PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018
(AUTONOMOUS)
M.E. - STRUCTURAL ENGINEERING – PART TIME
REGULATIONS 2015
CURRICULUM

SEMESTER I

Course Code	Course Title	L	T	P	C
PMA15101	Advanced Mathematics	3	2	0	4
PSE15102	Structural Dynamics	3	2	0	4
PSE15103	Theory of Elasticity and Plasticity	3	2	0	4

SEMESTER II

Course Code	Course Title	L	T	P	C
PSE15201	Advanced Structural Steel Design	3	2	0	4
PSE15203	Design of Pre-stressed Concrete Structures	3	2	0	4
PSE15204	Finite Element Method	3	2	0	4

SEMESTER I

PMA15101 ADVANCED MATHEMATICS 3 2 0 4

COURSE OBJECTIVES

- To familiarize the students in the field of differential equations to solve boundary value problems using Laplace Transform.
- To familiarize the students in the field of differential equations to solve boundary value problems using Fourier Transform associated with engineering applications.
- Have seen simple optimal control problems and can understand them as a special case of general variational problems
- To expose the students to conformal mapping and their applications to obtain solutions for buckling, dynamic response, heat and flow problems of one and two dimensional conditions.
- Introduce students to the fundamentals of vector and tensor algebra; and expose students to mathematical applications of Engineering.

UNIT 1 LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 9 + 6

Laplace transform, Definitions, properties – Transform of some simple function, Transform of error function, Dirac Delta function, Unit Step functions – Convolution theorem – Inverse Laplace Transform: Complex inversion formula – Solutions to partial differential equations: Heat equation, Wave equation

UNIT 2 FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 9 + 6

Fourier transform: Definitions, properties – Transform of elementary functions, Dirac Delta function – Convolution theorem – Parseval's identity – Solutions to partial differential equations: Heat equation, Wave equation, Laplace and Poisson equations.

UNIT 3 CALCULUS OF VARIATIONS 9 + 6

Concept of variation and its properties – Euler's equation – Functional dependent on first and higher order derivatives – Functional's dependant on functions of several independent variables – Variational problems with moving boundaries – Problems with constraints – Direct methods – Ritz and Kantorovich methods.

UNIT 4 CONFORMAL MAPPING AND APPLICATIONS 9 + 6

Introduction to analytic functions – conformal mappings and bilinear transformations – Schwarz Christoffel transformation – Transformation of boundaries in parametric form – Physical applications : Fluid flow and heat flow problems.

UNIT 5 TENSOR ANALYSIS 9 + 6

Summation convention – Contravariant and covaraiant vectors – Contraction of tensors – Innerproduct – Quotient law – Metric tensor – Chrirstoffel symbols – Covariant differentiation – Gradient, divergence and curl.

TOTAL : 45 + 30 = 75 PERIODS

COURSE OUTCOMES

On completion of the course the students will enable to

- solve boundary value problems usingLaplace
- solve boundary value problems using Fourier transform techniques.
- they will also solve Fluid flow and heat flow problems using conformal mapping.
- understand Vector and tensor algebra and its applications in applied sciences and engineering.
- formulate variational problems and analyse them to deduce key properties of system behaviour.

REFERENCES

1. Larry C. Andrews, Bhimsen K. Shivamoggi, “Integral Transforms for Engineers”, SPIE Optical Engineering press, Washington USA (1999).
2. Gupta, A.S., “Calculus of Variations with Applications”, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
3. Ramaniah.G. “Tensor Analysis”, S.Viswanathan Pvt. Ltd., 1990.
4. Sankara Rao, K., “Introduction to Partial Differential Equations”, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
5. Spiegel, M.R., “Theory and Problems of Complex Variables and its Application (Schaum’s Outline Series)”, McGraw Hill Book Co., 1981.

WEB LINKS

1. http://www.nptel.ac.in/courses/111103021/
2. http://www.thefouriertransform.com/
3. http://www.lecture-notes.co.uk/susskind/classical-mechanics/lecture-2/calculus-of-variations/

PSE15102 **STRUCTURAL DYNAMICS** **3 2 0 4**

COURSE OBJECTIVES

- To understand the response of structural systems to time-varying dynamic loads and displacements.
- To apply the behaviour and response of linear and nonlinear two degree of freedom structures with various dynamic loading, analysis with viscous dampers.
- To study the behaviour and response of MDOF structures with various dynamic loading.
- To determine the behaviour of structures subjected to dynamic loads such as wind, earthquake and blast.
- To compute the different dynamic analysis procedures for calculating the response of structures.

UNIT 1 PRINCIPLES OF DYNAMICS 9 + 6

Vibration and its importance to structural engineering problems - Elements of vibratory systems and simple harmonic motion - Generalized mass - D'Alembert's principle - Mathematical modelling of dynamic systems - Degree of freedom - Equation of motion for S.D.O.F - Damped and undamped free vibrations - Undamped forced vibration - Critical damping - Response to harmonic excitation - Damped or undamped - Evaluation of damping - resonance - band width method to evaluate damping - Force transmitted to foundation - Vibration isolation.

UNIT 2 TWO DEGREE OF FREEDOM SYSTEMS ` 9 + 6

Equations of Motion of two degree of freedom systems - Damped and undamped free vibrations - Undamped forced vibration - Normal modes of vibration - Applications.

UNIT 3 DYNAMIC ANALYSIS OF MDOF 9 + 6

Multidegree of freedom system- undamped free vibrations - Orthogonality relationship - Approximate methods - Holzer - Rayleigh - Rayleigh-Ritz - mode superposition technique - Numerical integration procedure- Central Difference - Newmark's method.

UNIT 4 DYNAMIC ANALYSIS OF CONTINUOUS SYSTEMS 9 + 6

Free and forced vibration of continuous systems- axial vibration of a beam- Flexural vibration of a beam - Rayleigh - Ritz method - Formulation using Conservation of Energy - Formulation using Virtual Work.

UNIT 5 PRACTICAL APPLICATIONS 9 + 6

Idealisation and formulation of mathematical models for wind, earthquake, blast and impact loading - Principles of analysis - Linear and Non-linear.

TOTAL : 45 +30 = 75 PERIODS

COURSE OUTCOMES

At the end of this course the student will be able to

- understand the response of structural systems to dynamic loads and displacements.
- realize the behaviour and response of linear and non-linear SDOF and MDOF structures with various dynamic loading.
- determine the behaviour and response of MDOF structures with various dynamic loading.
- find suitable solution for continuous system.
- understand the behaviour of structures subjected to dynamic loads such as wind, earthquake and blast .

REFERENCES

1. Anil K.Chopra, "Dynamics of Structures", Pearson Education, 2009.
2. Mario Paz, Structural Dynamics, "Theory and Computation", Kluwer Academic Publication, 2004.
3. Craig.R.R, "Structural Dynamics - An Introduction to Computer methods", John Wiley & Sons, 1989.
4. Manickaselvam ,V.K., "Elementary Structural Dynamics", Dhanpat Rai & Sons, 2001.
5. Madhujit Mukhopadhyay - Structural Dynamics Vibrations and Systems, Ane Books India Publishers, 2010.

WEB LINKS

1. http://nptel.ac.in/courses/105101006/
2. http://freevideolectures.com/Course/3129/Structural-Dynamics#
3. http://onlinelibrary.wiley.com/journal/10.1002/%28ISSN%291096-9845/issues

PSE15103 THEORY OF ELASTICITY AND PLASTICITY 3 2 0 4

COURSE OBJECTIVES

- To study the classical theory of linear elasticity for two and three dimensional state of stress.
- To obtain solutions for elasticity problems in rectangular and polar coordinates as well as torsion of prismatic bars.
- To introduce the energy principles and energy method of solution of solid continuum mechanics.
- To gain knowledge on torsion of non-circular sections and thin walled sections.
- To understand the plastic stress strain relations, criteria of yielding and elasto- plastic problems.

UNIT 1 ELASTICITY 9 + 6

Analysis of stress and strain, equilibrium equations - Compatibility equations - Stress strain relationship - Generalized Hooke's law.

UNIT 2 FORMULATION AND SOLUTION OF ELASTICITY PROBLEMS 9 + 6

Methods of formulation of elasticity problems, methods of solution of elasticity problems, Plane stress and plane strain - Simple two dimensional problems in Cartesian and polar co-ordinates.

UNIT 3 ENERGY METHODS 9 + 6

Numerical and Energy methods - Castiglianos theorem - Principle of Virtual work - Principle of stationary potential energy - Principle of least work - Rayleigh's method - Rayleigh-Ritz method- Finite difference method - Simple applications.

UNIT 4 TORSION 9 + 6

Introduction, general solution of torsion problems, boundary conditions, stress function method - Torsion of non-circular sections, Prandtl's membrane analogy, Torsion of thin walled open and closed sections - Thin walled multiple cell closed sections.

UNIT 5 INTRODUCTION TO PLASTICITY 9 + 6

Physical assumptions - Criterion of yielding, plastic stress and strain relationship - Elastic plastic problems in bending - Torsion and thick cylinder.

TOTAL : 45 + 30 = 75 PERIODS

COURSE OUTCOMES

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

- understand the stresses and strains.
- determine the solution of elasticity problems.
- compute the beams and columns deformation using energy methods.
- analyse torsion of non-circular sections and thin walled sections.
- solve problems of plasticity.

REFERENCES

1. Timeshenko.S.P and Goodier.J.N, "Theory of Elasticity", McGraw Hill International Edition, 2010.
2. Sadhu Singh, "Theory of Plasticity", Khanna Publishers, 2005.
3. Hill.R, "Mathematical theory of Plasticity", Oxford Publishers 1998.
4. Sadhu Singh, "Theory of Elasticity and Metal Forming Processes", Khanna Publishers, 2005.
5. Chakrabarthy, "Theory of Plasticity", McGraw Hill Co., 2006.

WEB LINKS

1. https://www.vidyarthiplus.com/shop/theory-of-elasticity-and-plasticity-premium-lecture-notes-evangeline-edition.html
2. https://onderwijsaanbod.kuleuven.be/syllabi/v/e/H08W3AE.htm#activetab=doelstellingen_idp1232512
3. http://www.faadooengineers.com/threads/10108-Theory-of-elasticity-and-plasticity-full-notes-ebook-free-download-pdf

II SEMESTER

PSE15201 ADVANCED STRUCTURAL STEEL DESIGN 3 2 0 4

COURSE OBJECTIVES

- To study the concept of limit state design, working stress design and design philosophies of tension and compression members.
- To study various connections (welded and riveted), seated connections (Unstiffened and Stiffened connections) and to design them.
- To focus on the study and design of steel structures subjected to torsion.
- To study the plastic analysis of steel structures.
- To study the design concepts of light gauge steel structures.

UNIT 1 DESIGN METHODOLOGIES 9+6

Concept of design methodologies -Philosophies of Limit State Design, Working stress design, LRFD-TENSION MEMBERS: Introduction – net sectional area for concentrically and eccentrically loaded members – tension splices - bending of tension members – stress concentrations. COMPRESSION MEMBERS: Introduction – practical end conditions and effective length factors – elastic compression members – restrained compression members.

UNIT 2 DESIGN OF CONNECTIONS 9+6

Types of connections - Welded and riveted - Throat and root stresses in Fillet welds - Seated connections - Unstiffened and stiffened seated connections - Moment resistant connections - Clip angle connections - Split beam connections - Framed connections.

UNIT3 TORSION MEMBERS 9+6

Introduction – uniform torsion – non uniform torsion – torsion design – torsion and bending – distorsion.

UNIT 4 PLASTIC ANALYSIS OF STRUCTURES 9+6

Introduction - shape factor - Moment redistribution - combined mechanisms - analysis of portal frames - Effect of axial force - Effect of shear force on plastic moment - Connections - requirement – Momentresisting connections - Design of straight corner connections - Haunched connections - Design of continuous beams.

UNIT 5 DESIGN OF LIGHT GAUGE STEEL STRUCTURES 9+6

Cold formed light gauge section - Type of cross sections - stiffened - multiple stiffened and unstiffened element - flat width ratio - effective design width - Design of light gauge compression member - Effective width for load and deflection determination - Design of tension members - Design of flexural members - Shear lag - Flange curling.

TOTAL :45+30 = 75PERIODS

COURSE OUTCOMES

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

- design various tension and compression members.
- design different types of steel connections and joints.
- have an exposure to design steel structures subjected to torsion.
- design for plasticity.
- perform design of light gauge steel structures.

REFERENCES

1. Subramanian .N, " Design of Steel Structures", Oxford University Press, 2008.
2. Dayarathnam.P, "Design of Steel Structures", A.H.Wheeler, India, 2007.
3. John E. Lothers, " Design in structural steel", Prentice Hall of India, New Delhi 1990.
4. Lynn S. Beedle, "Plastic Design of Steel Frames", John Wiley and Sons, New York 1990.
5. Wie Wen Yu, "Design of Cold Formed Steel Structures" , Mc GrawHIll Book Company, New York, 2010.

CODE BOOKS

1. IS:800-2007 - Indian Standard Code of Practice for general construction in steel (Limit State).
2. IS:875 (Part I to V) - Code of Practice for Design loads.
3. IS:801-1975 - Code of practice for use of cold formed light gauge steel structural members in general building construction.
4. IS:811 -1987 - Cold formed light gauge structural steel sections.
5. IS:6533-1989 (Part I & II) - Code of Practice for Design and Construction of Steel Chimney.
6. IS:802-1977 - Code of Practice for use of structural steel in Overhead Transmission Line Towers.
7. SP:6 - Handbook on Structural Steel Section.

WEB LINKS

1. https://engineering.purdue.edu/~ahvarma/CE%20470/
2. http://www.learnerstv.com/Free-engineering-Video-lectures-ltv323-Page1.html
3. http://peer.berkeley.edu/~yang/courses/ce248/CE248_LN_Floor_vibrations.pdf

PSE15203 DESIGN OF PRE-STRESSED CONCRETE STRUCTURES 3 2 0 4

COURSE OBJECTIVES

- To analyse various systems of prestressing using basic principles.
- To design flexural members for shear, bond and torsion and end blocks.
- To analyse and design continuous beams using the concept of linear transformation and cable profile.
- To design the tension and compression members and evaluate their application in design of pipes, water tanks, piles and flag mast.
- To analyse and design composite section and prestressed concrete bridges.

UNIT 1 PRINCIPLES AND BEHAVIOUR OF PRESTRESSING 9+6

Principles of Prestressing - Types and systems of prestressing, need forhigh strength materials - Analysis methods, losses, deflection (short-longterm), camber, cable layouts.

UNIT 2 DESIGN OF FLEXURAL MEMBERS 9+6

Behaviour of flexural members - Determination of ultimate flexural strength - Codal provisions - Design of flexural members - Design for shear - bond and torsion - Design of end blocks.

UNIT 3 DESIGN OF CONTINUOUS BEAMS 9+6

Analysis and design of continuous beams - Methods of achieving continuity - Concept of linear transformations, concordant cable profile and gap cables

UNIT 4 DESIGN OF TENSION AND COMPRESSIONMEMBERS 9+6

Design of tension members - Application in the design of prestressed pipes and prestressed concrete cylindrical water tanks - Design of compression members with and without flexure - application in the design of piles, flag masts and similar structures.

UNIT 5 DESIGN OF PRESTRESSED CONCRETE BRIDGES 9+6

Composite Beams - Analysis and design - Composite sections - Ultimate strength - Application in prestressed concrete bridges - Design of pre- tensioned and post tensioned girder bridges - Partial prestressing - advantages and applications.

TOTAL : 45+30 = 75 PERIODS

COURSE OUTCOMES

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

- explain the principle, types and systems of prestressing and analyse the deflections.
- determine the flexural strength and design the flexural members, end blocks.
- analyse the statically indeterminate structures and design the continuous beam.
- design the tension and compression members and apply it for design of piles.
- analyse the stress, deflections, flexural and shear strength and apply it for the design of bridges.

REFERENCES

1. Krishna Raju, “Prestressed Concrete”, Tata McGraw Hill Publishing Co, 2007.
2. Sinha.N.C.and.Roy.S.K, “Fundamentals of Prestressed Concrete”,S.Chand and Co., 2011.
3. Lin.T.Y., “Design of Prestressed Concrete Structures”, John Wiley and Sons Inc,1981.
4. Evans, R.H. and Bennett, E.W., “Prestressed Concrete”, Champman and Hall, London, 1998.
5. Rajagopalan.N, “Prestressed Concrete”, Narosa Publications, New Delhi, 2008.

CODE BOOKS

1. IS456 - 2000 - IS Code of Practice for Plain and Reinforced Concrete.
2. IS1343 - 1980 - IS Code of Practice for Prestressed Concrete.
3. IS1678-1998-Specification for Prestressed Concrete Pole for verhead Power Traction and Telecommunication lines.
4. IRC:6-2010 Standard Specifications and Code of Practice for Road Bridges, Section II - Loads and Stresses (Fifth Revision).
5. IRC:18-2000 Design Criteria for Prestressed Concrete Road Bridges(Post-Tensioned Concrete) (3rd Revision).
6. IRS - Indian Railway Standard Specifications.
7. BS8110 - 1985 - Code of Practice for Design and Construction.
8. IS784 - 2001 - IS Specification for Prestressed Concrete Pipes.
9. IS3370 - 1999 - Part III - IS Code of Practice for Concrete Structures for the storage of liquids.
10. IS875 - 1987 - Part I - IV - IS Code of Practice for Design loads.

WEB LINKS

1. http://www.assakkaf.com/ence_454_lecture_notes.htm
2. http://faculty.delhi.edu/hultendc/AECT480-Lecture%2024.pdf
3. http://www.colincaprani.com/structural-engineering/courses/lecture-notes/

PSE15204 FINITE ELEMENT METHOD 3 2 0 4

COURSE OBJECTIVES

- To equip with the Finite Element Analysis fundamentals.
- To formulate the design problems into FEA.
- To perform engineering simulations using Finite Element Analysis software (ANSYS).
- To understand the ethical issues related to the utilization of FEA in the industry.
- To execute the CAD interfaces, joints and connections, non-linear behavior, optimization and analysis to code.

UNIT 1 FORMULATION OF BOUNDARY VALUES 9 + 6

Basic steps in finite element anlaysis - Boundary value problems – Approximate solutions – Variational and weighed residual methods – Ritz and Galerkin formulations – Concept of piecewise approximation and finite element – Displacement and shape functions – Weak formulation – Minimum potential energy – Generation of stiffness matrix and load vector.

UNIT 2 STRESS ANALYSIS 9 + 6

Two dimensional problems – Plane stress, plane strain and axisymmetric problems – Triangular and rectangular elements – Natural coordinates – Computation of stiffness matrix for isoparametric elements - Numerical integration (Gauss quadrature) - Brick elements - Elements for fracture analysis – Introduction to plate bending and shell elements

UNIT 3 MESHING AND SOLUTION 9 + 6

Higher order elements – P and H methods of mesh refinement – Ill conditioned elements – Discretisation errors – Auto and adaptive mesh generation techniques - Error evaluation

UNIT 4 DYNAMIC ANALYSIS 9 + 6

Introduction – Vibrational problems – Equations of motion based on weak form – Longitudinal vibration of bars – Transverse vibration of beams – Consistent mass matrices – Element equations – Solution of eigenvalue problems – Vector iteration methods – Normal modes – Transient vibrations – Modeling of damping – Direct integration methods

UNIT 5 PLATE AND SHELL ELEMENTS 9 + 6

Formation of stiffness matrix for plate bending elements of triangular and quadrilateral elements - Concept of four node and eight node isoparametric elements - cylindrical thin shell elements.

TOTAL : 45 + 30 = 75 PERIODS

COURSE OUTCOMES

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

- develop finite element formulations of 1 degree of freedom problems and solve them
- use finite element analysis programs based upon either "p-method" or "h-method" finite element mathematical formulations
- use ansys software to perform stress, thermal and modal analysis
- compute the stiffness values of noded elements.
- perform modal analysis to determine its natural frequencies, and analyze harmonically-forced vibrations.

REFERENCES

1. S. S. Bhavikatti, "Finite Element Analysis", New Age Publishers,2007.
2. C. S. Krishnamoorthy, "Finite Element Analysis: Theory and Programming", Tata McGraw-Hill, 2008.
3. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", McGraw - Hill, 2005.
4. Chandrupatla, R.T. and Belegundu, A.D., "Introduction to Finite Elements in Engineering", Prentice Hall of India, 2011.
5. Moaveni, S., "Finite Element Analysis Theory and Application with ANSYS", Prentice Hall Inc., 2003.

WEB LINKS

1. http://www.colorado.edu/engineering/CAS/courses.d/IFEM.d/Home.html
2. http://nptel.ac.in/courses/112104115/
3. http://freevideolectures.com/Course/2357/Finite-Element-Method