PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

(AUTONOMOUS)

M.E. STRUCTURAL ENGINEERING (PART TIME)

REGULATIONS 2016

CURRICULUM

(CHOICE BASED CREDIT SYSTEM)

SEMESTER I

Course Code	Course Title	L	T	P	C
PMA16101	Advanced Mathematical methods	3	2	0	4
PSE16101	Structural Dynamics	3	2	0	4
PSE16102	Theory of Elasticity and Plasticity	3	2	0	4

SEMESTER II

Course Code	Course Title	L	T	P	C
PSE16201	Advanced Structural Steel Design	3	2	0	4
PSE16202	Aseismic Analysis and Designof Structures	3	2	0	4
PSE16203	Design of Pre-stressed Concrete Structures	3	2	0	4

SEMESTER I

PMA16101 ADVANCED MATHEMATICAL METHODS 3 2 0 4

COURSE OBJECTIVES

- To analyze the treatment involved in solving differential equations by means of Laplace transformation.
- To study the significance of the distribution of heat, signals and frequency.
- To familiarize with single and multi-dimensional problems of variation calculus
- To discuss about the suitable transformation of a function in a particular plane to another plane.
- To expose the mathematical applications of vectors and tensor analysis to handle diverse problems.

UNIT I LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 15

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 II FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 15

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 III CALCULUS OF VARIATIONS 15

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

UNIT IV CONFORMAL MAPPING AND APPLICATIONS 15

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 V TENSOR ANALYSIS 15

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

TOTAL : 75 PERIODS

COURSE OUTCOME

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

- solve the differential equations using Laplace Transform by applying its boundary conditions
- gain knowledge in Fourier transform techniques in distribution of heat and signal processing.
- understand the concepts of solving a variational problem using the Euler equation.
- solve fluid flow and heat flow problems using conformal mapping.
- apply the physical applications and simplifications of tensors.

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. James, G., "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2004.
4. Ramaniah.G. "Tensor Analysis", S.Viswanathan Pvt. Ltd., 1990.
5. SankaraRao, K., "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
6. Spiegel, M.R., "Theory and Problems of Complex Variables and its Application (Schaum's Outline Series)", McGraw Hill Book Co., 1981.
7. Lev D. Elsgolc., "Calculus of Variations" , Courier Corporation, 2012.
8. E. B. Saff, Arthur David Snider., "Fundamentals of Complex Analysis with Applications to Engineering and Science" , Prentice Hall, 2003.

WEB LINKS

1. https://www.youtube.com/watch?v=DPg5T-BQjU&list=PL4rxxS6x1HEYp6fYlYHnFZ2AqylTqVmAE
2. https://www.youtube.com/watch?v=Vg-EjShqy3M
3. https://www.youtube.com/watch?v=GiPOQC5nYMs&list=PL521C2DFD15FF568C
4. https://www.youtube.com/watch?v=DxD2Vx39YH8
5. https://www.youtube.com/watch?v=Hiaoe7USQd4

PSE16101 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 I PRINCIPLES OF DYNAMICS 15

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 II TWO DEGREE OF FREEDOM SYSTEMS ` 15

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

UNIT III DYNAMIC ANALYSIS OF MDOF 15

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 IV DYNAMIC ANALYSIS OF CONTINUOUS SYSTEMS 15

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 V PRACTICAL APPLICATIONS 15

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

TOTAL : 75 PERIODS

COURSE OUTCOMES

At the end of this course, the students 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”, DhanpatRai& Sons, 2001.
5. MadhujitMukhopadhyay - 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

PSE16102 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 I ELASTICITY 15

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

UNIT II FORMULATION AND SOLUTION OF ELASTICITY PROBLEMS 15

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 III ENERGY METHODS 15

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 IV TORSION 15

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 V INTRODUCTION TO PLASTICITY 15

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

TOTAL : 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

SEMESTER II

PSE16201 ADVANCED STRUCTURAL STEEL DESIGN 3 2 0 4

COURSE OBJECTIVES

- To understand the concepts of limit state design, working stress design and design philosophies of tension and compression members.
- To study the 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 design concepts of light gauge steel structures.

UNIT I DESIGN METHODOLOGIES 15

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 II DESIGN OF CONNECTIONS 15

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.

UNITIII TORSION MEMBERS 15

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

UNIT IV PLASTIC ANALYSIS OF STRUCTURES 15

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 V DESIGN OF LIGHT GAUGE STEEL STRUCTURES 15

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 : 75 PERIODS

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.
- design steel structures subjected to torsion.
- design for plasticity.
- design 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" ,McGrawHIll 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

PSE16202 ASEISMIC ANALYSIS AND DESIGN OF STRUCTURES 3 2 0 4

COURSE OBJECTIVES

- To understand the concepts of engineering seismology
- To analyse building for earthquake forces and introduce design concepts
- To explain the design guidelines for earthquake resistant masonry and earthen buildings
- To analyse rigid frames and shear wall for earthquake loading
- To gain knowledge on vibration control techniques

UNIT I EARTHQUAKE GROUND MOTION 15

Engineering Seismology - elastic rebound theory - plate tectonic theory - Seismic waves - earthquake size - measurement of earthquakes - strong ground motions - Tsunami - Seismic zoning map of India Information on some disastrous earthquakes.

UNIT II EARTHQUAKE ANALYSIS AND DESIGN CONCEPTS 15

Response spectra - introduction to methods of seismic analysis - Equivalent static analysis IS 1893 provisions - Response spectrum method - Time history method - Push over analysis - Mathematical modeling of multi-storey RC Building - Design methodology - Architectural consideration - geotechnical consideration - structural design consideration - Capacity design - Techniques of aseismic design.

UNIT III EARTHQUAKE DESIGN OF MASONRY BUILDINGS 15

Guidelines for earthquake resistant earthen buildings and masonry buildings - Design considerations.

UNIT IV EARTHQUAKE DESIGN OF RC STRUCTURES 15

Earthquake resistant design of RCC. Buildings - Material properties - Lateral load analysis - Design and detailing - Rigid frames - Shear wall - Coupled shear wall.

UNIT V SPECIAL TOPICS 15

Liquefaction, vibration control - Tuned mass dampers - Principles and application, Basic concept of seismic base Isolation - Various systems- Case studies

TOTAL :75 PERIODS

COURSE OUTCOMES

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

- describe ground motion and its relationship to seismic design of structures.
- calculate earthquake induced lateral force on the structure.
- include earthquake resistant features in masonry buildings.
- apply the basic principles of conceptual design for earthquake resistant RC buildings and carry out the detailed design of earthquake resistant RC buildings.
- adopt vibration control methods for buildings located in earthquake zone.

REFERENCES

1. Chopra A K, “Dynamics of Structures - Theory and Applications to Earthquake Engineering”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
2. PankajAgarwal and Manish Shrikhande, “Earthquake Resistant Design of Structures, Prentice”, Hall of India Pvt. Ltd., New Delhi, 2006.
3. Taranath B S, “Wind and Earthquake Resistant Buildings - Structural Analysis & Design”, Marcell Decker, NewYork, 2005.
4. Chen WF &Scawthorn, “Earthquake Engineering Hand book”, CRC Press, 2003.
5. S.K.Duggal, “Earthquake Resistant Design of Structures”, Oxford University Press, 2007

CODE BOOKS

1. IS:13920-1993 - Ductile detailing of reinforced concrete structures subjected to seismic forces - Code of Practice.
2. IS:1893 (Part I) - 2002 - Indian Standard Criteria for Earthquake Design of Structures - General Provisions and Buildings.
3. IS:4326 - 1993 - Earthquake Resistant Design and Construction of Buildings - Code of Practice.
4. IS:13827-1993 - Improving Earthquake Resistance of Earthen Buildings - Guidelines.
5. IS:13828 - 1993 - Improving Earthquake Resistance of Low Strength Masonry Buildings -- Guidelines.

WEB LINKS

1. http://www.tylin.com/en/services/seismic_analysis_retrofit_and_design
2. http://www.trb.org/Main/Blurbs/160387.aspx
3. http://www.sciencedirect.com/science/article/pii/S0886779801000517

PSE16203 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 I PRINCIPLES AND BEHAVIOUR OF PRESTRESSING 15

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

UNIT II DESIGN OF FLEXURAL MEMBERS 15

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 III DESIGN OF CONTINUOUS BEAMS 15

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

UNIT IV DESIGN OF TENSION AND COMPRESSIONMEMBERS 15

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 V DESIGN OF PRESTRESSED CONCRETE BRIDGES 15

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 : 75 PERIODS

COURSE OUTCOMES

At the end of this 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/