquake resistant construction **:** General ductile detailing requirements, ductile detailing of beam column joints, expansion & construction joints. **10 Hours**

Course Outcomes: On completion of this course, students are able to:		
CO		**BL**

CO1:	Describe stress and strain at a point, Generalized Hooke's law and strain displacement relations	C2
CO2:	Explain equilibrium and compatibility equation for the two-dimensionalrectangularcoordinatesystem&solveproblemsonstresspolynomials	C2
CO3:	Explain surface strain measurement technique using strain rosettes and solve problems on cantilever and section beams.	C2
CO4	Solve two dimensional problems in polar coordinate system using the Concepts of equilibrium and compatibility equation	C3
CO5	Develop the for stress distribution for the call of rotator discs and effect of circular hole in an infinite rate	C3

Extentofteaching: Itisclearlydefinedinthesyllabus

Scheme of SEE:i) Two questionsareto beset fromeach module.

ii)Totalfivequestionsaretobeansweredbyselectingminimumonequestionfromeachmodule.

ReferenceBooks:

1. N. Krishnaraju, -**"Design of Advanced Reinforced concretestructures"**CBSpublishers,NewDelhi.
2. A.K.Jain— **"LimitStatemethodofdesign"**NemichandandBros.,Roorkee
3. Park&Paulay—**"ReinforcedConcrete"**,JohnWiley&Bros.
4. B.C. Punmia, Ashok kumar Jain & Arun kumar Jain — **"LimitState design of Reinforced concrete"**, Laxmi Publication,NewDelhi.
5. V.Ramakrishnan&P.D.Arthur,**"Ultimatestrengthdesignofstructuralconcrete"**,

ADVANCED STRUCTURAL ENGINEERING LAB

SubjectCode: 24PSE16	Credits:2	
CIE:50Marks	SEE:50Marks	
Hours/Week: 03		TotalHours:42

1.)Rebound hammer test

2.)Ultrasonic pulse velocity

3.)NDT by core cutter

4.)Flexural test on Beam

5.)Test on Permeability of concrete

6.)Corrosion test on rebar in concrete

CADLAB

Subject Code: 24PSE17		Credits: 02
CIE : 50 Marks	SEE :50 Marks	SEE:03 Hrs.
Hours/Week: 3 Hrs.		Total Hours: 42

1.) Creation of spread sheets using Microsoft Excel for

1. Create a Spread sheet for design of Singly RCC beams.
2. Create a Spread sheet for design of Doubly RCC beams.
3. Create a Spread sheet for design of one-way Slab.
4. Create a Spread sheet for design of Two-way Slab
5. Create a Spread sheet for design of Axially loaded Column
6. Create a Spread sheet for design of Uniaxially loaded Column
7. Create a Spread sheet for design of Bi-axially loaded column.
8. Create a Spread sheet for design of footing
9. Create a spread Sheet for design of staircase
10. Create a Spread Sheet for analysis of continuous beams by moment distribution method.

2.) Use of commercial software for

1. Analysis and design of Continuous Beam by commercial software
2. Analysis and design of 3D Frame by commercial software
3. Modelling, Analysis and design of portal frames for varying load conditions and comparison with manual calculation (One Storey & One Bay) by commercial software.
4. Analysis and design of Truss for Industrial Warehouse by commercial software.

Question Paper Pattern: Student has to write algorithm and create spreadsheet to get the output for any of the One question from Sl. No 1 To Sl.No.10 and obtain design results with manual calculation as applicable for One question from Sl. No 11 to 14 in the above listed experiments.

60% Weightage for question no 1 (Sl.no 1 to Sl.no 10)

40% Weightage for question no 1 (Sl.no 11 to Sl.no 14)

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Scheme of Teaching and Examinations – 2024

M.Tech. STRUCTURAL ENGINEERING COURSE CIVIL ENGINEERING DEPARTMENT

Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Seminar	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	IPCC/PCC	24 PSE21	Matrix Methods Of Structural Analysis	02	00	02	03	50	50	100	4
2	PCC/PBLC	24 PSE22	Design of Earthquake Resistant Structures	02	00	02	03	50	50	100	3
3	PCC	24 PSE23	Finite Element Method	03	02	00	03	50	50	100	3
4	PEC	24PSE23x	Professional elective 1	02	00	02	03	50	50	100	3
5	PEC	24PSE24x	Professional elective 2	02	00	02	03	50	50	100	3
6	MPS	**24MPS25**	Mini Project/Technology-Based Societal Project	00	04	02	--	100	--	100	3
7	PCCL	24PSEL26	Software based Lab-2	01	02	00	03	50	50	100	2
8	AEC/SEC	24PSE27x	Ability/Skill Enhancement Course (Offline/Online)	00 01	02 00	--- ----	02 01	50	50	100	1
TOTAL				**13**	**10**	**10**	**21**	**450**	**350**	**700**	**22**

Note: **BSC**-Basic Science Courses, **PCC**: Professional core. **IPCC**-Integrated Professional Core Courses, **NCMC**- None Credit Mandatory Course, **PCCL**-Professional Core Course lab

AUD/AEC/SEC–Audit Course / Ability Enhancement Course/Skill Enhancement Course, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities** (Hours are for Interaction between faculty and students) **PBLC**: Project Based Learning Course, **MPS**: Mini Project

Professional Elective 1		**Professional Elective 2**	
Course Code under 24XXX23X	**Course title**	**Course Code under 24XXX24X**	**Course title**
24 PSE231	Theory of Plates and	24PSE241	Stability of Structures
24 PSE232	Design of Masonry	24PSE242	Advanced Foundation Engineering
24PSE233	Design of Prestressed concrete structures	24PSE 243	Composite and Smart Materials
24PSE234	Design of Bridges	24PSE 244	Optimisation Methods in Engineering Design

Proposed Syllabus for II Semester M.Tech.

(Structural Engineering)

MATRIX METHODS OF STRUCTURAL ANALYSIS

SubjectCode: 24PSE21	Credits:04	
CIE:50Marks	SEE:50Marks	SEE:03Hrs.
Hours/Week: 2Hrs.(Theory)+2Hrs. SDA		TotalHours:42hrs

Course Objectives:

1.Fundamentals of stiffness and flexibility methods for analysing indeterminate structures
2.Analysis of trusses, continuous beams and rigid frames by direct stiffness method
3. Analysis of trusses, continuous beams and rigid frames by flexibility method

MODULE-I

Stiffness method: Introduction, Fundamentals of Direct Stiffness method, local and global coordinate system, transformation of variables, load Vector, Relationship between member stiffness matrix and Global Stiffness Matrix.

Truss analysis using stiffness method: Member stiffness matrix (truss member) . Member global stiffness matrix for truss element. Application of the stiffness method for truss analysis (2-D only).

10 Hours

MODULE-II

Beam analysis using stiffness method : Member and Global stiffness matrix for beam. Application of the direct stiffness method for beam (Degree of freedom < or = 3).

Frame analysis using stiffness method: Member stiffness matrix for frame element. Member global stiffness matrix for frame element. Application of direct stiffness method for frame analysis (Degree of freedom < or = 3). (2-D only).

12 Hours

MODULE-III

Programming concept Bandwidth minimization technique, assembly of global stiffness matrices computer program. (beam, truss and frame)

06 Hours

MODULE-IV

Flexibility method: Introduction to flexibility method. Choice of redundant. Compatibility. Equilibrium equation for indeterminate system. Relationship between nodal displacement and nodal loads.Application of flexibility method for truss analysis. **14 Hours**

MODULE-V

Application of Flexibility method (beams and frames): Application of flexibility method for beam analysis and frame analysis (2-D only). **14 Hours**

Course outcomes:
At the end of the course the student will be able to:
1)Analyse the frame by direct stiffness method.
2)Analyse continuous beams and frames by direct stiffness method.
3)Evaluate the effect of temperature change and lack of fit by stiffness method.
4) Understand the concept of flexibility method and develop flexibility matrix and analyse truss by flexibility method.
5)Analyse beams and frames by flexibility method.

Extent of teaching: It is clearly defined in the syllabus.

Scheme of SEE: i) Two questions are to be set from each module.

ii) Total five questions are to be answered by selecting minimum one question from each . . . module.

Reference Books:

i) M Mukhopadhyay “Matrix, finite elements, Computer and Structural analysis”, Oxford &IBW, 1984

ii) W. Weaver J.M. Gere “Matrix Analysis of framed structures”, CBS publishers and Distributors, 1986

iii) S Rajshekharan. G Sankara Subramanian “Computational structural Mechanics”, PHI, 2001

iv) G.S Pandit & S P Gupta “Structural Analysis A Matrix Approach” Tata McGrawHill,1981

v) C.S Reddy “Basic structural Analysis”, Tata Mc Graw-Hill,1996

vi) L S Negi and R S Jangid “Structural Analysis”, Tata Mc Graw-Hill,l997

vii) H C Martin “Introduction to Matrix Methods of Structural analysis”, International text book Comoanv.1996.

DESIGN OF EARTHQUAKE RESISTANT STRUCTURES

SubjectCode: 24PSE22	Credits:03	
CIE:50Marks	SEE:50Marks	SEE:03Hrs.
Hours/Week: 2Hrs.(Theory)+2Hrs. SDA		TotalHours:42

Course objectives:

To enable the students to acquire the knowledge in the following topics:

1. Different types of earthquakes and different seismic instruments.
2. Analysis, Design of building according to earthquake design philosophy.
3. Structural configuration of earthquake resistance design.
4. Concept of ductility and design of column and beams with reference to ductility as per codal provisions.
5. Design of masonry building in shear flexure.

MODULES	Teaching Hours
MODULE - I Introduction to endogenic processes, Tectonic and volcanic earthquakes, General features of earth quakes with regard to Indian continent, magnitude and intensity scales, and seismic instruments. Response spectrum – elastic and elasto - plastic spectra, tripartite plot.	9 Hours
MODULE - II Equivalent static Method in earthquake resistant design. Dynamics of multistoried buildings – natural frequencies and mode shapes (Forced Vibration) . Analysis of multistoried buildings for obtaining seismic forces using IS 1893. (Dynamic Analysis)	9Hours
MODULE - III Structural configuration for earthquake resistant design, frames, shear walls and dual systems, effect of infill masonry walls on frames, problem of soft storey, capacity design procedures.	8Hours
MODULE - IV	8Hours

Ductility and energy absorption in buildings, confinement of concrete for ductility, ductility of columns and beams – IS 13920 code provisions.	
MODULE - V Behavior of masonry buildings during earthquake, failure patterns, strength of masonry in shear and flexure, concepts for earthquake resistant masonry buildings – code provisions.	**08 Hours**

Course Outcomes: On completion of this course, students are able to:

CO		**BL**
CO1:	Explain different types of earthquakes and their features &working of different seismic instruments.	C2
CO2:	Analyse multistory building for determining natural frequencies & mode shapes using static and dynamic techniques.	C4
CO3:	Compare performance of different structural configuration for earthquake resistance design.	C5
CO4	Design columns &beams with reference to ductility using codal provisions.	C4
CO5	Determine strength of masonry buildings in shear, flexure &failure pattern during earthquake.	C4

Extent of teaching: It is clearly defined in the syllabus.

Scheme of SEE: i) Two questions are to be set from each unit.

ii) Total five questions are to be answered by selecting minimum one question from each part.

Reference Books:

1. Clough and Penzien "Dynamics of Structures" (McGraw Hill book Co)
2. AY Yakushova "Geology with the Elements Geomorphology"(M[R Publisher Moscow).
3. Polyakov "Design of Earth Quake Resistant Structures"(MIR Publishers Moscow).

4. S F Borg “Earth quake Engineering Damage assessment and Structural design” (John Wiley and sons 1983) 5. Anil Chopra “Earthquake Resistant Design”. Ghose.S.K, “Earthquake resistance design of concrete structures” , SDCPL — R & D Center New Mumbai. 6. Design of Earthquake Resistant Structures –Pankaj Agarwal 7.	

FINITE ELEMENT METHOD

Subject code	24PSE23	Credit: 3
Hours/Week	42 Hrs	SEE:50Marks
Total hours:	CIE:50Marks	SEE:3hours

Prerequisite: Structural Analysis

Course objectives:

- To provide the fundamental concepts of the theory of the finite element method
- To develop proficiency in the application of the finite element method (modeling, analysis, and interpretation of results) to realistic engineering problems through the use of Softwares

Modules	Teaching Hours
ModuleI **Introduction**: Basic concepts of elasticity-Kinematic and Static variables for various types of structural problems approximate method of structural analysis-Rayleigh-Ritz. method-Finite difference method- Finite element method. Principles of finite element method-advantages& disadvantages-Finite element procedure. Finite element used for one, two& three dimensional problems-Element aspect ratio-mesh refinement vs higher order elements-Numbering of nodes to minimize bandwidth	9 hrs
ModuleII **Displacement Model**: Nodal displacement parameters -Convergence criterion-Compatibility requirements invariance-Shape function-Polynomial form of displacement function - Generalized and Natural coordinates-Lagrangian interpolation function- shape functions for one-, two- & three-dimensional element	8 hrs
Module-III **Concept of Isoparametric** Elements: Internal nodes and higher order elements-Serendipity and Lagrangian family of Finite Elements- Sub parametric and Super parametric elements- Condensation of internal nodes-Jacobian transformation Matrix-Variation method and minimization of Energy approach of element formulation (Development of strain displacement matrix and stiffness matrix)consistent load vector- numerical integration.	8 hrs
Module-IV **Application of Finite Element Method for the analysis of one-dimensional problems**: Analysis of simple beams and plane trusses and rigid plane frames.	9 hrs

Module-V	8 hrs
Application of Finite Element Method for the analysis of two dimensional problems: Application to plane stress/ strain/ axisymmetric problems using CST, LST &Quadrilateral elements. Choice of displacement function **Techniques for Non -linear Analysis**: Introduction to techniques for problems involving material non linearity and geometric non linearity.	

CourseOutcomes: Oncompletionofthiscourse,studentsareableto:

CO		BL
CO1:	Describe finite element analysis to structural systems	C3
CO2:	Identify ,formulate and solve engineering problems related to 3D Dimensional elements	C4
CO3:	Identify, formulate and solve engineering problems related to one, two and three dimensional isoparametric elements.	C4
CO4	Apply FEM analysis to one dimensional problem such as beams, trusses &rigid frames.	C4
CO5	Apply FEM analysis to two dimensional problems such as plates, shells and axi-symmetric problems.	C4

Questionpaperpattern:

1. Twoquestionsaretobesetfromeachmodule.
2. Totalfivequestionsaretobeansweredbyselectingminimumonequestionfromeac hmodule

Textbook:

Krishnamoorthy C S, “Finite Element Analysis”, Tata Mcgraw hill

Desai C and Abel J F, “Introduction to the Finte element method”, East West press pvt.Ltd,1972

Referencebooks:

Rajasekaran. S, "Finite Element Analysis in Engineering Design", Wheeler Publishing, 1999.

Cook R D. Malkan D S &Plesta M.E, "Concepts and Application of Finite Element Analysis", 3' Edition, John Wiley and Sons Inc., 1989

Shames 1 Hand Dym C J, *Energy and Finite Element Methods in Struetural Mechanics". MeGraw Hill, New York, 1985

PROFESSIONAL ELECTIVE-I

THEORY OF PLATES AND SHELLS

SubjectCode: 24PSE231	Credits:03	
CIE:50Marks	SEE:50Marks	SEE:03Hrs.
Hours/Week: 2Hrs.(Theory)+2Hrs. SDA		TotalHours:42

COURSE OBJECTIVES

- Present the foundations of the classical theory of thin elastic plates and shells based on the Kirchhoff-Love assumptions.
- Understand the limitations and differences of plate/shell theories within the context of the theory of elasticity.
- Introduce the nomenclature and theoretical development of plate and shell theory in the context of laminated elastic media.
- Apply plate and shell theory to problems involving various geometries and boundary conditions.
- Introduce numerical and analytic solution techniques.

	Teaching Hours
MODULE-I Plate Theory : Thin and Thick plates, Behavior of plates, Thin plate theories (Small deflection and large deflection theory), isotropic, anisotropic and orthotropic material, boundary conditions. Small deflection theory of Thin Plates in Bending: Assumptions for Small deflection of thin plates, isotropic plate in Cartesian co-ordinate system. Strain -displacement relation Stress -strain relation, Moment- curvature relation, Equilibrium equations. Plate equation.	9
MODULE-II Bending analysis of thin rectangular plates: Analysis of rectangular plates with all edges simply supported using Navier's solution for various loading conditions (Uniform loading, patch loading and concentrated load). Analysis of rectangular plates using Levy's solution for various boundary conditions and loading cases (Two opposite edges simply supported under Uniform loading, Two opposite edges clamped under uniform	9

intensity of loading and action of distributed moment along the two opposite edges).	
MODULE-III Analysis of circular plates in bending: Equilibrium equation. Plate equation. Analysis of simply supported circular plate subjected to uniform loading (Axisymmetric case). Analysis of Clamped circular plate subjected to uniform loading (Axisymmetric case). Analysis of Clamped annular plate subjected to uniform loading (Axisymmetric case). Shell Theory : Definition of shell, Types of shell, classification of shells, Advantages and disadvantages of shell roofs. Structural action of shells. Beam theory of cylindrical shells: Advantages and disadvantages of beam theory. Assumptions, range of validity. Beam analysis and arch analysis.	8
MODULE-IV **Membrane theory of Cylindrical shells:** Membrane theory. Equation of equilibrium. Expression for stresses under dead load and snow loads for Circular, Parabola, Catenary and Cycloid directrices. **Bending theory of Cylindrical shells**: Stress - strain relation, Moment curvature relation. Finsterwalder theory: Assumptions, Equation of equilibrium, Finsterwalder differential equation.	**8**
MODULE-V **Bending theory (continued):-**D.K.J theory: Comments on D.K.J theory, Equation of equilibrium, Flugge's simultaneous equations, D.K.J equation. Expression for stress resultants and displacements. **Membrane theory of shells of Revolution**: Introduction, equilibrium equations. Membrane analysis of spherical shells and rotation hyperboloid of one sheet. **Membrane theory of shells of translation**: Introduction. Membrane analysis of Synclastic shells (Elliptic paraboliod shell only).	8
Course outcomes:	

CO1: identify the concept of thin plates using various approaches.

CO2: analyze the thin plates subjected to different loading and boundary conditions.

CO3: discuss the behavior of shells and their classifications and stress-strain and force-displacement relationship.

CO4: analyze different types of shells subjected to different loading criterion and boundary conditions

Extent of teaching: It is clearly explained in the syllabus

Scheme of SEE: i) Two questions are to be set from each module

ii) Total five questions are to be answered by selecting minimum one question from each module.

Reference Books:

1. Timoshenko and S. Gere, "Theory of plates and shells", Tata Mcgraw-HillCo.Ltd New Delhi
2. N.K.Bairagi' "Plate Analysis" Khanna Publishers New Delhi
3. Szilard.R., "Theory and Analysis of Plates",PHI Publications
4. Ugural, "Stresses in Plates and Shells" Mcgraw-Hill Book Co.
5. N.K.Bairagi "Shell Analysis" Khanna Publishers New Delhi
6. G.Ramaswamy "Design and Construction of concrete shell roofs", CBS Publishers New Delhi
7. K. Chandrashekhara, "Analysis of thin concrete shells", Iota Mcgraw-Hill Co. Ltd New Delhi

DESIGN OF MASONRY STRUCTURES

Subject Code: 24PSE232	Credits:03	
CIE:50Marks	SEE:50Marks	SEE:03Hrs.
Hours/Week: 3Hrs.(Theory)		TotalHours:42

Course objectives:

This course will enable the students to

1. Understand properties of masonry units, strength and factors affecting strength.
2. Understand design criteria of various types of walls subjected to different load system.
3. Impart the culture of following the codes for strength,serviceability and durability as an ethics.
4.Provideknowledgeinanalysisand design of masonry elements

MODULE - I

Introduction, Masonry units, materials and types: History of masonry Characteristics of Brick, stone, clay block, concrete block, stabilized mud block masonry units – strength, modulus of elasticity and water absorption. Masonry materials – Classification and properties of mortars, selection of mortars. **8 Hours**

MODULE-II

Strength of Masonry in Compression: Behavior of Masonry under compression, strength and elastic properties, influence of masonry unit and mortar characteristics, effect of masonry unit height on compressive strength, influence of masonry bonding patterns on strength, prediction of strength of masonry in Indian context, failure theories of masonry under compression. Effects of slenderness and eccentricity, effect of rate of absorption, effect of curing, effect of ageing, workmanship on compressive strength.

9 Hours

MODULE-III

Flexural and shear bond, flexural strength and shear strength: Bond between masonry unit and mortar, tests for determining flexural and shear bond strengths, factors affecting bond strength, effect of bond strength on compressive strength, orthotropic strength properties of masonry in flexure, shear strength of masonry, test procedures for evaluating flexural and shear strength. **8 Hours**

MODULE-IV

Permissible Stresses: Permissible compressive stress, stress reduction and shape reduction factors, increase in permissible stresses for eccentric vertical and lateral loads, permissible tensile and shear stresses.

Design of load bearing masonry buildings: Permissible compressive stress, stress reduction and shape reduction factors, increase in permissible stresses for eccentric vertical and lateral loads, permissible tensile

and shear stresses, Effective height of walls and columns, opening in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action, lintels; Wall carrying axial load, eccentric load with different eccentricity ratios, wall with openings, freestanding wall. **9 Hours**

MODULE-V

Design of load bearing masonry for buildings up to 2 storeys using BIS code provisions. Earthquake resistant masonry buildings: Behavior of masonry during earthquakes, concepts and design procedure for earthquake resistant masonry, BIS code provisions

Masonry arches, domes and vaults: Components and classification of masonry arches, domes and vaults, historical buildings, construction procedure. **8 Hours**

CO	Course Outcome(CO)	BL
CO1	Explain different types of masonry construction such as brick, stone,reinforced walls in composite action and identify the loads on masonry walls.	C2
CO2	Summarize various formulae's for finding compressive strength, flexural and shear strength of masonry units.	C3
CO3	Explain permissible stresses and design criteria as perIS:1905 and SP-20.	C2
CO4	Design of walls under udl,axial loads and eccentric loads for solid walls, cavitywalls with and without piers	C5
CO5	Design of Laterally and transversely loaded walls	C5

Extent of teaching: It is clearly defined in the syllabus.

Scheme of SEE: i) Two questions are to be set from each module.

ii) Total five questions are to be answered by selecting minimum one question from each part.

REFERENCE BOOKS:

1. Hendry A.W., "Structural masonry"- Macmillan Education Ltd., 2nd edition
2. Sinha B.P & Davis S.R., "Design of Masonry structures"- E & FN Spon
3. Dayaratnam P, "Brick and Reinforced Brick Structures"- Oxford & IBH
4. Curtin, "Design of Reinforced and Prestressed Masonry"- Thomas Telford
5. Sven Sahlin, "Structural Masonry"-Prentice Hall
6. Jagadish K S, Venkatarama Reddy B V and Nanjunda Rao K S, "Alternative Building Materials and Technologies"-New Age International, New Delhi & Bangalore
7. IS 1905, BIS, New Delhi and SP20(S&T),New Delhi

DESIGN OF PRESTRESSED CONCRETE STRUCTURES

SubjectCode: 24PSE233	Credits:03	
CIE:50Marks	SEE:50Marks	SEE:03Hrs.
Hours/Week: 2Hrs.(Theory)+2Hrs. SDA		TotalHours:42

Course objectives:

1.Explain the fundamental concepts of stress analysis

2 Apply systems of pre-stressing for various sections of structural elements

3 Evaluate and analyze the stresses under various conditions

4 Design and detail the prestressed concrete members for various loading conditions

MODULE -I

Analysis for Flexure: General Concepts of stresses, Prestressing force transferred by i) Pre-Tensioning system, ii) Post tensioning system. Resultant Compression line, Load Balancing Concept. Prestressing Losses: Introduction, Immediate Losses, Time Dependent losses. **9Hours**

MODULE-II

Analysis of Members under Axial load: Introduction, Analysis at transfer, Analysis at services loads, Analysis at ultimate strength. Design Philosophy: Limit state of Collapse and Serviceability. Design for flexure: Stress range approach, Lins approach, Magnels Approach. Deflection of beams. **9 Hours**

MODULE-III

Design for Shear and Torsional mechanism of Shear Resistance in Concrete beams, Design for Shear in PSC beams, Shear in flanged beams, Failure of Concrete Elements under Torsion. Anchorage zone Stresses: Pre-tensioned and Post-tensioned pre-stressed Concrete Elements, Detailing of Reinforcement in General .**08 Hours**

MODULE-IV

Statically Indeterminate Structures: Analysis of pre-stressed indeterminate structures, continuous beams, linear transformation and concordance of cable profiles, frames, partial pre-stressing and codes of practice, analysis, design, crack control. Design of slabs One way and two way. **8 Hours**

MODULE-V

Composite Construction: Need for composite construction, types of Composite Construction, Flexural Stresses, Longitudinal and Transverse Shear Transfer, creep and Shrinkage Effects in Composite Construction. **8Hours**

Course Outcomes: On completion of this course, students are able to:		BL
CO1:	Understand the fundamental concepts of stress analysis	C2
CO2:	Apply systems of pre-stressing for various sections of structural elements	C2
CO3:	Analyse and evaluate the stresses under various conditions	C3
CO4	Design the prestressed concrete members for various loading conditions	C4
CO5	Design of Prestressed Beams	C4

Extent of teaching: It is clearly defined in the syllabus

Scheme of SEE: i) Two questions are to be set from each module.

ii) Total five questions are to be answered by selecting minimum one question from each module.

Reference Books:

1.Krishnaraju Pre-stressed Concrete, Tata Mcgraw Hill, 2007

2.N Rajagopalan – Prestressed Concrete narosa, 2nd Ed. 2006 Zeevaert, “Foundation Engineering for Difficult subsoil conditions” -L - Van Nostrand Reinhold Company, 1972

DESIGN OF BRIDGES

Subject Code: 24PSE234	Credits:03	
CIE:50Marks	SEE:50Marks	SEE:03Hrs.
Hours/Week: 3Hrs. (Theory)		TotalHours:42

Course objectives:

1. **Types and importance of bridges and basic investigations for proposing bridge at a site.**
2. **Details of different types of foundations for a proposed bridge its stability analysis for different components of substructures.**
3. **Loads as per IRC and stresses on different components of bridge and design of RCC slab culvert.**
4. **Design of pipe culvert and box culvert for a proposed highway road.**
5. **Design of RCC T-beam girder bridge by different methods and detailing**

MODULE - I

Introduction to Bridge Structures and Fundamentals of Bridge Design (12 hours)

Bridge and its components, Types of bridges and their characteristics, Selection of bridge type, Essential design data and their acquisition, General design requirements. Bridge Loads and Bridge Responses.

Bridge Deck Analysis and Method of Lateral load Distribution: General principle and methods of bridge deck analysis, Effective Width Method, Courbon's Method, Distribution Coefficient Method, Hendry Jaeger Method, Longitudinal and lateral positioning of moving loads and response calculation,

MODULE - II

Design of RCC Bridge: Slab bridge, T-beam Slab Bridge. **12 Hours**

MODULE - III

Balanced Slab bridge, Rigid frame bridge, Box girder bridge. **12 Hours.**

MODULE - IV

Design of Prestressed concrete bridges. (Simply supported case only) **12 Hours**

MODULE - V

Design of Piers & Abutments, Bearings: Types of bearings & design of bearings. **08Hours**

CO		BL
CO1:	**Explain different types of bridges and determine hydraulic inputs required for design of bridges**	C2

CO2:	**Explain different types of foundation, principles of stability analysis of abutment, pier and wing walls and analyse abutment from stability criteria**	**C4**
CO3:	**Explain different types of loads for design of bridges and design a RCC slab culvert**	**C5**
CO4	**Design a Pipe and Box culvert**	**C5**
CO5	**Design a T-Beam Bridges**	**C5**

Extent of teaching: It is clearly defined in the syllabus.

Scheme of SEE: i) Two questions are to be set from each unit.

ii) Total five questions are to be answered by selecting minimum one question from each part.

Reference Books:

1. Victor, D.J., "Essentials of Bridge Engineering". Oxford and IBH Publications, New Delhi.
2. Krishna Raju, N., "Design of Bridges", Oxford and IBH Publications New Delhi.
3. Jagadish T.R., and Jayaram, M.A., "Design of Bridge structures", Prentice Hall of India, New Delhi.
4. Relevant IRC and BIS codes.

PROFESSIONAL ELECTIVE-II
STABILITY OF STRUCTURES

SubjectCode: 24PSE241	Credits:03	
CIE:50Marks	SEE:50Marks	SEE:03Hrs.
Hours/Week: 2Hrs.(Theory)+2Hrs. SDA		TotalHours:42

Course objectives:

1. To impart the knowledge on linear and nonlinear behavior of structures
2. To familiarize the student with stability of plates under combined loading

MODULE-I

Concepts of stability Effect of initial imperfection - South well plot - empirical formulae for designs. methods of successive approximations. Large deflection theory. Numerical examples. **8 Hours**

MODULE-II

Beam Column-Concentrated load, number of point loads and UDL case Numerical Examples. **8 Hours**

MODULE-III

Euler's buckling load - Classical approaches -imperfect method. Equilibrium method, energy methods, buckling of laced, battened and tapered columns, Numerical Examples. **8 Hours** .

MODULE-IV

Inelastic buckling of straight columns, double modules theory, tangent modules theory, effect of shear on buckling, Secant modulus theory, buckling of frames Eigen value problem. **9 Hours**

MODULE-V

Buckling flexure, torsional buckling of thin walled open section columns, lateral buckling of simply supported beams of rectangular and I – section. Buckling of slightly curved beams.

Buckling of plates and shells (simple Cases). **9Hours**

Course Outcomes:

At the end of this course, students will be able to:

CO1. To analyse structures with linear and method of approximations.

CO2. To analyse the structures at beam column junctions

CO3. To Analyze and solve buckling of columns.

CO4. To Analyze and solve in elastic buckling of columns

CO5. To analyse buckling of curved beams and thin members (plates and shells).

Extent of Teaching: It is clearly defined in the syllabus

Scheme of SEE :i) Two questions are to be set from each module.

ii) Total five questions are to be answered by selecting minimum one question from each module.

Reference Books:

1. Timoshenko S P & Gere J M "Theory of Elastic Stability"

McGraw Hill Book Co. 1963

2. Blowich "Buckling Strength of Metal Structures"

3. Gerard "Structural Stability Theor

`ADVANCED FOUNDATION DESIGN

Subjectcode	24PSE242	Credit:03
Hours/Week	3hours.(Theory)	SEE:50Marks
Totalhours:42	CIE:50Marks	SEE:3hours

Prerequisite: Geotechnica lengg-I,Geotechnical engg-II

Course objectives:

To enable the students to acquire the knowledge in the following topics:

1. Types of shallow foundations,Bearing capacity according to BIS.
2. Classification of pile foundation,Group efficiency of piles.
3. Construction of different types of drilled piers and caissons.
4. Components of well foundation and forces acting on it.
5. Classification of expansive soils,Design of foundations in swelling soils, Drilled piers, Under reamed piles.

Modules	**Teaching Hours**
ModuleI Shallow foundations: Presumptive Bearing Capacity according to BIS, Factors affecting bearing capacity and settlement.Factors influencing selection of depth of foundation, type of shallow foundations – isolated footing.Combined footing,strap footing, Strip footing and Raft (Proportioning only)	9hours
Module-II Pile foundations :Necessity,Classification,Loadbearing capacity by static formula, Dynamic formula, pile load test and Penetration tests, pipe groups, group capacity of piles in sand and clay, group efficiency of piles, settlement of piles,negative skin friction, underreamed piles.	8hours
ModuleIII Drilled piers and casissons: Introduction,construction,advantages and disadvantages of drilled piers.Design of open, pneumatic and floating caissons.Advantages and disadvantages of floating caissons.	8hours
Module-IV **Well foundation:** Different shapes and characteristics of wells.Components ofwellfoundation.Terzaghi'sAnalysis,IRCmethod,Forces acting on well foundation.Sinking of wells.Causes and remedies of this and shifts.	7hours
Module-V **Foundation in expansive soils:** Expansive soils, Parameters of Expansive soils,Classification of Expansive soils, Causes of moisture changes in soils, Effects of swelling on buildings, Preventive measures for expansive soils, Modification of expansivesoils,Design of foundations in swelling soils, Drilledpiers, Belled drilled pier ,Under-reamed piles,construction of Under-reamed piles,Identification of	10hours

collapsible soils, Design of foundation on collapsible soils not subjected to wetting,design of foundations subjected to wetting, Illustrativ eexamples ,problems.		
CO		BL
CO1:	Apply principles of soil design for shallow foundations.	C4
CO2:	Design pile and pile groups with reference to dimensions.	C3
CO3:	Explain the construction of drilled piers and principles of design for open, pneumatic and floating caissons.	C5
CO4	Explain the construction of drilled piers and principles of design for open,pneumatic and floating caissons.	C2
`CO5	Determinetheeffectsofexpansivesoilonfoundationsandapplysoildesignprinciple forfoundation in swelling soil.	C2

Textbook:

1. PunmiaB.C.,"SoilMechanics andFoundationEngineering,LaxmiPublicationsCo.,India.
2. Donald P. Coduto, "Geotechnical Engineering Principles & Practices", Prentice-hall of IndiaLtd,India.
3. MurthyV.N.S.,"GeotechnicalEngineering:PrinciplesandPracticesofSoilMechanicsandFoundationEngineering", CRC Press, NewYork.

COMPOSITE AND SMART MATERIALS

Subjectcode	24PSE243	Credit: 3
Hours/Week	42 Hrs	SEE:50Marks
Totalhours:42	CIE:50Marks	SEE:3hours

Prerequisite:

Course objectives: Students Will Be Able To **:**

1 . Apply the mechanical behavior, design principles, and analysis techniques of composite materials.

2. typically include understanding and mastering various aspects of electromechanical materials and their behavior

3. Comprehend the principles and functionalities of single and dual actuators, Establish relationships between applied loads and resulting deformations, strains, and stresses. Investigate the mechanisms through which these actuators achieve strain and displacement.

4. Comprehend the application of open-loop and closed-loop transfer functions, stability criteria, deflection control using piezoelectric sensors and actuators, and shape memory alloys.

5. Comprehend the usage of chemical and structural characterization, along with the material behavior and technological implications of these materials .

Modules	Teaching Hours
ModuleI **Introduction to the Composite materials**: classifications and applications.Anisotropic elasticity- unidirectional and anisotropic laminate, thermo-mechanical properties, micro-mechanical analysis, characterization tests. Classical composite lamination theory, cross and angle-play laminates, symmetric, anti symmetric and general symmetric laminates, mechanical coupling. Analysis of simple laminated structural elements ply-stress and strain, lamina failure theories-first fly failure, vibration and buckling analysis. Sandwich structure face and core materials, secondary failure modes environmental effects, manufacturing of composites.	8 hrs
ModuleII **Introduction to smart materials and structures-piezo electric materials**-coupled eletro mechanical constitutive relations-depoling and coercive field-field-strain relation-hysterics-creep-strain rate effects-manufacturing.	8 hrs
Module-III **Actuators and sensors**-single and dual actuators-pure extension, pure bending-bending extension relations-uniform strain beam model-symmetric induced strain actuators-bond shearing force- Bernoulli's-Euler (BE) beam models-embedded actuators- Asymmetric induced strain actuators in uniform strain and Euler-Bernoulli models. Uniform strain model energy principle formulation-BE model- single and dual surface bonded actuators-Extension-bending and torsion model.	10 hrs
Module-IV **Introductions to control systems**-open loop and close loop transfer functions-stability criteria- deflection control of beams like structures-using piezo electric sensors and actuators-shape memory alloy.	8 hrs

Module-V	8 hrs
Introduction to Nano structured materials, chemical and structural characterization. material behavior and technological implications to these materials.	

Course Outcomes: On completion of this course, students are able to:

CO		BL
CO1:	Classify Composite materials and its applications	C3
CO2:	Understand the application of smart materials in structural elements	C4
CO3:	Understand the behavior of Actuators and sensors	C4
CO4	Apply the knowledge of control systems in structural elements	C4
CO5	Understand the structural Characterization of nano material	C4

Questionpaperpattern:

11. Twoquestionsaretobesetfromeachmodule.
12. Totalfivequestionsaretobeansweredbyselectingminimumonequestionfromeac hmodule

Textbook:

Bhagwan D, Agaravalam&Lawrence J Brutman, " Analysis and Performance of Fiber Composites", John Wiley and Sons.

Robert M Jones, "Mechanic of Composite Materials", McGraw Hill Publishing Co.

Referencebooks:

1. Lecture notes on, "Smart Structures", by Inderjith Chopra, Department of AcrospaceEngg. University of Maryland

2. Crawley E &Anderson E. *Detailed Models of Piezocermic actuation of Beams". proceedings of the 30th AIAA/ASME/ASME/ASCE/AHS/ASC-Structural dynamics and Material conference, AIAA Washington DC. April 1989.

3. Crawley E &DeLuisJ, "Use of Piezoelectric actuators as elements of Intelligent Structures*. AIAA Journal, Vol. 25, No 10, Oct 1987. pp 1373-1385

OPTIMISATION METHODS IN ENGINEERING DESIGN

Subjectcode	24PSE244	Credit: 3
Hours/Week	42 Hrs	SEE:50Marks
Totalhours:	CIE:50Marks	SEE:3hours

Prerequisite:

Courseobjectives: Students will be able to

1. Understanding the basic concepts and definitions of optimization. Recognizing optimization problems in engineering and real-world applications.
2. Understanding the fundamental concepts and principles of linear programming (LP), Geometric interpretation of LP problems in terms of feasible regions and optimal solutions.
3. Applying non-linear programming techniques to structural optimization problems, Formulating and solving problems related to sizing, shape, and topology optimization. Considering practical constraints such as material properties, safety factors, and manufacturing limitations.
4. Understanding the principles and applications of geometric programming. Identifying posynomial and monomial structures within the NLP problem. Implementing conversion techniques and solving GP problems using computational methods.
5. Understanding the principles of course focusing on Dynamic Programming, the conversion of Non-linear Programming (NLP) as a sequence of Linear Programming (LP) or Dynamic Programming, and Structural Optimization techniques

Modules	Teaching Hours
ModuleI **Introduction**: Introduction to optimization, engineering applications of optimization, Formulation of structural optimization problems as programming problems. **Optimization Techniques**: Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimization solutions by penalty function techniques, Lagrange multipliers techniques and feasibility techniques.	8 hrs
ModuleII **Linear Programming**: Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, simplex algorithms, revised simpler methods, duality in linear programming.	8 hrs

Module-III **Non-linear programming:** Non-linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic and cubic methods, Unconstrained optimization methods, direct search methods, random search methods, descent methods, constrained optimization techniques such as direct methods, the complex methods, cutting plane method, exterior penalty function methods for structural engineering problems	10 hrs
Module-IV **Geometric programming**: Geometric' programming, conversion of NLP as a sequence of LP/geometric programming	8 hrs
Module-V **Dynamic programming**: Dynamic programming conversion of NLP as a sequence of LP/Dynamic programming. Structural Optimization: Formulation and solution of structural optimization problems by different techniques	8 hrs

Course Outcomes: On completion of this course, students are able to:

CO		**BL**
CO1:	Identify the real word objectives and constraints based on actual problem descriptions	C3
CO2:	Create mathematical optimization models	C4
CO3:	Work through proper solution techniques	C4
CO4	Make recommendations based on solutions analyses and limitations of models	C4
CO5	Search entire space of possibilities using Dynamic programming to define the optimum solution	C4

Question paper pattern:

1. Two questions are to be set from each module.
2. Total five questions are to be answered by selecting minimum one question from each module

Textbooks

Rao S.S,"Optimization– Theory and Practice", Wiley Eastern Ltd

Referencebooks:

Spunt, "Optimum Structural Design", Prentice Hall Uri Krisch, "Optimum StructuralDesign",McGraw-Hill Richard Bronson, "Operation Research", Schaum's Outline Series

PROPOSED SCHEME FOR III SEMESTER M.TECH.

POOJYA DODDAPPA APPA COLLEGE OF ENGINEERING, KALABURAGI
Scheme of Teaching and Examinations – 2024
M.Tech. STRUCTURAL ENGINEERING COURSE CIVIL ENGINEERING DEPARTMENT
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

IIISEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini–Project/ Internship	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PEC	24 PSE 31x	Professional Elective 3 (Online Courses)	03	00	00	03	50	50	100	3
2	PEC	24 PSE 32x	Professional Elective 4 (Online Courses)	03	00	00	03	50	50	100	3
3	INT	**24INT33**	Research Internship /Industry-Internship leading to project work/ Startup	Two-semester duration, SEE in the IV semester which leads to project work /start-up			03	100	---	100	4
4	PROJ	24PROJ34	Project Phase-I				03	100	---	100	2
TOTAL				**09**	**12**	**03**	**12**	**300**	**100**	**400**	**12**

Note: **PEC**: Professional Elective Courses, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities** (Hours are for Interaction between faculty and students). **INT**: Internship: Research Internship / Industry Internship Leading to the project work /start-up, **PROJ: Project Phase-I**: Problem statement out of undergone Internship (Industry /Research) report submission Only CIE.

PROPOSED SCHEME FOR IV SEMESTER M.TECH.

IV SEMESTER										
Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical /Field	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	INT	24INT41	Research Internship / Industry Internship Leading to Project Work/Start-up	Two Semester Duration		03	100	100	200	12
2	PROJ	24PRO42	Project Phase-II			03	100	100	200	12
TOTAL						**06**	**200**	**200**	**400**	**24**
INT: Industry/ Research Internship leading to the project work /startup**PROJ**: Project work outcome of Internship (Project Phase-II is Viva voce SEE)										

PROJECT WORK (24PROJ41): The objective of the Project work is

- To encourage independent learning and the innovative attitude of the students.
- To develop an interactive attitude, communication skills, organization, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire teamwork.
- To expand intellectual capacity, credibility, judgment, and intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instill responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involved in group discussions to present and exchange ideas.

CIE procedure for Project Work:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

Online Course: These are the MOOC courses that the relevant stream's Board of Studies has recommended; you can access them at www.online.vtu.ac.in. To qualify for those courses, the students must complete 12 to 16-week courses. The courses chosen have not to be the same as that of the coursesor subjects covered in the preceding semesters. Depending on the needs of the degree program, the BoS may recommend interdisciplinary courses. It is required to pass the course and qualify.