Course Structure

Master of Technology

Structural Engineering (SE)

I YEAR – I SEMESTER

S No.	COURCE CODE	SUBJECT	L	T	P/ Drg	C
1	18CE1001	Advanced Structural Analysis	3	-	-	3
2	18CE1002	Advanced Solid Mechanics	3	-	-	3
3	**Professional Elective Course (PEC) – I**		3	-	-	3
	18CE1008	Theory of Thin Plates and Shells				
	18CE1009	Theory and Applications of Cement Composites				
	18CE1010	Theory of Structural Stability				
4	**Professional Elective Course (PEC) – II**		3	-	-	3
	18HS0837	Analytical and Numerical Methods for Structural Engineering				
	18CE1011	Structural Health Monitoring				
	18CE1012	Structural Optimization				
5	18CE1003	Structural Design Lab	-	-	4	2
6	18CE1004	Advanced Concrete Lab	-	-	4	2
7	18HS0823	Research Methodology and IPR	2	-	-	2
8	18HS0818	English for Research Paper Writing	2	-	-	-
Contact periods / week			16	-	8	**18**
			Total/Week		**24**	

I YEAR – II SEMESTER

S No.	COURCE CODE	SUBJECT	L	T	P/ Drg	C
1	18CE1005	FEM in Structural Engineering	3	-	-	3
2	18CE1006	Structural Dynamics	3	-	-	3
3	**Professional Elective Course (PEC) – III**		3	-	-	3
	18CE1013	Advanced Steel Design				
	18CE1014	Design of Formwork				
	18CE1015	Design of High Rise Structures				
	18CE1016	Design of Masonry Structures				
4	**Professional Elective Course (PEC) – IV**		3	-	-	3
	18CE1017	Design of Advanced Concrete Structures				
	18CE1018	Advanced Design of Foundations				
	18CE1019	Soil Structure Interaction				
	18CE1020	Design of Industrial Structure				
5	18CE1007	Model Testing Lab	-	-	4	2
6	18HS0838	Numerical Analysis Lab	-	-	4	2
7	18CE1025	Mini Project	-	-	4	2
8	18HS0819	Personality Development Through Life Enlightenment Skills	2	-	-	-
Contact periods / week			14	-	12	**18**
			Total/Week		**26**	

II YEAR – I SEMESTER

S No.	COURCE CODE	SUBJECT	L	T	P/ Drg	C
1	**Professional Elective Course (PEC) – V**		3	-	-	3
	18CE1021	Design of Prestressed Concrete Structures				
	18CE1022	Analysis of Laminated Composite Plates				
	18CE1023	Fracture Mechanics of Concrete Structures				
	18CE1024	Design of Plates and Shells				
2	**Open Elective Course – I**		3	-	-	3
	18HS0824	Business Analytics				
	18ME3121	Industrial Safety				
	18ME3122	Advances in Operations Research				
	18CE1028	Cost Management of Engineering Projects				
	18ME3123	Composite Materials				
	18EE2128	Waste to Energy				
3	18CE1026	Dissertation Phase – I	-	-	20	10
Contact Periods / Week			6	-	20	**16**
			Total/Week **26**			

II YEAR – II SEMESTER

S No.	COURCE CODE	SUBJECT	L	T	P/ Drg	C
1	18CE1027	Dissertation Phase – II	-	-	32	16
Contact Periods / Week			**-**	**-**	32	**16**
			Total/Week **32**			

Note:

- L – Lecture hour; T – Tutorial; Drg – Drawing; P Practical; C – Credits.
- Total No of Credits is 18+18+16+16=68

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	3	**-**	**-**	**3**

(18CE1001) ADVANCED STRUCTURAL ANALYSIS

Course Objectives

- *Student shall learn analysis of continuous beam, portal frames, pin jointed structures by Flexibility and Stiffness matrix methods.*
- *Formation of global Stiffness matrix from local Stiffness matrix and equation solving Techniques.*

Course Outcomes:

After completion of this course, the student shall understand

- *Analysis of continuous beam by stiffness & flexibility matrix methods*
- *Analysis of Rigid Jointed frames by Stiffness & flexibility matrix methods*
- *Analysis of Pin Jointed Structures by Stiffness & Flexibility matrix methods*
- *Formation global & element stiffness matrix, direct stiffness method*
- *Equation solution Techniques*

UNIT-I

Indeterminacy: Determination of static and kinematic indeterminacies of two, dimensional and three-dimensional portal frames, Pin-jointed trusses and hybrid frames, Coordinate systems, Structural idealization.

UNIT-II

Introduction to Matrix Methods of Analysis: Flexibility and stiffness matrices, Force displacement relationships for axial force, couple, torsional moments, Stiffness method of analysis and flexibility method of analysis.

UNIT-III

Analysis of Continuous Beams: Stiffness method and flexibility method of analysis, Continuous beams of two and three spans with different end conditions.

Analysis of Two-Dimensional Pin Jointed Trusses: Stiffness and flexibility methods, Computation of joint displacement and member forces.

UNIT-IV

Analysis of Two - Dimensional Portal Frames: Stiffness and flexibility method of analysis of 2-D portal frames with different end conditions - Plotting of bending moment diagrams.

UNIT-V

Solution Techniques: Solution of system of linear algebraic equations, direct inversion method, Gauss elimination method, Cholesky method, Banded equation solvers, Frontal solution technique.

Text Books:

1. Basic Structural Analysis, C. S. Reddy, 3rd edition, Tata McGraw-Hill Education Private Limited, New Delhi.
2. Structural Analysis (A Matrix Approach), 2nd edition, G.S. Pandit, S.P. Gupta, Tata McGraw-Hill Education Private Limited, New Delhi.

References Books:

1. Structural Analysis, 3rd edition, R.C. Coates, M.G. Coutie, F.K. Kong, Van Nostrand Reinhold publishers.
2. Matrix Structural Analysis, 2nd edition, William McGuire, Richard H. Gallagher, Ronald D. Ziemian, Create Space Independent Publishing Platform.
3. Matrix Structural Analysis, John L Meek, Tata McGraw-Hill Education Private Limited, New Delhi.

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	3	**-**	**-**	**3**

(18CE1002) ADVANCED SOLID MECHANICS

Course Objectives:

- *Student shall learn about plane stress and plane strain analysis*
- *Analysis of Stress and strain in three dimensions and torsion of Prismatic bars*

Course Outcomes:

After completion of this course, the student shall understand

- *Two-dimensional analysis of stress and strain*
- *Three-dimensional analysis of stress and strain*

UNIT-I

Introduction: Elasticity, Notation for forces and stresses, Components of stress, Components of strain, Hooke's law.

Plane Stress and Plane Strain Analysis: Plane stress, plane strain, Differential equations of equilibrium, Boundary conditions, Compatibility equations, Stress function.

UNIT-II

Two Dimensional Problems in Rectangular Coordinates: Solution by polynomials, Saint Venant's principle, Determination of displacements, Bending of simple beams, Application of Fourier series for two dimensional problems, Gravity loading.

UNIT-III

Two Dimensional Problems in Polar Coordinates: General Equation in polar co-ordinates, Stress distribution symmetrical about an axis, Pure bending of curved bars, Strain components in polar coordinates, Displacements for symmetrical stress distributions, Simple problems.

UNIT-IV

Analysis of Stress and Strain in Three Dimensions: Introduction, Principal stresses, Stress ellipsoid and stress-director surface, Determination of the principal stresses, Determination of the maximum shearing stress, Homogeneous deformation, Principal axes of strain, Rotation, Differential equations of equilibrium, Conditions of compatibility, Determination of displacements, Equations of equilibrium in terms of displacements.

UNIT-V

Torsion of Prismatic Bars: Torsion of prismatic bars – Elliptical cross section – Other elementary solutions – Membrane analogy – Torsion of rectangular bars.

Text Books:

1. Theory of Elasticity, S.P. Timoshenko, G.N. Goodier, Tata McGraw-Hill Education Private Limited, New Delhi.
2. Theory of Elasticity and Plasticity, Dr. Sadhu Singh, 4th edition, Khanna Publications.

References Books:

1. Mechanics of materials, 2nd edition, E. P. Popov, Prentice Hall publications.
2. Elasticity Theory, Applications and Numeric, 3rd edition, Martin H. Sadd, Elsevier publications, Academic Press, India.
3. Introduction to Theory of Elasticity, R.J. Atkin, N. Fox, Reprint of the Longman Group Ltd., London, 1980 edition.

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PROFESSIONAL ELECTIVE COURSE (PEC) – I
(18CE1008) THEORY OF THIN PLATES AND SHELLS

Course Objectives:

This subject is taught to impart knowledge about the behaviour of plates and shells.

Course Outcomes:

After completion of this course, the student shall be able to

- *Analyze the plates using Navier's and Levy's method*
- *Analyze the circular, rectangular and square plates by finite difference method*
- *Design the curved shells and roofs*
- *Design the various folded plate structures*

UNIT-I:

Bending of Long Rectangular Plates to a Cylindrical Surface Differential equation for cylindrical bending of plates – Uniformly loaded rectangular plates with simple supported edges and with built in edges.

UNIT-II:

Pure bending of plates: Slopes – Curvatures of bent plates – Relations between bending moments and curvature – Particular cases – Strain energy in pure bending – Limitations. Symmetrical bending of circular plates: Differential equation – Boundary conditions.

UNIT-III:

Simply supported rectangular plates under sinusoidal loading: Naviers solution and its application to concentrated load – Levy's solution for uniformly distributed load or hydrostatic pressure.

UNIT-IV

Introduction to Shells: Parametric representation of a surface; The first quadratic form; Equation to the normal of a surface; The second quadratic form; Principal curvatures, Gauss curvature, and lines of curvature; Some definitions; Classification of shell surfaces.

UNIT-V

Cylindrical shells: Membrane theory of cylindrical shells; Bending theory of cylindrical shells loaded Symmetrically –Approximate solution by Schorer's method, Beam method of analysis

Text Books:

1. Theory of Plates and Shells, 2nd edition, S. Timoshenko, S. Woinowsk Tata Mc Graw-Hill Publishing Company Limited, New Delhi.
2. Stresses in plates and shells by A.C. Ugural, McGraw-Hill, 1999.
3. "Stresses in Shells" by Flugge. Blaisdell Publishing Co, 1966

References Books:

1. Design and construction of concrete shell roofs, 1st edition, G.S. Ramaswamy, CBS Publishers and distributors
2. Theory and Design of Concrete Shells, Chatterjee, Binoy Kumar, Oxford and IBNew Delhi.
3. Analysis of Thin concrete Shells, K. Chandrasekhara, Oxford and IBH, Kolkata, 1971.
4. Analysis of plates by T.K. Varadan and K. Bhaskar, Narosa Publishing House, 1999.

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PROFESSIONAL ELECTIVE COURSE (PEC) – I

(18CE1009) THEORY AND APPLICATIONS OF CEMENT COMPOSITES

Course Objectives:

This subject is taught to impart knowledge about the applications of cement composite

Course Outcomes:

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

- *Formulate constitutive behaviour of composite materials – Ferrocement, SIFCON and Fibre Reinforced Concrete*
- *Mechanical properties of cement composites*
- *Admixtures and special uses of cements.*
- *X-ray diffraction and SEM analysis of materials.*

UNIT-I

Cement Composites: Types of Cement Composites, Terminology, Constituent Materials and their Properties, Construction Techniques for Fibre Reinforced Concrete - Ferro cement, SIFCON, Polymer Concretes, Preparation of Reinforcement, Casting and Curing.

UNIT-II

Mechanical Properties of Cement Composites: Behavior of Ferro cement, Fiber Reinforced Concrete in Tension, Compression, Flexure, Shear, Fatigue and Impact, Durability and Corrosion.

UNIT-III

Analysis and Design of Cement Composite Structural Elements: Ferro cement, SIFCON and Fibre Reinforced Concrete.

UNIT-IV

Admixtures and Special Uses of Cements: Organic retarders and accelerators, Air-entraining agents and grinding aids, water reduces and super plastic very high strength cement-based materials

UNIT-V

X-Ray Diffraction and Sem Analysis of Materials: Fundamental principles of X-ray Diffraction and SEM analysis. X-ray Diffraction of cement, composite and other admixture waste materials.

Text Books:

1. Mechanics of Composite Materials, Jones R. M 2nd Ed., Taylor and Francis, BSP Books, 1998. Ferro cement – Theory and Applications, Pama R. P., IFIC, 1980.
2. New Concrete Materials, Swamy R.N., 1st Ed., Blackie, Academic and Professional, Chapman & Hall, 1983.
3. Taylor, H.F.W (1997). Cement Chemistry, Thomas telford, 2nd Edition, New York.

Reference Books

1. Natural Resources Canada and Forintek Canada Corp., Building Materials in the context of sustainable Development, Summary report and research guidelines *(Ottawa: Forintek Canada Corp., 1994)
2. M.R. Rixom, Chemical Admixtures for concrete (New York: E&F.N. Spon., 1986).
3. H.P. Klug and L.E. Alexander, X-ray diffraction Procedures for Polycrystalline Abd Amorphous Materials, John Wiley, New York (1974).

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PROFESSIONAL ELECTIVE COURSE (PEC) – I
(18CE1010) THEORY OF STRUCTURAL STABILITY

Course objectives:

Student shall learn about

- *Beam columns with different loads, elastic and inelastic buckling of bars, mathematical treatment of stability problems, torsional buckling of thin walled bars*
- *Lateral buckling of rectangular cross-sectional beams and buckling of rectangular plates.*

Course Outcomes:

The student shall be able to,

- *Analyze elastic and inelastic buckling of bars*
- *Understand the various numerical methods for treatment of stability problems and buckling of rectangular cross-sectional beams and plates*

UNIT-I

Beam Columns: Differential equation for beam columns, Beam column with concentrated loads, Continuous lateral load, Couples, Beam column with built in ends, Continuous beams with axial load.

UNIT-II

Elastic Buckling of Bars: Elastic buckling of straight columns, Effect of shear stress on buckling, Eccentrically and laterally loaded columns, buckling of a bar on elastic foundation, buckling of bar with intermediate compressive forces and distributed axial loads, buckling of bars with change in cross section, Effect of shear force on critical Load-Built up columns.

UNIT-III

Inelastic Buckling: Buckling of straight bars, double modulus theory and Tangent modulus theory.

Mathematical Treatment of Stability Problems: Buckling problem, Orthogonality Relation-Ritz method, Timoshenko method and Galerkin's method.

UNIT-IV

Torsional Buckling: Pure torsion of thin walled bar of open cross section, Non-uniform torsion of thin walled bars of open cross section, Torsional buckling, Buckling by Torsion and Flexure.

UNIT-V

Lateral Buckling of Simply Supported Beams: Beams of rectangular cross section subjected to pure bending.

Buckling of Simply Supported Rectangular Plates: Derivation of equation of plate subjected to constant compression in two directions and one direction.

Text Books:

1. Theory of Elastic Stability, 2nd edition, Stephen P. Timoshenko & James M. Gere, Dover Publications.
2. Principles of Structural Stability Theory (Prentice-Hall Civil Engineering and Engineering Mechanic Series), Alexander Chajes, Prentice Hall Publications, 1974.

References Books:

1. Structural Stability Theory and Implementation, Reprint Edition of 1987, Wai-Fan Chen, E.M. Lui, PTI Prentice Hall Private Limited.
2. Theory of Beam Columns, Vol I&II, 2nd edition, Atsuta, Chen W.F., Tata McGraw-Hill Education Private Limited, New Delhi.
3. Introduction to the Elastic Stability of Structures (Prentice-Hall Civil Engineering and Engineering Mechanic Series), 1st edition, Smites, George, Prentice Hall Publishers.
4. Guide to Stability Design Criteria for Metallic Structures, 6th edition, Ronald D. Ziemian, Wiley Publications

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PROFESSIONAL ELECTIVE COURSE (PEC) – II

(18HS0837) ANALYTICAL AND NUMERICAL METHODS FOR STRUCTURAL ENGINEERING

Course Objectives:

- *To train the students thoroughly in Mathematical concepts of Interpolation, Curve fitting, Numerical Differentiation and Integration and their applications*
- *To prepare students for lifelong learning and successful careers using mathematical concepts of Interpolation, Curve fitting, Numerical solution of ordinary differential equations and their applications*
- *To develop the skill pertinent to the practice of the mathematical concepts including the students' abilities to formulate and modeling the problems, to think creatively and to synthesize information*

Course Outcomes:

At the end of the course, students would be expected to:

- *Have acquired ability to participate effectively in group discussions*
- *Have developed ability in writing in various contexts*
- *Have acquired a proper level of competence for employability*
- *Have acquired computational skills to solve real world problems in engineering*

UNIT-I

Introduction to Numerical Methods: Why study numerical methods. Sources of error in numerical solutions: truncation error, round off error. Order of accuracy - Taylor series expansion

Direct Solution of Linear systems: Gauss elimination, Gauss Jordan elimination. Pivoting, inaccuracies due to pivoting. Factorization, Cholesky decomposition. Diagonal dominance, condition number, ill conditioned matrices, singularity and singular value decomposition. Banded matrices, storage schemes for banded matrices, skyline solver.

UNIT-II

Iterative solution of Linear systems: Jacobi iteration. Gauss Seidel iteration. Convergence criteria.

Direct Solution of Non-Linear systems: Newton Raphson iterations to find roots of a 1D nonlinear equation. Generalization to multiple dimensions. Newton Iterations, Quasi Newton iterations. Local and global minimum, rates of convergence, convergence criteria.

UNIT-III

Partial Differential Equations: Introduction to partial differential equations. Definitions & classifications of first and second order equations. Examples of analytical solutions. Method of characteristics.

Numerical Differentiation:

Difference operators (forward, backward and central difference). Stability and accuracy of solutions. Application of finite difference operators to solve initial and boundary value problems.

UNIT -IV

Introduction to the Finite Element Method as a method to solve partial differential equations: Strong form of the differential equation. Weak form. Galerkin method: the finite element approximation. Interpolation functions: smoothness, continuity, completeness, Lagrange polynomials. Numerical quadrature: Trapezoidal rule, Simpsons rule, Gauss quadrature**.**

UNIT - V

Numerical integration of time dependent partial differential equations:

Parabolic equations: algorithms - stability, consistency and convergence, Lax equivalence theorem. Hyperbolic equations: algorithms - Newmark's method, stability and accuracy, convergence, multistep methods. Types of integral equations. Fredholm integral equations of the first and second kind. Fredholm's Alternative theorem. Collocation and Galerkin methods for solving integral equations.

Text books:

1. Higher Engineering Mathematics, B.S. Grewal, Khanna publishers.
2. Advanced Engineering Mathematics, Peter V.O' Neil, CENGAGE publisher.
3. Concepts and Applications of Finite Element Analysis, 4th edition, Robert D. Cook, John Wiley and sons Inc., New York.

Reference Books:

1. An Introduction to Numerical Analysis, Atkinson K.E., J. Wiley and Sons, 1989.
2. Theory and Problems of Numerical Analysis, Scheid F, McGraw Hill Book Company, (Shaum Series), 1988.
3. Introductory Methods of Numerical Analysis, Sastry S. S, Prentice Hall of India, 1998.

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	3	**-**	**-**	**3**

PROFESSIONAL ELECTIVE COURSE (PEC) – II
(18CE1011) STRUCTURAL HEALTH MONITORING

Course Objectives:

- *This subject is taught to impart knowledge about the Structural Health Monitoring Concepts.*

Course Outcomes:

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

- *Acquire the fundamental knowledge on structural health monitoring and analyse smart materials*
- *Understand the Structural Health Monitoring Applications in civil engineering structures and techniques for health monitoring.*
- *Assess the different Non-Destructive Testing Methods.*
- *Assess the health of structure using Durability tests.*
- *Suggest repairs and rehabilitation measures of the structure*

UNIT-I

Introduction to Structural Health Monitoring: Definition of Structural Health Monitoring (SHM) – Principle and Organization of a SHM System – SHM versus NDE – Advantages of SHM – Active and Passive Smart Materials – SHM Technologies – Piezoelectric Sensors – Magneto strictive Sensors – Optical Fibre Sensors – Dynamic Response Analysis using Laser Doppler Vibrometer – Challenges in Implementation of SHM

UNIT-II

Applications of SHM In Civil Engineering: Applications of SHM in Bridge Structures – Concrete Structures – Applications for External Post tensioned cables

Vibration of Plates: Elasticity Equations for Plate Vibration – Axial Vibration of Rectangular Plates – Axial Vibration of Circular Plates – Flexural Vibration of Rectangular Plates – Flexural Vibration of Circular Plates

UNIT-III

Non-Destructive Testing of Concrete Structures: Introduction to NDT – Importance and Need of Non-Destructive Testing – Basic Methods for NDT of Concrete Structures – Testing of Concrete – Quality Control Tests – Partial Destructive Tests – Fundamental Principle – Equipment – General Procedure - Visual Inspection Test- Schmidt Rebound Hammer Test

UNIT-IV

Durability Tests: Fundamental principle – Equipment – General Procedure – Half- Cell Electrical potential methods – Permeability Test – Resistivity measurement – Electromagnetic methods of Testing Concrete – Radiographic Testing – Ultrasonic Pulse Velocity Test

UNIT-V

Introduction to Repairs and Rehabilitations of Structures: Repair of Structure – Common Types of Repairs – Repair in Concrete Structures – Repairs in Under Water Structures – Guniting – Shot Create – Underpinning. Strengthening of Structures – Strengthening Methods – Retrofitting – Jacketing.

Textbooks:

1. Structural Health Monitoring, Daniel Balageas, Claus Peter Fritzen, Alfredo Güemes, John Wiley and Sons, 2006.
2. Structural Health Monitoring with Wafer Active Sensors, Victor Giurglutiu, Academic Press Inc, 2007.
3. Guide Book on Non-destructive Testing of Concrete Structures, Training course series No.17, International Atomic Energy Agency, Vienna, 2002
4. Maintenance and Repair of Civil Structures, B.L. Gupta and Amit Gupta, Standard Publications.

References Books:

1. Health Monitoring of Structural Materials and Components Methods with Applications, Douglas E Adams, John Wiley and Sons, 2007.
2. *Structural Health Monitoring of Civil Infrastructure System*, Vistasp M. Karbhari and Farhad Ansari, Wood Head Publishing Limited, Cambridge, 2009.
3. Non-Destructive Evaluation of Concrete Structures by Bungey - Surrey University Press

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PROFESSIONAL ELECTIVE COURSE (PEC) – II
(18CE1012) STRUCTURAL OPTIMIZATION

Course Objectives:

This subject is taught to impart knowledge about the structural optimization

Course Outcomes:

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

- *Acquire the fundamental knowledge on Optimization Techniques*
- *Understanding the principle of Calculus for optimization*
- *Understanding Linear Programming Techniques*
- *Apply Linear Programming techniques to Plastic design of Frames.*
- *Understanding Dynamic Programming Technique to apply for Design of Beams and Frames*

UNIT-I

Introduction to Optimization: Historical Development – Engineering Applications of Optimization – Art of Modeling Objective Function – Constraints and Constraint Surface – Formulation of Design Problems as Mathematical Programming Problems – Classification of Optimization Problems – Optimization Techniques – Classical and Advanced Techniques

UNIT-II

Optimization Using Calculus: Stationary Points – Functions of Single and Two Variables – Global Optimum Convexity and Concavity of Functions of One and Two Variables Optimization Of Function Of One Variable And Multiple Variables – Gradient Vectors –Examples Optimization Of Function Of Multiple Variables Subject To Equality Constraints – Lagrangian Function Optimization Of Function Of Multiple Variables Subject To Equality Constraints – Hessian Matrix Formulation – Eigen Values Kuhn-Tucker Conditions –Examples

UNIT-III

Linear Programming : Standard form of linear programming (LP) problem – Canonical form of LP problem – Assumptions in LP Models – Elementary operations Graphical method for two variable optimization problem – Examples Motivation of simplex method – Simplex algorithm and construction of simplex tableau – Simplex criterion – Minimization versus maximization problems Revised simplex method – Duality in LP – Primal-dual relations – Dual Simplex method

– Sensitivity or post optimality analysis Other algorithms for solving LP problems – Karmarkar's projective scaling method

UNIT-IV

Application of linear programming methods for plastic design of frames – Minimum weight design and rigid frame

UNIT-V

Introduction to quadratic programming – Geometric programming – and dynamic programming – Design of beams and frames using dynamic programming technique

Textbooks:

1. S.S. Rao, "Engineering Optimization: Theory and Practice", New Age International P. Ltd., New Delhi, 2000.
2. Optimization Concepts and Application in Engineering- Belegundu A.D. and Chandrupatla T.R
3. G. Hadley, "Linear programming", Narosa Publishing House, New Delhi, 1990.

Reference Books:

1. Elements of Structural Optimization, Haftka, Raphael T., Gürdal, Zafer, Springer.
2. Variational methods for Structural optimization, Cherkaev Andrej, Springer

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I M. TECH - I SEM. (SE)	**L**	**T**	**P**	**C**
	-	**-**	**4**	**2**

(18CE1003) STRUCTURAL DESIGN LAB

Course Objectives:

- *The objective of Structural Design laboratory is to understand the Design and Detail all the Structural Components of Frame Buildings.*

Course Outcomes:

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

- *Design and Detail all the Structural Components of Frame Buildings.*
- *Design and Detail complete Multi-Storey Frame Buildings.*

LIST OF EXPERIMENTS:

Design and detailed drawing of complete G+ 3 structures by individual student using latest relevant IS codes.

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I M. TECH - I SEM. (SE)	**L**	**T**	**P**	**C**
	-	**-**	**4**	**2**

(18CE1004) ADVANCED CONCRETE LAB

Course Objectives:

The objective of concrete laboratory is to determine the strength characteristics of reinforced cement concrete and conducting NDT.

Course Outcomes:

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

- *Design high grade concrete and study the parameters affecting its performance.*
- *Conduct Non-Destructive Tests on existing concrete structures.*
- *Apply engineering principles to understand behaviour of structural/ elements.*

List of Experiments/Assignments:

1. Study of stress-strain curve of high strength concrete, Correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture.
2. Effect of cyclic loading on steel.
3. Non-Destructive testing of existing concrete members.
4. Behavior of Beams under flexure, Shear and Torsion.

Reference Books:

1. Properties of Concrete, Neville A. M., 5th Edition, Prentice Hall, 2012. Concrete Technology, Shetty M. S., S. Chand and Co., 2006.

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I M. TECH - I SEM. (SE)	**L**	**T**	**P**	**C**
	2	**-**	**-**	**2**

(18HS0823) RESEARCH METHODOLOGY AND IPR

Course Educational Objectives:

- *Understand some basic concepts of research and its methodologies.*
- *Identify appropriate research topics.*
- *Enrich knowledge to their research field.*
- *Process for filing Patent.*

Course Outcomes:

- *Understood the Meaning of research problem, Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.*
- *Got the knowledge of How to get new ideas.*
- *Acquired the knowledge of various government and NGO or agencies for Research Funding*.

UNIT-I:

Introduction: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT–II

Literature Studies: Effective literature studies approaches, analysis, Plagiarism, Research ethics.

UNIT–III

Report Writing: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT-IV

Nature of Intellectual Property: Patents, Designs, Trade and Copyright.

Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-V

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications**,** New Developments in IPR: Administration of Patent

System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Text Books:

1. Resisting Intellectual Property, Taylor & Francis Ltd ,2007.
2. Industrial Design, Mayall, McGraw Hill, 2002
3. Product Design, Niebel, McGraw Hill, 2004

Reference Books:

1. Research methodology: An introduction for science & engineering students. Stuart Melville and Wayne Goddard, 2005
2. Research Methodology: A Step by Step Guide for beginners, Ranjit Kumar, 2 nd Edition, 2006

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(18HS0818) ENGLISH FOR RESEARCH PAPER WRITING

Course objectives:

Students will be able to:

- *Understand that how to improve your writing skills and level of readability.*
- *Learn about what to write in each section.*
- *Understand the skills needed when writing a Title.*
- *Ensure the good quality of paper at very first-time submission.*

UNIT - I

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT - II

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts and Introduction.

UNIT - III

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT - IV

Key skills needed when writing a Title, key skills needed when writing abstract, key skills needed when writing an Introduction, skills when writing a Review of the Literature.

UNIT - V

Skills needed when writing the Methods, skills needed when writing the Results, skills needed when writing the Discussion, skills needed when writing the Conclusions.

Text Books:

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

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(18CE1005) FEM IN STRUCTURAL ENGINEERING

Course Objectives:

The Student shall learn the concepts of FEM, Discretization, and Rayleigh Ritz method of functional approximation. Principles of Elasticity, 1-D, 2-D, 3-D FEM, isoperimetric formulation and finite element analysis of plates.

Course Outcomes:

After completion of this course, the student shall understand

- *The history of FEM, methods of functional approximation*
- *Principles of Elasticity, isoperimetric formulation*
- *Finite element analysis of plates*

UNIT-I

Introduction: Concepts of FEM, Steps involved Merits and demerits, Energy principles, Discretization, Rayleigh Ritz method of functional approximation.

Principles of Elasticity: Stress equations, Strain displacement relationships in matrix form, Plane stress, plane strain and axi-symmetric bodies of revolution with axi-symmetric loading.

UNIT-II

One-Dimensional FEM: Stiffness matrix for beam and bar Elements-Shape functions for 1-D elements, Static condensation of global stiffness matrix, Solution, Initial strain and temperature effects.

UNIT-III

Two-Dimensional FEM: Different types of elements for plane stress and plane strain analysis, Displacement models, generalized coordinates, Shape functions, Convergent and compatibility requirements, Geometric invariance, Natural coordinate system, Area and volume coordinates, Generation of element stiffness and nodal load matrices, Static condensation.

UNIT-IV

Isoparametric Formulation: Concept, Different isoperimetric elements for 2-D analysis, Formulation of 4-noded and 8-noded isoperimetric quadrilateral elements, Lagrangian elements - Serendipity elements.

Axi-Symmetric Analysis: Bodies of revolution, Axi-symmetric modeling, Strain displacement relationship, Formulation of axi-symmetric elements.

UNIT-V

Three-Dimensional FEM: Different 3-D elements, 3-D strain, displacement relationship, Formation of hexahedral and isoperimetric solid element.

Text Books:

1. Finite Element Analysis –Theory & Programming, 2nd edition, C.S. Krishna Murthy, Tata Mc Graw-Hill Education Private Limited, New Delhi.
2. Introduction to Finite Element Method, 4th edition, Tirupati Chandrupatla, Ashok D. Belegundu, Prentice Hall Publications.

References Books:

1. Concepts and Applications of Finite Element Analysis, 4th edition, Robert D. Cook, John Wiley and sons Inc., New York.
2. An Introduction to Finite Element Method, 3rd edition, J.N. Reddy, Tata Mc Graw-Hill Publishing Company Limited, New Delhi.
3. Finite Element Procedures, 2nd edition, Klaus-Jurgen Bathe, Prentice Hall.
4. Finite Element Analysis (Theory and Programming), 2nd edition, C.S. Krishnamurthy, Tata Mc Graw-Hill Publishing Company Limited, New Delhi.

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(18CE1006) STRUCTURAL DYNAMICS

Course Objectives:

- *Student shall learn about introduction to structural dynamics-single and multi-degree of freedom systems*
- *To understand Free and Forced vibrations, Practical vibration analysis*

Course Outcomes:

After completion of this course, the student shall understand the concepts OD

- *Structural dynamics-single and multi-degree of freedom systems*
- *Free and Forced vibrations*
- *Practical Vibration analysis*

UNIT-I

Introduction to Structural Dynamics: Introduction - Elements of a vibratory system, Degrees of freedom, Continuous systems, lumped mass idealization, Oscillatory motion, Simple harmonic motion, Fundamental objective of dynamic analysis, Types of prescribed loading, Methods of discretization, Formulation of the equations of motion for single degree of freedom (SDOF) systems,

UNIT-II

Single Degree of Freedom System: Solutions of the equation of motion, free vibration response, Undamped and damped, Critical damping, Logarithmic decrement, Forced vibrations of SDOF systems, Harmonic excitation, Dynamic magnification factor, Bandwidth. Response to harmonic, periodic, impulsive and general dynamic loading, Duhamel integral.

UNIT-III

Multi Degree of Freedom System: Selection of the degree of freedom, Evaluation of structural property matrices, Formulation of MDOF equations of motion, Undamped free vibrations, Solution of Eigen value problem for natural frequencies and mode shapes, Analysis of dynamic response, Normal coordinates, Uncoupled equations of motion, Orthogonal properties of normal modes, Mode superposition procedure.

UNIT-IV

Continuous System: Introduction –Flexural vibrations of beams- Elementary Case- Equation of motion –Analysis of Undamped free shapes of simple beams with different end conditions- principles of application to continuous beams.

UNIT-V

Practical Vibration Analysis: Stool method, Fundamental mode analysis, Analysis of second and higher modes, Holzer method - Basic procedure, Transfer matrix procedure.

Text Books:

1. Dynamics of Structures, 2nd edition, Clough and Penzium, Tata McGraw-Hill Education Private Limited, New Delhi.
2. Structural Dynamics (Theory and Computation), 3nd edition, Mario Paz, Springer publications.

References Books:

1. Dynamics of structures (Theory and Applications to Earthquake Engineering), Anil K Chopra, 4th edition, Pearson Education, New Delhi.
2. Elements of Mechanical Vibrations, R.N. Iyengar, I.K. International Publishing House.
3. Dynamics of Structures, 3rd edition, Jagmohan L. Humar, CRC Press (Taylor and French Group).
4. Engineering Vibrations, 2nd edition, William J. Bottega, CRC Press (Taylor and French Group).

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PROFESSIONAL ELECTIVE COURSE (PEC) – III
(18CE1013) ADVANCED STEEL DESIGN

Course Educational Objectives:

Student shall learn about

- *Design of Light Gauge compression members and beams*
- *Analysis and design of Transmission Towers*
- *Plastic analysis and design of continuous beams, Portal frames*
- *Limit State Design of steel Tension members and laterally restrained beams.*

Course Outcomes:

After completion of this course, the student shall be able to

- *Design light Gauge steel compression and Flexural members*
- *Analyze and design Transmission towers*
- *Analyze and design continuous beams and portal frames using plastic theory*
- *Design steel Tension members and laterally restrained beams using limit state method*

UNIT -I

Plastic Behavior of Structural Steel: Introduction, Plastic theory, Plastic hinge concept, Plastic collapse load, conditions of plastic analysis, Theorem of Plastic collapse, Methods of Plastic analysis. Portal frames (up to two bay two storey) and single span gable frames.

UNIT-II

Design in Light Gauge Steel: Introduction, types of sections, material, local buckling of thin elements stiffened compression members, multiple stiffened compression elements, compression members, laterally supported flexural members

UNIT-III

Transmission Line Towers: Introduction, Types of towers, Tower configuration, Loads, Analysis and design of self-supporting simple towers.

UNIT-IV

Tubular Structures: Introduction, Classification, Advantages and disadvantages, Behavior of tubular sections, minimum thickness, combined stresses, connections, Design of truss elements including purlins.

UNIT-V

Design of Industrial Buildings: Introduction, Selection of roofing and wall material, selection of bay width, structural framing, purlins, girts and eave strut, plane trusses, floor plates, end bearings, Design of Gantry girders

Text Books:

1. Design of Steel Structures, 3rd edition, S.K. Duggal, Tata McGraw-Hill Education Private Limited, New Delhi.
2. Design of Steel Structures, 2nd edition, N Subramanian, Oxford Higher Education, New Delhi.
3. Comprehensive Design of Steel Structures, 2nd edition, B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Laxmi Publications Private Limited, New Delhi.

References Books:

1. Design of Steel Structures, K.S. Sai Ram, Dorling Kindersley (India), Pvt. Ltd, Pearson Education in South Asia.
2. Design of Steel Structures, L.S. Negi, 2nd edition, Tata McGraw-Hill Education Private Limited, New Delhi.
3. (ISI)-No.6, Structural Engineers Handbook, Bureau of Indian Standard. Design of Steel Structures, 6th edition, Arya and Ajmani, New Chand Publishers of collapse in flexure and shear, Limit state of serviceability.

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PROFESSIONAL ELECTIVE COURSE (PEC) – III
(18CE1014) DESIGN OF FORMWORK

Course Objectives:

- *Designing formwork for foundations, wall, column, beam, and slab elements,*
- *Planing and estimation of the cost of formwork and scaffolding for various applications*

Course Outcomes:

- *At the end of the course, students will be able to*
- *Select proper formwork, accessories and material.*
- *Design the form work for Beams, Slabs, columns, Walls and Foundations.*
- *Design the form work for Special Structures.*

UNIT-I

Introduction: Requirements and Selection of Formwork.

Formwork Materials: Timber, Plywood, Steel, Aluminum, Plastic, and Accessories. Horizontal and Vertical Formwork Supports.

UNIT-II

Formwork Design: Concepts, Formwork Systems and Design for Foundations, Walls, Columns, Slab and Beams.

UNIT-III

Formwork Design for Special Structures: Shells, Domes, Folded Plates, Overhead Water Tanks, Natural Draft Cooling Tower, Bridges.

UNIT-IV

Flying Formwork: Table Form, Tunnel Form, Slip Form, Formwork for Precast Concrete, Formwork Management Issues –Pre- and Post-Award.

UNIT-V

Formwork Failures: Causes and Case studies in Formwork Failure, Formwork Issues in Multi-Story Building Construction.

Text Books:

1. Formwork for Concrete Structures, Kumar Neeraj Jha, Tata McGraw Hill Education, 2012. IS 14687: 1999, False work for Concrete Structures - Guidelines, BIS.
2. Formwork for Concrete Structures, Peurifoy, Mc Graw Hill India, 2015.

References Books:

1. Formwork for Concrete Structures Mary Krumboltz Hurd – 2005

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PROFESSIONAL ELECTIVE COURSE (PEC) – III
(18CE1015) DESIGN OF HIGH RISE STRUCTURES

Course Objectives:

The design aspects and analysis methodologies of tall buildings will be introduced. The stability analysis of tall buildings is another important objective of this course

Course Outcomes:

At the end of the course, students,

- *understanding on the behavior of tall buildings subjected to lateral building.*
- *should have knowledge about the rudimentary principles of designing tall buildings as per the existing codes.*

UNIT-I

Design Criteria and Materials: Development of High Rise Structures – General Planning Considerations – Design philosophies – Materials used for Construction – High Strength Concrete – High Performance Concrete – Self Compacting Concrete – Glass – High Strength Steel

Loading: Gravity Loading – Dead Load – Live Load – Live load reduction technique – Impact Load – Construction Load – Sequential Loading. Lateral Loading – Wind load – Earthquake Load. Combination of Loads.

UNIT-II

Behavior of Various Structural Systems: Factors affecting growth, Height and Structural form. High rise behavior of Various structural systems – Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wall frames, tubular structures, cores, outrigger – braced and hybrid mega systems.

UNIT-III

Analysis and Design: Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of buildings as total structural system considering overall integrity and major subsystem interaction, Analysis for member forces, drift and twist, computerized general three-dimensional analysis.

UNIT-IV

Buckling Analysis: Overall buckling analysis of frames, wall-frames, Approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first-order and P-Delta analysis, Translational, Torsional instability, out of plumb effects, stiffness of member in stability, effect of foundation rotation.

UNIT-V

Tall Buildings: Structural Concept, Configurations, various systems, Wind and Seismic loads, Dynamic approach, structural design considerations and IS code provisions. Firefighting design provisions.

Text Books:

1. Design Of High Rise Structures -Feng Fu – 2018
2. Design of High Rise Structures -Harry G. Poulos - 2017
3. Bryan Stafford Smith, Alex coull, "Tall Building Structures, Analysis and Design", John Wiley and Sons, Inc., 1991.
4. Taranath B.S., "Structural Analysis and Design of Tall Buildings", McGraw Hill, 2011.

Reference Books:

1. Linty, Stotes Burry.D, "Structural Concepts and systems for Architects and Engineers", John Wiley, 1988.
2. Lynn S. Beedle, "Advances in Tall Buildings", CBS Publishers and Distributors, Delhi, 1986.
3. Wolfgang Schueller "High Rise Building Structures", John Wiley and Sons, New York 1977.

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PROFESSIONAL ELECTIVE COURSE (PEC) – III
(18CE1016) DESIGN OF MASONRY STRUCTURES

Course objectives:

Student shall learn about

- *Understand masonry materials and its mechanical Construction.*
- *Strength of stability of axial loaded masonry walls*
- *Load consideration masonry & reinforced masonry*
- *Design of masonry walls*

Course Outcomes:

The student shall be able to,

- *Understand the masonry design approaches.*
- *Determine Reinforced Masonry Members.*
- *Determine strength of stability*
- *Determine masonry walls in composite action*

UNIT-I

Masonry Units, Materials, Types and Masonry Construction: Bricks, Stone and Block masonry units- strength, modulus of elasticity and water absorption of masonry materials – classification and properties of mortars. Defects and Errors in masonry construction – cracks in masonry, types, reason for cracking, methods of avoiding cracks.

UNIT-II

Strength and Stability: Strength and stability of axially loaded masonry walls, effect of unit strength, mortar strength, joint thickness, rate of absorption, effect of curing, effect of ageing, workmanship, strength formulae and mechanism of failure for masonry subjected to direct compression.

UNIT-III

Design Considerations: Effective height of walls and columns, openings in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action in lintels. Problems on design considerations for solid walls, cavity walls, wall with pillars.

UNIT-IV

Load Consideration of Masonry: Wall carrying axial load, Eccentric load with different eccentricity ratios, Wall with openings, free standing wall.

Reinforced Masonry: Applications, Flexural and Compression Elements, Shear Wall.

UNIT-V

Design of Masonry Wall: Design of load bearing masonry for building up to 3 storeys using IS:1905 and SP :20 Procedure

Masonry Walls in Composite Action: Composite wall-beam element, infilled Frames.

Text Books:

1. Structural Masonry – Henry, A.W: Mecmillian Education Ltd.,1990
2. Design of Reinforced Masonry Structures, Narendra Taly, ICC, 2nd Edition
3. Brick and reinforced brick structures –Dayaratnam.P: Oxford & IBH ,1987

References Books:

1. Design of masonry structures- Sinha B.P Devies: E&FN spon 1997.
2. IS 1905-1987 ''Code of practice for structural use of un reinforced masonry-(3rd revision) BIS, New Delhi.
3. SP20 (S&T)-1991,''Hand Book on Masonry Design and construction-(1rd revision) BIS, New Delhi.

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PROFESSIONAL ELECTIVE COURSE (PEC) – IV
(18CE1017) DESIGN OF ADVANCED CONCRETE STRUCTURES

Course Objectives:

- *To understand the concepts of designing reinforced cement concrete structures.*
- *To familiarize students with behavior and design procedure of some of the special structural elements so that they can perform better in the analysis and design of these structures in practical situations.*

Course Outcomes:

- *Analyze the special structures by understanding their behavior.*
- *Design and prepare detail structural drawings for execution citing relevant IS codes*

UNIT - I

Estimation of Crack width In Reinforced Concrete Members: Introduction to Limit State Collapse and Limit State Serviceability- Factors Affecting Crack Width in Beams - Mechanism of Flexural Cracking- Calculation of Crack Widths - Simple Empirical Method - Estimation of Crack Width in Beams by IS 456 of BS 8110 - Shrinkage and Thermal Cracking

UNIT - II

Design of Reinforced Concrete Deep Beams: Introduction - Minimum Thickness - Steps of Designing Deep Beams - Design by IS 456 - Design according to British Practice - ACI Procedure for Design of Deep Beams - Checking for Local Failures - Detailing of Deep Beams

UNIT - III

Shear in Flat Slabs and Flat Plates: Introduction - Checking for One-way (wide beam) shear - Two-way (Punching) shear- Permissible punching shear - Shear due to Unbalanced Moment (Torsional moments)- Calculation of j values - Strengthening of column areas for moment transfer by torsion which produces shear - Shear Reinforcement Design - Effect of openings in Flat slabs - Shear in Two – way Slabs with beams

UNIT – IV

Design of Ribbed Slabs: Introduction- Specification Regarding the Slabs- Analysis of the Slabs for Moment and Shear- Ultimate Moment of Resistance- Design of Shear- Deflection- Arrangement of Reinforcement

UNIT – V

Design of Plain Concrete Walls: Introduction - Braced and Unbraced walls - Slenderness of walls- Eccentricities of vertical loads at Right angles to wall - Empirical design method for plane concrete walls carrying axial load - Design of walls for In-plane Horizontal forces - Rules for detailing of steel in concrete walls

Design of Shear Walls: Introduction - Classification of shear walls - Classification according to behavior - Loads in shear walls - Design of Rectangular and flanged shear walls - Derivation of formula for moment of Resistance of Rectangular shear walls

Text Books:

1. Advanced R.C.C by Krishnam Raju, CBS Publishers & distributors, New Delhi.
2. Structural Design and drawing (RCC and steel) by Krishnam Raju, Univ.Press, New Delhi
3. Advanced RCC by Varghese, PHI Publications, New Delhi.

Reference Books:

1. P. Purushothaman, Reinforced concrete Structural Elements: Behavior, analysis and Design, TATA McGraw Hill.
2. C.E. Reynolds and J.C. Steedman, Reinforced Concrete Designers Hand book, A view point publication.
3. Limit State Design of Reinforced Concrete Structures by P. Dayaratnam, Oxford & IBH Publishers.

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PROFESSIONAL ELECTIVE COURSE (PEC) – IV
(18CE1018) ADVANCED DESIGN OF FOUNDATIONS

Course Objective:

- *To produce Civil Engineering students who have ability to design foundation systems for structures such as Tall towers, Bridges etc.*
- *To familiarize the student with design of Sheet piles and Coffer dams.*

Course Outcomes:

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

- *Student will demonstrate the ability to identify a suitable foundation system for a structure*
- *Student will be capable of analyzing and designing foundations for structures such as tall towers, bridges.*

UNIT-I

Introduction: Depth, Spacing of footings, Erosion problems, Water table effects, foundations on sands, Silts, Clays, landfills (qualitative treatment only). Introduction to design of Spread footings, Rectangular footings, and Eccentrically loaded spread footings, Basics of beams on elastic foundation and Ring foundations.

UNIT-II

Mat Foundations: Types, bearing capacity, Settlements, Sub grade reaction, Design guidelines.

UNIT-III

Deep Foundations: Stresses during pile driving, Tension piles, Negative skin friction, and under-reamed piles. Guidelines for design of pile caps, Batter piles, laterally loaded piles- Ultimate capacity of laterally loaded piles. Drilled piers – Uses, load carrying capacity, Settlements

UNIT-IV

Sheet Pile Walls: Cantilever sheet piles and Anchored bulkheads, Earth pressure diagram Determination of Depth of embedment in sands and clays – Timbering of trenches- Earth pressure diagrams – Forces in struts

UNIT-V

Coffer Dams: Stability, bearing capacity, Settlements (Qualitative treatment only).

Text Books:

1 Das, B.M., "Principles of Foundation Engineering"4th Edition, Cengage Learning, Singapore, 1999.

2 Bowles, J.E., "Foundation Analysis and Design", 4th Edition, McGraw- Hill International, 1988.

References Books:

1. Venkataramaiah C., "Geotechnical Engineering", 5th Edition, New Age International Pvt. Ltd, Publishers, 2009.
2. Swami Saran, "Analysis and Design of Substructures",3 rd. Edition, Oxford & IBH Publishing Company Pvt. Ltd, 2009.
3. Gopal Ranjan &ASR Rao, "Basics and Applied Soil Mechanics", 4thEdition, New Age International Pvt. Ltd, Publishers, 2002.

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PROFESSIONAL ELECTIVE COURSE (PEC) – IV
(18CE1019) SOIL STRUCTURE INTERACTION

Course Educational Objectives:

- *Focus is on idealization of soil response to closely represent continuum behavior and interaction analysis between the soil-structure with reference to relative stiffness of beams, slabs and piles under different loading conditions.*

Course Outcomes:

At the end of this course students will have the capacity to

- *Idealize soil response in order to analyze and design foundation elements subjected to different loadings.*

UNIT I

Soil Response Models of Interaction Analysis: Introduction to soil – Foundation interaction problems, Soil behavior, Foundation behavior, Interface behavior, soil-foundation interaction analysis, soil response models, Elastic continuum, Winkler, Two parameter elastic models, Elastic – plastic behavior, Time dependent behavior.

UNIT II

Infinite and Finite Beams on Elastic Foundations: Infinite beam, General solution of the elastic line – concentrated and distributed loads on beams – Idealization of semi-infinite and finite beams - Classification of finite beams, different end conditions and loads – solutions by general method, finite difference and application packages

UNIT III

Plate on Elastic Medium: Infinite plate, elastic continuum, Winkler, Two parameters, Thin and thick plates, Analysis of finite plates, rectangular and circular plates, simple solution, ACI method, Numerical analysis of finite plates, Analysis of highway and airfield pavements – Application packages

UNIT IV

Analysis of Pile and Pile Groups: Elastic analysis of single pile – Methods of analysis for settlement of pile – Solutions for settlement and load distribution in pile – Pile tip load – settlement of pile groups – Analysis – Interaction between piles – end bearing and floating piles – Effect of pile cap – Piled raft – Application packages

UNIT V

Laterally Loaded Pile: Load - deflection prediction for laterally loaded piles, subgrade reaction and elastic analysis, Interaction analysis, pile raft system, solutions through influence charts and Application packages

Text Books:

1. Salgado, R., "The Engineering of Foundations", Tata McGraw Hill Education Private Limited, New Delhi, 2011.
2. Murthy, V.N.S., "Advanced Foundation Engineering", CBS Publishers, New Delhi, 2007.
3. Saran, S, "Analysis and Design of Substructures", Taylor & Francis Publishers, 2006
4. McCarthy, D.F. "Essentials of Soil Mechanics and Foundations", Basic Geotechnics, Sixth Edition, Prentice Hall, 2002.

Reference Books

1. Hemsley, J.A, "Elastic Analysis of Raft Foundations", Thomas Telford, 1998.
2. ACI 336, "Suggested Analysis and Design Procedures for Combined Footings and Mats", American Concrete Institute, Dehit, 1988.
3. Scott, R.F. "Foundation Analysis", Prentice Hall, 1981.
4. Poulos, H.G., and Davis, E.H., "Pile Foundation Analysis and Design", John Wiley, 1980.
5. Kurien, N.P., "Design of Foundation Systems: Principles and Practices Narosa Publishing House, New Delhi, 1999.

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PROFESSIONAL ELECTIVE COURSE (PEC) – IV
(18CE1020) DESIGN OF INDUSTRIAL STRUCTURE

Course Objectives:

- *To study the requirements, planning and design of Industrial structures.*

Course Outcomes:

- *On completion of this course student will be able to plan industrial structures for functional requirements.*
- *They will be able to design various structures such as Cooling Towers, Chimneys, and Transmission Towers with required foundations.*

UNIT-I

Introduction: General - Specific requirements for industries like textile, sugar, cement, chemical, etc. – Site layout and external facilities. Planning of Building Work – Standards - Structural materials including plastics – Polymers - Fibre glass - Pressed card boards

Planning and Functional Requirements: Classification of Industries and Industrial structures - planning for Layout Requirements regarding Lighting, Ventilation and Fire Safety - Protection against noise and vibration - Guidelines of Factories Act

UNIT-II

Behavior and Design of Connections: Connection behavior -Design requirements of bolted and welded connections- unstiffened and stiffened seat connections –framed connections- Connections for force and moment transmission-tee stub and end plate connections- Column stiffeners and other reinforcement-principles of semi-rigid connections.

UNIT-III

Power Plant Structures: Types of power plants – Containment structures - Cooling Towers- Bunkers and Silos -Pipe supporting structures

UNIT-IV

Transmission Line Structures and Chimneys: Analysis and design of steel monopoles, transmission line towers – Sag and Tension calculations- Methods of tower testing – Design of self-supporting and guyed chimney- Design of Chimney bases

UNIT-V

Foundation: Design of foundation for Towers, Chimneys and Cooling Towers - Machine Foundation - Design of Turbo Generator Foundation.

Text Books:

1. Jurgen Axel Adam, Katharria Hausmann, Frank Juttner, Klauss Daniel, *Industrial Buildings: A Design Manual*, Birkhauser Publishers, 2004.
2. Manohar S.N, *Tall Chimneys - Design and Construction*, Tata McGraw Hill, 1985
3. Santhakumar A.R. and Murthy S.S., *Transmission Line Structures*, Tata McGraw Hill, 1992.
4. Srinivasulu P and Vaidyanathan.C, *Handbook of Machine Foundations*, Tata McGraw Hill, 1976.

References Books:

1. 'Procs. *Of advanced course on Industrial Structures'*, Structural Engineering Research Centre, 1982.
2. Salmon, C, G., and Johnson, J.E., 'Steel Structures-Design and Behavior', Harper and Row, 1980.

CODE BOOKS:

1. IS 800 -2007, Indian Standard Code of practice for General Construction in Steel.
2. IS: 6533: Part 1- 1989 Code of Practice for Design and Construction of steel chimney.
3. SP 6: Part 1: 1964 Handbook for structural engineers - Structural steel sections.
4. IS 802: Part 1: Sec 1: 1995 Code of practice for use of structural steel in overhead transmission line towers, Part 1 Materials and Loads and permissible stresses Section 1 Materials and Loads
5. IS 6533: Part 2-1989 Code of practice for design and construction of steel chimneys Part 2 Structural aspects.

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(18CE1007) MODEL TESTING LAB

Course Objectives:

Student shall learn about the Static testing of plates, shells, and frames models.

Course Outcomes: *At the end of the course, students will be able to*

- *Understand the response of structures.*
- *Prepare the models.*
- *Conduct model testing for static loading*
- *Conduct model testing for free and forced vibrations*

Syllabus Content:

1. Stress and Deflection Analysis in Beams with Different Support Conditions.
2. Stress Analysis of Flat Plates and Simple Shells.
3. Stress and Deflection Analysis in Cantilever Beam
4. Stress and Deflection Analysis in Beam with Angular Loads
5. Stress Analysis of a Rectangular Plate with Circular Hole
6. Thermal Stress and Heat Transfer Analysis of Plate.
7. Thermal Stress Analysis of Cylindrical Shells
8. Vibration Analysis of a beam

Note: The above experiment is performed by using any finite element analysis simulation software.

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(18HS0838) NUMERICAL ANALYSIS LAB

Course Objectives:

- *To train the students thoroughly in Mathematical concepts of Interpolation, Curve fitting, Numerical Differentiation and Integration and their applications*
- *To prepare students for lifelong learning and successful careers using mathematical concepts of Interpolation, Curve fitting, Numerical solution of ordinary differential equations and their applications*
- *To develop the skill pertinent to the practice of the mathematical concepts including the student's abilities to formulate and modeling the problems, to think creatively and to synthesize information*

Course Outcomes: *At the end of the course, students will be able to*

- *Find Roots of non-linear equations by Bisection method and Newton's method.*
- *Do curve fitting by least square approximations*
- *Solve the system of Linear Equations using Gauss - Elimination/ Gauss - Seidal Iteration/ Gauss - Jorden Method*
- *To Find Numerical Solution of Ordinary Differential Equations by Euler's Method, Runge-Kutta Method.*

Syllabus Contents:

1. Find the Roots of Non-Linear Equation Using Bisection Method.
2. Find the Roots of Non-Linear Equation Using Newton's Method.
3. Curve Fitting by Least Square Approximations.
4. Solve the System of Linear Equations Using Gauss - Elimination Method.
5. Solve the System of Linear Equations Using Gauss - Seidal Iteration Method.
6. Solve the System of Linear Equations Using Gauss - Jorden Method.
7. Integrate numerically using Trapezoidal Rule.
8. Integrate numerically using Simpson's Rules.
9. Numerical Solution of Ordinary Differential Equations by Euler's Method.
10. Numerical Solution of Ordinary Differential Equations by Runge- Kutta Method.

Note: The above methods should model in C Programming or Mat Lab

Test books:

1. Higher Engineering Mathematics, B.S. Grewal, Khanna publishers.
2. Advanced Engineering Mathematics, Peter V. O'Neil, CENGAGE publisher.

Reference Books:

1. An Introduction to Numerical Analysis, AtkinsonK.E., J. Wiley and Sons, 1989.
2. Theory and Problems of Numerical Analysis, Scheid F, McGraw Hill Book Company, (Shaum Series), 1988.

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(18HS0819) PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

Course Objectives:

- *To learn to achieve the highest goal happily.*
- *To become a person with stable mind, pleasing personality and determination.*
- *To awaken wisdom in students.*

Course Outcomes

Students will be able to:

- *Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life.*
- *The person who has studied Geeta will lead the nation and mankind to peace and prosperity.*
- *Study of Neetishatakam will help in developing versatile personality of students.*

Unit-1

Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)
- Verses- 52,53,59 (don'ts)
- Verses- 71,73,75,78 (do's)

Unit-2

- Approach to day to day work and duties.
- Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

Unit-3

- Statements of basic knowledge.
- Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18
- Personality of Role model. Shrimad Bhagwad Geeta:

Chapter2-Verses 17, Chapter 3-Verses 36,37,42,

- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

Suggested Reading:

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata.
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P. Gopinath, 4. Rashtriya Sanskrit Sansthanam, New Delhi.

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PROFESSIONAL ELECTIVE COURSE (PEC) – V
(18CE1021) DESIGN OF PRESTRESSED CONCRETE STRUCTURES

Course Objectives:

- Student shall learn about Losses of prestress, Analysis and design of sections for flexure and shear, Bond and anchorage.
- To understand deflections of prestressed concrete beams, Circular prestressing and analysis and design of statically indeterminate structures.

Course Outcomes:

After completion of this course, the student shall understand

- Concept of pre-stressed concrete
- Losses of Prestress
- Deflections of prestressed concrete elements
- Circular prestressing, Analysis and design of statically indeterminate beams.

UNIT I

Introduction: Historic development – General principles of prestressing pretensioning and post tensioning –Advantages and limitations of prestressed concrete - Materials – High strength concrete and high tensile steel their characteristics.

Methods of Prestressing: Methods and Systems of Prestressing; Pre-tensioning and post tensioning methods – Analysis of post tensioning - Different systems of prestressing like Hoyer System, Magnel System Freyssinet system and Gifford – Udall System

UNIT-II

Losses of Prestress: Estimation of the loss of prestress due to various causes like elastic shortening of concrete, Creep of concrete - Shrinkage of concrete, Relaxation of stress in steel, Slip in anchorage, friction etc.

UNIT-III

Flexure: Elastic analysis of concrete beams prestressed with straight, eccentric, bent and parabolic tendons, Kern lines, Cable profile, Design criteria as per I.S. code of practice, Elastic design of Beams (rectangular, I, and T-sections) for flexure, Introduction to partial prestressing.

UNIT-IV

Shear, Bond, Bearing and Anchorage: Shear in PSC beams, Principal stresses, Conventional elastic design for shear - Transfer of prestress in pre-tensioned members, Transmission length, Bond stresses, bearing at anchorage, Anchorage zone stresses in post tensioned members, Analysis

and design of end blocks by Guyon, Magnel and approximate methods, Anchorage zone reinforcements.

Deflections: Introduction, Factors influencing deflections, Short term and long term/ time deflections of un-cracked and cracked members.

UNIT-V

Composite Construction: with precast PSC beams and cast in-situ RC slab – Analysis and design, creep and shrinkage effects. Partial prestressing - principles, analysis and design concepts, crack-width calculations

Circular Prestressing: Introduction, Circumferential prestressing, Design of **p**restressed concrete tanks, Dome prestressing.

Text Books:

1. *Prestressed Concrete,* 4th edition, N Krishna Raju, Tata Mc Graw-Hill Education Private Limited, New Delhi.
2. *Design of Reinforced Concrete Structures,* S. Ramamrutham, Dhanpat Rai Publishing Company.
3. *Prestressed Concrete (Problems and Solutions),* N. Krishna Raju, CBS Publishers.
4. *Prestressed Concrete,* 2nd edition, N. Rajagopalan, Narosa Book Distributors.

References Books:

1. *Design of Prestressed Concrete Structures*, 3rd edition, T.Y. Lin, Ned H. Burns, John Willey and Sons.
2. *Design of Prestressed Concrete,* 2nd edition, Arthur H. Nilson, Wiley Publications *Prestressed Concrete,* K.U. Muthu, Azmi Ibrahim, Maganti Janardhana, M. Vijayanand

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PROFESSIONAL ELECTIVE COURSE (PEC) – V

(18CE1022) ANALYSIS OF LAMINATED COMPOSITE PLATES

Course Objectives:

Students Should able to Lean the Composite plates in engineering structures continues to increase dramatically, and there have been equally significant advances in modelling for general and composite materials and structures in particular.

Course outcomes:

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

- *Analyse the rectangular composite plates using the analytical methods.*
- *Analyse the composite plates using advanced finite element method.*
- *Develop the computer programs for the analysis of composite plates.*

UNIT-I

Introduction: Displacement Field Approximations for Classical Laminated Plate Theory (CLPT) and First Order Shear Deformation Theory (FSDT), Analytical Solutions for Bending of Rectangular Laminated Plates using CLPT.

UNIT-II

Governing Equations. Navier Solutions of Cross-Ply and Angle-Ply Laminated Simply-Supported Plates, Determination of Stresses. Levy Solutions for Plates with Other Boundary Conditions

UNIT-III

Finite Element Models of the Classical Plate Theory (CLPT) – Weak Forms – Spatial Approximations – Semi discrete Finite Element Model – Quadrilateral Elements and Numerical Integration – Finite Element Solutions for Bending of Rectangular Laminated Plates using CLPT

UNIT-IV

Introduction to Finite Element Method, Rectangular Elements, Formation of Stiffness Matrix, Formation of Load Vector, Numerical Integration, Post Computation of Stresses.

UNIT-V

Finite Element Solutions for Bending of Rectangular Laminated Plates using FSDT. Finite Element Model, C0Element Formulation, Post Computation of Stresses.

Text / Reference Books:

1. Mechanics of Laminated Composites Plates and Shells, Reddy J. N., CRC Press.
2. Laminated Composite Plates and Shells by Ye, Jianqiao

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PROFESSIONAL ELECTIVE COURSE (PEC) – V

(18CE1023) FRACTURE MECHANICS OF CONCRETE STRUCTURES

Course Objectives:

- To impart knowledge on the mechanisms of failure and non-linear fracture mechanics.

Course outcomes:

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

- The learner will be able to understand the Basics Concepts of Fracture Mechanics & its Mechanism
- Identify and classify cracking of concrete structures based on fracture mechanics.
- Understanding Stresses at Crack Tip and different Criteria involved
- The Learner Will able to Understand Nonlinear Fracture Mechanics & Failures Surfaces
- The learner will be able to understand the concepts of CTOD and CMD.

UNIT-I

Fracture Mechanics Principles: Introduction, Mechanisms of Fracture, a crack in structure, the Griffith's criterion, modern design – strengths, stiffness and toughness. Stress intensity approach

UNIT-II

Stress Analysis for Members with Cracks: Linear elastic fracture mechanics, Crack tip stress and deformations, Relation between stress intensity factor and fracture toughness, Stress intensity-based solutions. Crack tip plastic zone estimation, Plane stress and plane strain concepts. The Dugdale approach, the thickness effect.

UNIT-III

Elastic – Plastic Fracture Mechanics: Introduction, Elasto–plastic factor criteria, crack resistance curve, J-integral, Crack opening displacement, crack tip opening displacement. Importance of R-curve in fracture mechanics, experimental determination of J-integral, COD and CTOD.

UNIT-IV

Fatigue and Fatigue Crack Growth Rate: Fatigue loading, various stages of crack propagation, the load spectrum, approximation of the stress spectrum, the crack growth integration, fatigue crack growth laws.

UNIT-V

Fracture Resistance of Materials: Fracture criteria, fatigue cracking criteria, effect of alloying and second phase particles, effect of processing and anisotropy, effect of temperature, closure.

Text Books:

1. Elementary engineering fracture mechanics – David Broek – Sijthoff & Noordhoff – Alphen aan den Rijn – Netherlands
2. Fracture Mechanics, Suri C. T. and Jin Z.H., 1st Edition, Elsevier Academic Press, 2012.
3. Fracture mechanics of concrete structures – Theory and applications – Rilem Report – Edited by L. Elfgreen – Chapman and Hall – 1989.

Reference Books:

1. Fracture mechanics – applications to concrete – Edited by Victor, C. Li, & Z.P. Bazant – ACI SP 118.
2. Valliappan S. "Continuum Mechanics Fundamentals" (1982), Oxford IBH, N D. New Delhi.
3. Venkataraman and Patel "Structural Mechanics with introduction to Elasticity and Plasticity" – Mcgraw Hill, 1990.
4. Shanes – "Introduction to Solid Mechanics – II Edition, PH, 1989.

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PROFESSIONAL ELECTIVE COURSE (PEC) – V
(18CE1024) DESIGN OF PLATES AND SHELLS

Course Objectives:

To understand the principals involved in the analysis and design of plates and shells.

Course Outcomes:

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

- *Analyze and design prismatic folded plate systems*
- *Analyze and design shells using approximate solutions*
- *To analyze different types of plates (rectangular and circular) under different boundary connections by various classical methods and approximate methods*

UNIT I

Thin Plates with Small Deflection: Laterally loaded thin plates – governing differential equations - Simply supported and fixed boundary conditions

UNIT II

Design of Circular Plates: Symmetrical bending of Circular plates - Differential equation for symmetrical bending of laterally loaded circular plates - uniformly loaded circular plates - Circular plates with circular hole at center - circular plate concentrically loaded

UNIT III

Thin Shells: Geometry of shells - Detailing of Reinforcement in shells - edge beams and transfer beam Structural actions - Membrane theory

UNIT IV

Design of Shells: Cylindrical shells - Design of spherical dome –Folded plate structures - Design of folded plates

UNIT V

Design of Doubly Curved Shells: Analysis and design of doubly curved shells – Elliptic paraboloid - Conoid and hyperbolic paraboloid roofs.

Text Books:

1. *Theory of Plates and Shells,* Timoshenko and Woinowsky-Krieger S., Tata Mc Graw Hill Edition, 2010.
2. G.S. Ramaswamy, *Design and Construction of Shell Structures,* CBS Publishers, New Delhi, 1996

3. *Design of Reinforced Concrete Shells & Folded Plate*, Varghese P. C., 1st Edition.
4. Bairagi N K, *A text book of Plate Analysis*, Khanna Publishers, New Delhi, 1996.

Reference Books:

1. *Design of Plate and Shell Structures*, Jawad Maan H., Springer Science.
2. Szllard, R. *Theory of Analysis of Plates*, Prentice Hall Inc.
3. K Chandrashekhara, "*Analysis of thin concrete shells*", New Age International, 1995
4. Billington D. P., *Thin Shell Concrete Structures*, McGraw-Hill, 1995
5. Design of Plate and Shell Structures, Jawad Maan H., Springer Science.

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OPEN ELECTIVE COURSE – I

(18HS0824) BUSINESS ANALYTICS

Course Objective: *The course is to understand the management and administration, functions of management, formal and informal organization, staffing, creativity and innovation, process of communication.*

Course Outcomes:

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

- *Design, device, and query relational databases for operative data.*
- *Design, implement, populate and query data warehouses for informational data.*
- *To integrate very large data sets to make business decisions.*
- *Evaluate the use of data from acquisition through cleansing, warehousing, analytics, and visualization to the ultimate business decision.*
- *Evaluate the key concepts of business analytics.*
- *Determine when to implement relational versus document-oriented database structures.*
- *Outline the relationship of the business analytics process within the organization's decision-making process.*
- *Examine and apply appropriate business analytic techniques and methods.*
- *Execute real-time analytical methods on streaming datasets to react quickly to customer needs.*
- *To critically analyze the predictive analysis methods.*

UNIT I

Introduction to Descriptive analytics, Descriptive Statistics, Probability Distributions, Inferential Statistics through hypothesis tests, Permutation & Randomization Test

UNIT II

Regression, ANOVA (Analysis of Variance), Machine Learning Introduction and Concepts Differentiating, algorithmic and model-based frameworks, Regression: Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbors', Regression &Classification

UNIT III

Supervised Learning with Regression and Classification techniques- Bias-Variance Dichotomy, Model Validation Approaches, Logistic Regression, Linear Discriminant Analysis, Quadratic

Discriminant Analysis, Regression and Classification Trees, Support Vector Machines, Ensemble Methods: Random Forest, Neural Networks, Deep learning

UNIT IV

Unsupervised Learning and Challenges for Big Data Analytics- Clustering, Associative Rule Mining, Challenges for big data analytics

UNIT V

Prescriptive analytics Creating data for analytics through designed experiments, creating data for analytics through Active learning, creating data for analytics through Reinforcement learning, Graph Visualization, Data Summaries, Model Checking & Comparison

Text Books:

1. Hastie, Trevor, et al. The elements of statistical learning.Vol.2. No. 1. New York: springer, 2009.
2. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons, 2010
3. Tom White "Hadoop: The Definitive Guide" Third Edition, O'reilly Media, 2012.

References Books:

1. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
2. Vincent Granville, Developing Analytic Talent: Becoming a Data Scientist, wiley, 2014.
3. Jeffrey Stanton & Robert De Graaf, Introduction to Data Science, Version 2.0, 2013.

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OPEN ELECTIVE COURSE – I
(18ME3121) INDUSTRIAL SAFETY

***Course Objectives*:**

- *To learn about mechanical and electrical hazards.*
- *To learn about P mechanical and electrical hazards.*
- *To learn about Wear and Corrosion and their prevention.*
- *To learn about Periodic and preventive maintenance*

***Course Outcomes*:**

Students undergoing this course are able to

- *Understand the points of factories act 1948 for health and safety.*
- *Understand the cost & its relation with replacement economy.*
- *Understand the concepts of sequence of fault finding activities*
- *Understand the Program and schedule of preventive maintenance of mechanical and electrical equipment.*

UNIT-I:

Industrial Safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT-II:

Fundamentals of Maintenance Engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT-III:

Wear and Corrosion and their Prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT-IV:

Fault Tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, Any one machine tool, Pump, Air compressor, Internal combustion engine, Boiler, Electrical motors, Types of faults in machine tools and their general causes.

UNIT-V:

Periodic and Preventive Maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: Machine tools, Pumps, Air compressors, Diesel generating (DG) sets Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Text Books:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services, 2002
2. Maintenance Engineering, H. P. Garg, S. Chand and Company, 2008

Reference Books:

1. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication, 2009
2. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London, 2010

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OPEN ELECTIVE COURSE – I
(18ME3122) ADVANCES IN OPERATIONS RESEARCH

***Course Objectives*:**

- *To learn about Optimization Techniques.*
- *To learn about Graphical solution revised simplex method*
- *To learn about Nonlinear programming problem.*
- *To learn about Scheduling and sequencing and Competitive Models*

***Course Outcomes*:**

Students undergoing this course are able to

- *Understand the Inventory Control Models*
- *Understand the Graphical solution revised simplex method*
- *Understand the concepts of Kuhn-Tucker conditions min cost flow.*
- *Understand the Probabilistic inventory control models and Dynamic Programming*

UNIT-I:

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.

UNIT-II:

Formulation of an LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

UNIT-III:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

UNIT-IV:

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

UNIT-V:

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Text Books:

1. Operations Research, An Introduction, H.A. Taha, PHI, 2008
2. Principles of Operations Research, H.M. Wagner, PHI, Delhi, 1982.
3. Introduction to Optimization: Operations Research, J.C. Pant, Jain Brothers, Delhi, 2008

Reference Books:

1. Operations Research: Hitler Liebermann McGraw Hill Pub. 2009
2. Operations Research: Paneer selvam, Prentice Hall of India 2010

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OPEN ELECTIVE COURSE – I

(18CE1028) COST MANAGEMENT OF ENGINEERING PROJECTS

Course Objectives:

- *To study fundamentals of engineering project economics*
- *To understand dynamics of money over time*
- *To understand the significance of Benefit & Cost Analysis*
- *To get familiarised with depreciation, inflation and taxes*
- *To know the procedures of equipment costing*
- *To understand the basic concepts of Financial Management*

Course Outcomes:

- *Student can access the present value and future value for money*
- *Student can apply the principals of Benefit & Cost Analysis and*
- *Break-Even comparison*
- *Student can calculate the depreciation cost for construction equipment and can estimate the cost for construction equipment*
- *Can prepare profit and loss, balance sheets etc*

UNIT – I

Engineering economics: Basic principles – Time value of money, Quantifying alternatives for decision making, Cash flow diagrams, Equivalence- Single payment in the future (P/F, F/P), Present payment compared to uniform series payments (P/A, A/P), Future payment compared to uniform series payments (F/A, A/F), Arithmetic gradient, Geometric gradient.

UNIT – II

Comparison of alternatives: Present, future and annual worth method of comparing alternatives, Rate of return, Incremental rate of return, Break-even comparisons, Capitalized cost analysis, Benefit-cost analysis.

UNIT – III

Depreciation, Inflation and Taxes: Depreciation, Inflation, Taxes. Equipment economics: Equipment costs, Ownership and operating costs, Buy/Rent/Lease options, Replacement analysis.

UNIT – IV

Cost Estimating: Types of Estimates, Approximate estimates – Unit estimate, Factor estimate, Cost indexes, parametric estimate, and Life cycle cost.

UNIT – V

Financial management: Construction accounting, Chart of Accounts, Financial statements – Profit and loss, Balance sheets, Financial ratios, Working capital management.

Text Books:

1. Blank, L. T. and Tarquin, A. J., "Engineering Economy", Fourth Edition, WCB/McGraw-Hill, 1998.
2. Bose, D. C., "Fundamentals of Financial management", 2nd ed., PHI, New Delhi, 2010.

Reference Books:

1. Boyer, C. B. and Merzbach, U. C., "A History of Mathematics", 2nd ed., John Wiley & Sons, New York, 1989.

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OPEN ELECTIVE COURSE – I
(18ME3123) COMPOSITE MATERIALS

***Course Objectives*:**

- *To learn about Classification and characteristics of Composite materials*
- *To learn about layup method and Mechanical Behavior of composites*
- *To learn about Manufacturing of Metal Matrix Composites and Manufacturing of Polymer Matrix Composites*
- *To learn about Laminar Failure Criteria and Laminate strength-ply discount truncated maximum strain criterion*

***Course Outcomes*:**

Students undergoing this course are able to

- *Understand the need of composite materials.*
- *Understand the Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites.*
- *Understand the concepts of Manufacturing of Ceramic Matrix Composite and Metal Matrix Composite.*
- *Understand the various manufacturing method of composites.*

UNIT–I:

Introduction: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT – II:

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT – III:

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites:

Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT–IV:

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepress – hand layup method – Autoclave method – Filament winding method – Compression Moulding – Reaction injection Moulding. Properties and applications.

UNIT – V:

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hydro thermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Text Books:

1. Material Science and Technology – Vol 13 – Composites by R.W. Cahn – VCH, West Germany, 2003
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Bala Subramanian, John Wiley & Sons, NY, Indian edition, 2007.

References Books:

1. Hand Book of Composite Materials-ed-Lubin. 2010
2. Composite Materials – K.K. Chawla. 2009
3. Composite Materials Science and Applications – Deborah D.L. Chung, 2012
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi, 2012

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OPEN ELECTIVE COURSE – I
(18EE2128) WASTE TO ENERGY

UNIT-I

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

UNIT-II

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods -Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-III

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers –Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-IV

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-V

Properties Of Biogas (Calorific Value And Composition): Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Text Books:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
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