SIR PADAMPAT SINGHANIA UNIVERSITY UDAIPUR

School of Engineering

Department of Civil Engineering

Vision

To establish an outstanding center of national and international reputation that brings out civil engineers with high technical competencies; to offer specialized courses dealing with the contemporary issues and cater to the societal needs; to promote consultancy and high-end research to meet the current and future challenges in the field of civil engineering.

Mission

To serve the society by imparting quality of education and skills to its students.

To prepare our students to be the technical, business and global leaders of tomorrow by inculcating technical, communication skills and teamwork.

To promote research and consultancy for industrial and societal needs.

To instill moral, ethical and professionalism values among the students.

M. Tech. Degree Programme (Part Time)
Course Structure

(2022-2025)

SIR PADAMPAT SINGHANIA UNIVERSITY

Udaipur

SCHOOL OF ENGINEERING

Course Curriculum of 3-Year M. Tech. Degree (Part Time) Programme in Civil Engineering with specialization in Structural Engineering (Batch- 2022-25)

Overview

The Structural Engineering specialization under the Department of Civil Engineering offers a wide range of subjects by keeping in view the current trends and future infrastructural demands. The curriculum provides inclusive knowledge of earthquake-resistant building design to hands-on experience of structure design by specialized software. With all the required facilities that any student can ask for, we are bound to deliver the best not only in Udaipur but India.

Programme Educational Objectives (PEOs)

PEO1 – Accomplishment: Graduates will lead successful professional life by applying their domain specific knowledge demonstrating leadership skills with ethical attitudes in broad societal context while working in a multi/inter disciplinary setting.

PEO2 – Competence: Graduates will excel in providing ethical solutions as an individual or a member or a leader of a team by investigating, analysing, formulating and solving complex engineering problems for the sustainable development of society.

PEO3 – Expertise: Graduates will exhibit professionalism while communicating with local, national and foreign peers bound with regulations and leading life- long learning.

Program Outcomes (PO's)

PO1: Core Knowledge: Graduates will demonstrate an ability to identify, formulate and solve complex engineering problems in the area of specialization and evaluate them to select optimal feasible solution considering safety, environment and other realistic constraints.

PO2: Modern and Advanced Tools: Graduates will demonstrate skills to use modern engineering tools, software and equipment to analyze and solve complex engineering problems using multidisciplinary approach.

PO3: Research Aptitude: Graduates will demonstrate skill of good researcher to work on a problem, starting from scratch, to research into literatures, methodologies, techniques, tools, and conduct experiments and interpret data to develop methodologies, techniques, modern tools and products for the betterment of society.

PO4: Report Writing: Graduates will be able to present their work unequivocally before scientific community through reports and presentations to give and take clear instructions.

PO5: Ethics and Sustainable Development: Graduates will exhibit the traits of professional integrity and ethics and demonstrate the responsibility to implement the research outcome for sustainable development of the society.

Program Specific Outcomes (PSOs)

PSO1: Professional Excellence (Mastery): Graduates will demonstrate research skills to critically analyse complex Structural Engineering problem for synthesizing new and existing information for their solutions

PSO2: Research problem solving skills: Graduates will be able to take up real life and/or research related problems in the field of analysis and design of structures and

to create optimal solutions of these problems through comprehensive analysis and designing

Batch: 2022-25

Postgraduate Core (PC)		Postgraduate Elective (PE)	
Category	**Credits**	**Category**	**Credits**
Professional Core Subjects	27	Professional Electives	12
Total	27	Total	12
		Grand Total	39

Distribution of Total Credits & Contact Hours in all Semesters

Batch 2022-25

S. No.	Semester Number	Credits/Semester	Contact Hours/Week
1	I	10	11
2	II	10	10
3	III	10	10
4	IV	09	09
	Total	39	-

Course Structure: M. Tech. 2022-25

Semester - I

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CEE4105	Advanced Structural Analysis	3	0	1	4
2	CEE4106	Theory of Elasticity & Plasticity	3	0	0	3
3	CEE4107	Advanced Concrete Science & Technology	3	0	0	3
					Total Credits	10
					Total Contact hours/week	11

Semester - II

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CEE4204	Dynamics of Structures	3	1	0	4
2	CEE4202	Research Methodology and IPR	3	0	0	3
3	CEE4204	Advanced Construction Techniques & Management	3	0	0	3
					Total Credits	10
					Total Contact hours/week	10

Semester - III

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CEE4108	Earthquake Resistant Design	3	1	0	4
2	CEE4109	Finite Element Method in Structural Engineering	3	0	0	3
3	PE-I	Professional Elective - I	3	0	0	3
					Total Credits	10
					Total Contact hours/week	10

Semester - IV

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	PE-II	Professional Elective - II	3	0	0	3
2	PE-III	Professional Elective - III	3	0	0	3
3	PE-IV	Professional Elective - IV	3	0	0	3
					Total Credits	09
					Total Contact hours/week	09

List of Professional Elective(s) - I

S. No.	Course Code	Course Title	L	T	P	Credit
1	CEE4151	Theory of Thin Plates and Shell	3	0	0	3
2	CEE4152	Theory and Applications of Cement Composites	3	0	0	3
3	CEE4104	Environmental Impact Assessment	3	0	0	3
4	CEE4153	Advanced Foundation Design	3	0	0	3
5	CEE4141	Global Climate Change Adaptation & Mitigation	3	0	0	3

List of Professional Elective(s) - II

S. No.	Course Code	Course Title	L	T	P	Credit
1	CEE4251	Theory of Elastic Stability	3	0	0	3
2	CEE4252	Ground Improvement Techniques	3	0	0	3
3	CEE4253	Advanced Steel Design	3	0	0	3

List of Professional Elective(s) - III

S. No.	Course Code	Course Title	L	T	P	Credit
1	CEE4254	Advanced Bridge Engineering	3	0	0	3
2	CEE4255	Design of Advanced Concrete Structures	3	0	0	3
3	CEE4256	Fracture Analysis & Non-Destructive Testing	3	0	0	3
4	CEE4257	Seismic Design of Foundation	3	0	0	3

List of Professional Elective(s) - IV

S. No.	Course Code	Course Title	L	T	P	Credit
1	CEE4258	Advanced Pre-stressed Concrete Design	3	0	0	3
2	CEE4259	Repair and Rehabilitation of Structures	3	0	0	3
3	CEE4260	Cost Management of Engineering Projects	3	0	0	3

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Semester - I

(Departmental Core Subject)

CEE4105	L-T-P-C
Advanced Structural Analysis	3-0-1-4
Prerequisite	Structural Analysis

Objective: *The main objective is to expand the student knowledge of the stiffness and flexibility methods studied in the basic structural analysis courses.*

Course Outcomes: *On completion of the course students will be able to; analyze various types of load carrying structures like truss, beam, frame and grid and should be able to calculate member forces, shear force and bending moments, students will be able to incorporate various kinds of loading like temperature, sinking of support, lack of fit, etc. while analyzing various load carrying structures.*

Course Content

Module 01: Introduction

Matrix formulation of redundant beam analysis (Clapeyron's three moment theorem & slope deflection method).

Module 02: Matrix method for plane & truss

Stiffness & flexibility approaches for plane & space truss plane space frames.

Module 03: Matrix method for space frame

Stiffness & flexibility approaches for space frames.

Module 04: Matrix method for beams & foundation

Stiffness & flexibility approaches for simple beams & grillage foundation.

List of Experiments

S. No.	Title of the Experiment	Module
1.	Modeling & analysis of bunkers, silos & chimneys.	01
2.	Dynamic analysis of multi-story RC framed structures.	03
3.	Modeling & analysis of space truss & frames.	01
4.	Analysis of Tall Structures	03

Text/Reference Books

1. Analysis of Structures. Thandavamoorthy T.S. Oxford University Press. 2011.
2. Intermediate Structural Analysis. Wang C.K. Mc Graw Hills. 1983.

Digital Material

1. Matrix Method on Structural Analysis online content. https://nptel.ac.in/courses/105/105/105105180/

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Semester - I

(Departmental Core Subject)

CEE4106	L-T-P-C
Theory of Elasticity & Plasticity	3-0-0-3
Prerequisite	Strength of Materials

Objective: *The objective of this course is to: impart knowledge of various theories of elasticity and apply them to solve 2D Cartesian and polar problems; demonstrate various theories of torsion and apply them to solve 2D torsional problems; provide knowledge of various theories of plastic behaviour and apply them to solve 2D problems.*

Course Outcomes: *After the completion of the course, the student should be able to: demonstrate the knowledge of fundamental methods of elasticity for 2-D Cartesian and Polar problems; analyze torsional problems and apprise various theories to solve 2-D torsional problems; analyze concept of material yielding and plastic behaviour of structures.*

Course Content

Module 01: Analysis of Stress

Introduction, body & surface force, state of stress at a point, principal stresses, stress invariants, 2 & 3-dimensional stress tensors, equations of equilibrium & compatibility, plane stress problems & constitutive relationships, planes of maximum shear, octahedral stresses & the states of pure shear; decomposition into hydrostatic & pure shear states, equations in Cartesian, polar & cylindrical co-ordinate systems, Stress Quadric of Cauchy.

Module 02: Analysis of Strain

Introduction, deformations, linear & rectangular strain components, strain invariants & strain tensors, shear strain components, cubical dilation, principal strains, plane strain problems in Cartesian, polar & cylindrical co-ordinates.

Module 03: Stress-Strain Relations for Linearly Elastic Solids

Introduction, generalized statement of Hooke's Law, stress-strain relationships for isotropic materials, relations between the elastic constants & displacement equations of equilibrium.

Module 04: Theories of Failure & introduction to ideally plastic solids

One-dimensional elastic-plastic relations, isotropic & kinematic hardening, yield function, flow rule, hardening rule, incremental stress-strain relationship, governing equations of elasto-plasticity, simple elastic plastic problem, expansion of a thick walled cylinder, Mohr's Theory of failure, ideally plastic solid, yield surfaces of Tresca & Von Mises, Prandtl-Reuss & Saint Venant-Von Mises equations.

Module 05: Torsion

Torsion of general prismatic bars, circular & elliptical bars, rectangular bars. Membrane analogy, torsion of thin-walled open sections, torsional stress concentration.

Text/Reference Books

1. Advanced Mechanics of Solids. Srinath L.S., 2nd Edition. TMH Publishing Co. Ltd. New Delhi. 2003.
2. Advanced Strength & Applied Stress Analysis. Budynas R.G. 2nd Edition. McGraw Hill Publishing Co. 1999.
3. Theory of Elasticity. Timoshenko S.P. & Goodier J.N. 3rd Edition. McGraw Hill Publishing Co. 1970.

Digital Material

1. Theory of Elasticity Lecture Compilation. Prof. Biswanath Banerjee, IIT Kharagpur.https://www.youtube.com/watch?v=eICv1p8WjgI&list=PLbRMhDVUMngcbhsZgRWuYCi2kKQwQ0Av1

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Semester - I

(Departmental Core Subject)

CEE4107 L-T-P-C
Advanced Concrete Science & Technology 3-0-0-3
Prerequisite Building Material & Construction Technology

Objective: *The objective of this course is to: impart the concept of cement hydration, concrete microstructure, rheology, and early age properties of concrete; to make students understand the impact of admixtures on the properties of fresh and hardened concrete; to educate students about concrete mix design as per Indian standard and developing self-compacting concrete, fiber reinforcing concrete and light weight concrete*.

Course Outcomes: *On completion of the course students will be able to: comprehend rheology and early age properties of cement concrete; understand and assess the impact of admixtures on the properties of fresh and hardened concrete; design concrete mixes as per Indian Standard Code; develop self-compacting concrete, fiber reinforcing concrete and light weight concrete*.

Course Content

Module 01: Cement

Importance of Bogue's compounds, Structure of a Hydrated Cement Paste, Volume of hydrated product, porosity of paste & concrete, transition Zone, Elastic Modulus, factors affecting strength & elasticity of concrete, Rheology of concrete in terms of Bingham's parameters.

Module 02: Chemical Admixtures

Mechanism of chemical admixture, Plasticizers & super plasticizers & their effect on concrete property in fresh & hardened state, Marsh Cone test for optimum design of super plasticizer, retarder, accelerator, air-entraining admixtures & new generation superplasticizers.

Module 03: Mineral Admixture

Fly ash, Silica fume, GGBS & their effect on concrete property in fresh state & hardened state.

Module 04: Mix Design

Factors affecting mix design, design of concrete mix by BIS method.

Module 05: RMC concrete

Manufacture, transporting, placing, precautions, methods of concreting - pumping, under-water concreting, shotcrete, High volume fly ash concrete- concept, properties, typical mix.

Module 06: Special types of concrete

Self- compacting concrete: Concept, materials, tests, properties, application & typical mix. Ferro cement: Materials, techniques of manufacture, properties & applications. Fibre reinforced concrete: Fibre types & properties, behavior of FRC in compression, tension including pre-cracking stage & post-cracking stages, behavior in flexure & shear. Light weight concrete: Materials properties & types. Typical light weight concrete mix, high density concrete, high strength concrete & high performance concrete- materials, properties & applications, typical mix.

Text/Reference Books

1. Concrete Technology. Neville A.M. & Brookes J.J. Pearson Publishers. New Delhi.
2. Properties of Concrete. Neville A.M. Pearson Publishers. New Delhi. 2004.
3. Concrete Technology. Shetty M.S. S. Chand & Company. New Delhi. 2002.
4. Concrete Technology. Gambhir M.L. Tata McGraw Hills. New Delhi. 1995.

Digital Material

1. Advanced Topics on Science & Technology of Concrete. Prof. Manu Santhanam. https://nptel.ac.in/courses/105/106/105106187/

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Semester - II

(Departmental Core Subject)

CEE4204	L-T-P-C
Dynamics of Structure	3-1-0-4
Prerequisite	Earthquake Engineering

Objective: *The objective of this course is to: impart knowledge to study behaviour of SDOF system under various dynamic loading; demonstrate concept of SDOF to MDOF system using classical and numerical techniques; provide knowledge to study behaviour of distributed mass model using classical technique.*

Course Outcomes: *After the completion of the course, the student should be able to: demonstrate the dynamic behaviour of structural systems; find response of structural systems under dynamic load; devise mathematical model for solving field problems.*

Course Content

Module 01: Dynamic Loading

Nature of harmonic, earthquake & blast loadings. Amplitude, frequency & time-period of vibrations.

Module 02: Single Degree of Freedom System

Free & forced vibrations, resonance, harmonic force, periodic force & impulse.

Module 03: Multi Degree of Freedom system

Free & forced vibrations of lumped MDOF system, numerical method of finding the natural frequencies & mode shapes, orthogonality relationship of the principal modes, Rayleigh's Principle & its application for finding the fundamental frequency,

mode superposition method & evaluation of dynamic response, Time-History analysis.

Module 04: Continuous Systems

Equation of motion, Undamped free vibrations, Forced vibrations of bars & beams. introduction to wind loads.

Text/Reference Books

1. Dynamics of Structures. Chopra A.K. 4th Edition. Prentice-Hall International. 2011.
2. Dynamics of Structures. Clough R.W. & Penzien J. Computers & Structures Inc. University Ave. Berkeley, CA94704. USA.
3. Structural Dynamics: Theory & Computation. Paz M. 4th Edition. Kluwer Academic Publishers. 2003.

Digital Material

1. Lectures on Structural Dynamics. Prof. P. Banerji, IIT Bombay. https://nptel.ac.in/courses/105/101/105101006/

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Semester - II

(Departmental Core Subject)

CEE4202 L-T-P-C
Research Methodology and IPR 3-0-0-3

Objective: *The objective of this course is to impart knowledge about the research problem formulation, ethics and IPR as applicable in research and development.*

Course Outcomes: *On completion of this course the student will be able to understand research problem formulation; Analyze research related information; Follow research ethics and understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity. They will be able to understand that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering. They will be able to understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.*

Course Content

Module 01: 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

Module 2: Effective literature studies approaches, analysis Plagiarism, Research ethics

Module 3: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Module 4: 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.

Module 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Module 6: 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/Reference Books

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
4. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

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Semester - II

(Departmental Core Subject)

CEE4205 L-T-P-C
Advanced Construction Techniques & Management 3-0-0-3
Prerequisite Construction Management

Objective: *The objective of this course is to: familiarize students with modern construction planning techniques; enable students understand various construction methods and different construction control and management techniques.*

Course Outcomes: *On completion of this course the student will be able to: understand and apply modern construction planning techniques; comprehend different construction methods and control management techniques.*

Course Content

Module 01: Construction Planning

Construction facilities, Schedules, Layout of Plant utilities.

Module 02: Construction Methods

Excavation & handling of Earth & Rock; Production & handling of Aggregates & Concrete, cooling of concrete in dams, Drainage treatment of aquifers/sub-terrainian reservoirs; Tunneling, Tunneling in soft rocks, Grouting, chimney formation, etc.

Module 03: Construction Control & Management

CPM/PERT, Human Factors, Organization.

Text/Reference Books

1. Construction Planning, Equipment & Methods. Peurifoy R.L. & Ledbetter W.B. McGraw Hill Singapore. 1986.

2. Total Project Management- The Indian Context. Joy P.K. MacMillan India Ltd. New Delhi.1992.

Digital Material

1. Project Planning & Control. https://nptel.ac.in/courses/105/106/105106149/

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Semester - III

(Departmental Core Subject)

CEE4108	L-T-P-C
Earthquake Resistant Design	3-1-0-4
Prerequisite	---------

Objective: *To impart in depth knowledge to the students for planning & designing various types of structures exhibiting ample safety under probable earthquakes.*

Course Outcomes: *On completion of this course: The students will be able to understand the fundamental concept, principle & application of earthquake engineering. The students will be able to understand response spectrum analysis to determine structure response and design earthquake forces. The students will be able to understand the codal provision for earthquake resistance design of structures as per Indian standard*

Course Content

Module 01: Basic Concepts

A seismic Design of Structures. Philosophy & principles of earthquake resistance design – Strength & stiffness, ductility design & detailing, design of energy absorbing devices, concepts of seismic base isolation & seismic active control. Building forms & architectural design concepts – Horizontal & vertical eccentricities due to mass & stiffness distribution, structural redundancy & setbacks. Equivalent static lateral earthquake force on building (IS:1893).

Module 02: Seismic Analysis of Buildings

Equivalent static method: Seismic coefficients–evaluation, estimation of fundamental period, base shear & its distribution, Vulnerability Atlas

Module 03: Seismic Design of Building Components (Beam and Column)

Seismic resistant properties of reinforced concrete; Seismic behavior and design of linear reinforced concrete elements; codal provisions (IS: 13920).

Module 04: Restoration & Retrofitting

Evaluation (Seismic qualification) of existing buildings – Aging, weathering, development of cracks, improper load path, asymmetry. Materials & equipment for restoration & retrofitting. Methodologies for retrofitting – For walls, roofs, slabs, columns & foundation of building in stones, brick or reinforced concrete structures.

Text/Reference Books

1. Earthquake Resistant Design of Structures. S.K. Duggal. Oxford University Press. 2007Total Project Management- The Indian Context. Joy P.K. MacMillan India Ltd. New Delhi.1992.
2. Earthquake Resistant Design of Structures. Agarwal P. & Shrikh M. Prentice Hall of India Pvt. Ltd.

Digital Material

1. Earthquake Resistant Design.
   https://nptel.ac.in/courses/105/102/105102016/

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Semester - III

(Departmental Core Subject)

CEE4109 L-T-P-C
Finite Element Methods in Structural Engineering 3-0-0-3

Objective: *The main objective is to use finite element method to solve continuum problems as well as time-dependent (dynamic) problems. The students should be able to write FE codes/scripts for complex problems.*

Course Outcomes: *On completion of the course students will be able to; use Finite Element Method for structural analysis; execute the Finite Element Program/ Software; solve continuum problems using finite element analysis.*

Course Content

Module 01: Introduction

History and Applications. Spring and Bar Elements, Minimum Potential Energy Principle, Direct Stiffness Method, Nodal Equilibrium equations, Assembly of Global Stiffness Matrix, Element Strain and Stress.

Module 02: Beam Elements

Flexure Element, Element Stiffness Matrix, Element Load Vector.

Module 03: Method of Weighted Residuals

Galerkin Finite Element Method (Bubnov and Petrov Galerkin), Application to Structural Elements, Interpolation Functions, Compatibility and Completeness Requirements, Polynomial Forms, Applications.

Module 04: Different Types of elements in FEA

Triangular Elements, Rectangular Elements, Three-Dimensional Elements, Isoparametric Formulation, Axi-Symmetric Elements, Numerical Integration, Gaussian Quadrature, Pascal's triangle.

Module 05: Application of FEA to continuum and dynamic problems

Plane Stress, CST and LST Elements, Plane Strain Rectangular Element, Iso-parametric Formulation of the Plane Quadrilateral Element, Axi-Symmetric Stress Analysis, Strain and Stress Computations. Applications of FEA to field problems. Time-dependent (vibration) problems using FEA and brief introduction to meshless Finite element.

Text/Reference Books

1. Finite Element Analysis, Seshu P., Prentice-Hall of India,2005.
2. Concepts and Applications of Finite Element Analysis, Cook R. D., Wiley J., New York, 1995.
3. Fundamentals of Finite Element Analysis, Hutton David, Mc-Graw Hill, 2004.
4. Finite Element Analysis, Buchanan G.R., McGraw Hill Publications, New York, 1995.
5. Finite Element Method, Zienkiewicz O.C. & Taylor R.L. Vol. I, II & III, Elsevier, 2000.
6. Finite Element Methods in Engineering, Belegundu A.D., Chandrupatla, T.R., Prentice Hall India, 1991.

Digital Material

1. Finite Element Analysis.
2. https://archive.nptel.ac.in/courses/105/105/105105041/
3. https://nptel.ac.in/courses/105105041
4. Finite Element Method.
5. https://onlinecourses.nptel.ac.in/noc22_me43/preview

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Semester - III

(Professional Elective - I)

CEE4151	L-T-P-C
Theory of Thin Plates and Shells	3-0-0-3
Prerequisite	----------

Objective: *The objective of this course is to introduce the students with the concepts of thin plate and shells, their analysis methods like numerical techniques.*

Course Outcomes: *At the end of this course the student will be able to:*

1. Use analytical methods for the solution of thin plates and shells.

2. Use analytical methods for the solution of shells.

3. Apply the numerical techniques and tools for the complex problems in thin plates.

4. Apply the numerical techniques and tools for the complex problems in shells.

Course Content

Module 01: Introduction: Space Curves, Surfaces, Shell Co-ordinates, Strain Displacement Relations, Assumptions in Shell Theory, Displacement Field Approximations, Stress Resultants, Equation of Equilibrium using Principle of Virtual Work, Boundary Conditions.

Module 02:

Static Analysis of Plates: Governing Equation for a Rectangular Plate, Navier Solution for Simply- Supported Rectangular Plate under Various Loadings, Levy solution for Rectangular Plate with other Boundary Conditions.

Module 03:

Circular Plates: Analysis under Axi- Symmetric Loading, Governing Differential Equation in Polar Co-ordinates. Approximate Methods of Analysis- Rayleigh-Ritz approach for Simple Cases in Rectangular Plates.

Module 04:

Static Analysis of Shells: Membrane Theory of Shells - Cylindrical, Conical and Spherical Shells

Module 05:

Shells of revolution: with Bending Resistance - Cylindrical and Conical Shells, Application to Pipes and Pressure Vessels.

Module 06: Thermal Stresses in Plate/ Shell

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Text/Reference Books

1. Theory of Plates and Shells, Timoshenko S. and Krieger W., McGraw Hill.
2. Stresses in Plates and Shells, Ugural Ansel C., McGraw Hill.
3. Thin Elastic Shells, Kraus H., John Wiley and Sons.
4. Theory of Plates, Chandrasekhara K, Universities Press.

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Semester - III

(Professional Elective - I)

CEE4152	L-T-P-C
Theory and Applications of Cement Composites	3-0-0-3
Prerequisite	----------

Objective: *The objective of this course is to make the students aware of various complex composite materials like FRC, SICON, etc. and their classification.*

Course Outcomes: *At the end of this course the student will be able to:*

1. Formulate constitutive behaviour of composite materials – Ferrocement, SIFCON and Fibre Reinforced Concrete - by understanding their strain- stress behaviour.

2. Classify the materials as per orthotropic and anisotropic behaviour.

3. Estimate strain constants using theories applicable to composite materials.

4. Analyse and design structural elements made of cement composites.

Course Content

Module 01: Introduction: Classification and Characteristics of Composite Materials- Basic Terminology, Advantages. Stress-Strain Relations- Orthotropic and Anisotropic Materials, Engineering Constants for Orthotropic Materials, Restrictions on Elastic Constants, Plane Stress Problem, Biaxial Strength, Theories for an Orthotropic Lamina.

Module 02: Mechanical Behaviour: Mechanics of Materials Approach to Stiffness- Determination of Relations between Elastic Constants, Elasticity Approach to Stiffness- Bounding Techniques of Elasticity, Exact Solutions - Elasticity Solutions with Continuity, Halpin, Tsai Equations, Comparison of approaches to Stiffness.

Module 03: Cement Composites: Types of Cement Composites, Terminology, Constituent Materials and their Properties, Construction Techniques for Fibre Reinforced Concrete - Ferrocement, SIFCON, Polymer Concretes, Preparation of Reinforcement, Casting and Curing.

Module 04: Mechanical Properties of Cement Composites: Behavior of Ferrocement, Fiber Reinforced Concrete in Tension, Compression, Flexure, Shear, Fatigue and Impact, Durability and Corrosion.

Module 05: Application of Cement Composites: FRC and Ferrocement- Housing, Water Storage, Boats, and Miscellaneous Structures. Composite Materials- Orthotropic and Anisotropic behaviour, Constitutive relationship, Elastic Constants.

Module 06: Analysis and Design of Cement Composite Structural Elements - Ferrocement, SIFCON and Fibre Reinforced Concrete.

Text/Reference Books

1. Mechanics of Composite Materials, Jones R. M. 2nd Ed. Taylor and Francis, BSP Books. 1998.
2. Ferrocement – Theory and Applications. Pama R. P. IFIC. 1980.
3. New Concrete Materials. Swamy R.N. 1st Ed. Blackie, Academic and Professional, Chapman & Hall. 1983.

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Semester - I

(Professional Elective - I)

CEE4104	L-T-P-C
Environmental Impact Assessment	3-0-0-3
Prerequisite	----------

Objective: *The objective of this course is to make the students aware of the several norms, policies, rules & regulations of the Environmental Impact Assessment.*

Course Outcomes: *At the end of this course the student will be able to: identify environmental attributes for the EIA study; identify methodology and prepare EIA reports; specify methods for prediction of the impacts.*

Course Content

Module 01: Introduction to Environmental Impact Assessment

Introduction, Historical development of EIA, EIA in project cycle, Legal Aspects & objectives of EIA, General Methodology, Public participation in EIA, different components of EIA.

Module 02: Methodology

General Methodology, Public participation in EIA, different components of EIA.

Module 03: Impact prediction and assessment

Mathematical modeling for impact prediction, cumulative impact assessment, documentation of EIA findings.

Module 04: Impact Analysis, mitigation and management

Environmental impact analysis, Mitigation & impact management, case studies & environmental auditing.

Module 05: Socio-economic Impact Assessment

Concept of socio-economic impact assessment.

Text/Reference Books

1. Environmental Impact Assessment - Practical solutions to recurrent problems. Lawrence D.P. Wiley-Interscience. New Jersey. 2003.
2. Environmental Impact Assessment. Canter L.W. McGraw Hill. New York. 1996.
3. Environmental Impact Analysis: Process and Methods. James. T. Maughan. CRC Press. 2017.

Digital Material

1. Environmental Impact Assessment. NPTEL.
   Link: https://nptel.ac.in/courses/120/108/120108004/
2. Website of Ministry of Environment, Forest and Climate Change, Government of India. Link: http://moef.gov.in/

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Semester - I

(Professional Elective - I)

CEE4153 L-T-P-C
Advanced Foundation Design 3-0-0-3
Prerequisite Reinforced Concrete Structures

Objective: *To equip the students to understand the analysis & design of various foundation systems required for various infrastructure projects.*

Course Outcomes: *On completion of the course students will be able to: identify a suitable foundation system for a structure; evaluate the importance of raft foundation and principles of design for buildings and tower structures; analyze and design pile foundations*.

Course Content

Module 01: Bearing Capacity

Bearing capacity on slopes, settlement analysis of foundation on sand & clay. Advanced bearing capacity theories.

Module 02: Shallow Foundation

Design of isolated footing & steel grillage, combined footing of rectangular, trapezoidal cantilever types, Mat, or raft foundation of dry & saturated soil floating foundations.

Module 03: Deep Foundation

Settlement of piles; vertical & lateral loads in pile foundation, negative skin friction & uplift capacity of pile, design of pile caps, design of well foundation & caissons of different types, design of bridge pairs resting on piles & machine foundation.

Module 04: Retaining structures

Design of retaining walls- Gravity, cantilever & counterfort type. Design of sheet piles & cofferdams, braced excavations.

Text/Reference Books

1. Design of Foundation Systems: Principles & Practices. Kurien N.P. Narosa. New Delhi. 1992.
2. Foundation Analysis & Design. Bowles J.E. Mc-Graw Hill Book & Company.
3. Principles of Foundation Engineering. Das B.M. Thomson Brooks/Cole.

Digital Material

1. Advanced Topics on Advanced Foundation Design. https://nptel.ac.in/courses/105/108/105108069/

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Civil Engineering

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Semester - I

(Departmental Professional Elective-I)

CEE4141 L-T-P-C

Global Climate Change Adaptation & Mitigation 3-0-0-3

Prerequisite Environmental Engineering

Objective: *To develop a basic knowledge about the climate change & Imitigation measures.*

Course Outcomes*: Upon successful completion of this course, it is expected that students will be able to: Be familiar with the*

Course Content

Module 01: Introduction

Introduction to global climate; Global climatic models; Methods of reconstructing climate

Module 02: Fundamental

Quaternary climates, sea level changes, glacial/interglacial cycles; Geological records of climate change, sedimentology, stable isotopes, geochemistry

Module 03: Regulatory

Geochronology – relative and numerical methods;

Module 04: Water

Vegetation dynamics, migration history, the response of vegetation to climatic reversals

Text/Reference Books

1. Climate Mitigation and Carbon Finance Global Initiatives & Challenges. Sahoo, A.K. New India Publishing Agency, 2012.

Digital Material

1. Introduction to climate change

   https://youtu.be/hwWuZ9EnrCI

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Semester - II

(Professional Elective - II)

CEE4251	L-T-P-C
Theory of Elastic Stability	3-0-0-3
Prerequisite	Strength of Materials

Objective: *The objective of this course is to: provide the knowledge of static and dynamic stability analysis of various structures; impart the knowledge of inelastic buckling through problem solving; illustrate dynamic stability of structures using numerical techniques.*

Course Outcomes: *After the completion of the course, the student should be able to: demonstrate concepts of stability of structures and differentiate between Elastic and In-Elastic buckling; find buckling loads of structures for various boundary conditions; evaluate static and dynamic stability of field problems.*

Course Content

Module 01: Euler's Buckling Load

Assumptions, derivations of Euler's critical load, members with eccentric loading & initially imperfect columns.

Module 02: Beam Columns

Beam column equations, beam column with concentrated load, several concentrated load, continuous lateral load. Beam-column with end couple.

Module 03: Column Stability

General differential equation, buckling problem as characteristic value (eigen value) & orthogonality relations; inelastic behavior of materials, effect of dynamic loading.

Module 04: Energy methods for buckling

Theorem of stationary potential energy, comparison with the principle of conservation of energy, energy & stability considerations, Rayleigh-Ritz method, Timoshenko's concept of solving buckling problems, columns with variable cross-section & the use of Trigonometric series.

Text/Reference Books

1. Theory of Elastic Stability. Timoshenko S. & Gere J. 2nd Ed. Mc-Graw Hill Inc. 1961.
2. Stability Analysis & Design of Structures. Gambhir M.L. Springer. 1st Ed. 2004.
3. Stability of Structures. Bazant Z. & Cedolin L. Oxford University Press. Inc. 1991.

Digital Material

1. Theory of Elastic Stability Lecture Compilation. https://www.youtube.com/watch?v=L1lVpnRhHs&list=PL9c0a7_1jnQ4ETPRtJ-7ys1Y6ZXR-toDl

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Semester - II

(Departmental Elective - I)

CEE4252	L-T-P-C
Ground Improvement Techniques	3-0-0-3
Prerequisite	Soil Mechanics

Objective: *This course provides an overview of latest ground improvement techniques. This course will help to understand the problems related to soil & select the best method to improve the soil. This course gives the detail knowledge of various soil stabilization techniques.*

Course Outcomes: *On completion of this course: The students will be able to understand the different ground improvement techniques. The graduate will be able to understand the methods of stabilization. The graduate will be able to understand the methods and properties of reinforced soil.*

Course Content

Module 01: Soil compaction

laboratory methods, field methods, compaction control.

Module 02: Soil stabilization

Using additives, sand drains, stone columns, lime columns.

Module 03: Grouting

Types of grouts, methods of grouting.

Module 04: Soil reinforcement

Using strips, geogrids, geotextiles, geomembranes; Dewatering methods; Soil nailing; Underpinning; Tunneling

Text/Reference Books

1. Soil Mechanics. Lambe T.W. & Whitman R.V. John Wiley & Sons. 1969.

2. Soil Mechanics in Engineering Practice. Terzaghi K., Peck R. B. & Mesri G. John Wiley & Sons. 1996.
3. Engineering Principles of Ground Modification. Hausmann M. R. McGraw Hill. 1990.

Digital Material

1. Ground Improvement Techniques
   https://nptel.ac.in/courses/105/108/105108075/

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Semester - II

(Professional Elective - II)

CEE4253	L-T-P-C
Advanced Steel Design	3-0-0-3
Prerequisite	Steel Design

Objective: *This course provides an advanced overview of the steel structures/ components by different design processes, analyze and design beams and columns and design welded and bolted connections.*

Course Outcomes: *On completion of this course: The students will be able to*:

1. *Design steel structures/ components by different design processes.*
2. *Analyze and design beams and columns for stability and strength, and drift.*
3. *Design welded and bolted connections.*

Course Content

Module 01: Properties of Steel: Mechanical Properties, Hysteresis, Ductility.
Hot Rolled Sections: compactness and non-compactness, slenderness, residual stresses.

Module 02: Design of Steel Structures: Inelastic Bending Curvature, Plastic Moments, Design Criteria Stability, Strength, Drift.

Module 03: Stability of Beams: Local Buckling of Compression Flange &Web, Lateral Torsional Buckling.

Module 04: Stability of Columns: Slenderness Ratio, Local Buckling of Flanges and Web, Bracing of Column about Weak Axis.

Module 05: Method of Designs: Allowable Stress Design, Plastic Design, Load and Resistance Factor Design.

Module 06: Strength Criteria: Beams - Flexure, Shear, Torsion, Columns - Moment Magnification Factor, Effective Length Interaction, Biaxial Bending, Joint Panel Zones. Drift Criteria: P Effect, Deformation Based Design.

Connections: Welded, Bolted, Location Beam Column, Column Foundation, Splices

Text/Reference Books

1. Design of Steel Structures - Vol. II, Ramchandra. Standard Book House, Delhi.
2. Design of Steel Structures - Arya A. S., Ajmani J. L., Nemchand and Bros., Roorkee.
3. The Steel Skeleton- Vol. II, Plastic Behaviour and Design - Baker J. F., Horne M. R., Heyman
4. J., ELBS.
5. Plastic Methods of Structural Analysis, Neal B. G., Chapman and Hall London.
6. IS 800: 2007 – General Construction in Steel - Code of Practice, BIS, 2007.
7. SP – 6 - Handbook ofStructural Steel Detailing, BIS,1987

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Semester - II

(Professional Elective - III)

CEE4254	L-T-P-C
Advanced Bridge Engineering	3-0-0-3
Prerequisite	Bridge Engineering

Objective: *The objective of this course is to: provide knowledge of loads and analysis for different types of bridges; impart knowledge for design of different types of RC bridges including bearings with relevant codes; provide knowledge for construction, inspection, and maintenance of bridges.*

Course Outcomes: *After the completion of the course, the student should be able to: demonstrate types of bridges, their components and selection of bridge site; analyse various types of bridges with appropriate loads and methods; design of bridges and bearings along with reinforcement details.*

Course Content

Module 01: Introduction

Site Investigation, Bridge Hydrology, Geometry of Bridges, Steel, R.C.C., Prestressed Road & Rail Bridges; Suspension & Cable Stayed Bridges: Bearings, Joints, etc.

Module 02: Design of Bridge Components

Grillage Analogy, Design of composite bridges (steel & concrete): box girder bridges in concrete. Design of abutments, piers & their foundations. Design of bearings.

Module 03: Bridge Maintenance

Construction methods & maintenance of bridges. Multi-beam & multi-cell R.C.C. bridges.

Text/Reference Books

1. Design of Bridge Structures. Jagadeesh T.R. Prentice-Hall International. 2nd Ed. 2009.
2. Elements of Bridge Engineering. Pant M.K. Katson Publication. 1st Ed. 2014.

Digital Material

1. Bridge Design Engineering. Prof. Nirjhar Dhang, IIT Kharagpur. https://nptel.ac.in/courses/105/105/105105165/

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Semester - II

(Professional Elective - III)

CEE4255	L-T-P-C
Design of Advanced Concrete Structures	3-0-0-3
Prerequisite	Design of RCC Structures

Objective: *The objective of this course is to: give student information about the analysis the special structures by understanding their behaviour; design and prepare detail structural drawings for execution citing relevant IS codes.*

Course Outcomes: *After the completion of the course, the student should be able to: Analyse the special structures by understanding their behaviour; design and prepare detail structural drawings for execution citing relevant IS codes.*

Course Content

Module 01: Introduction

Design philosophy, Modeling of Loads, Material Characteristics.

Module 02:

Reinforced Concrete - P-M, M-phi Relationships, Strut-and-Tie Method, Design of Deep Beam and Corbel, Design of Shear Walls, Compression Field Theory for Shear Design, Design against Torsion; IS, ACI and Eurocode.

Module 03:

Steel Structures - Stability Design, Torsional Buckling - Pure, Flexural and Lateral,

Module 04:

Design of Beam-Columns, Fatigue Resistant Design, IS code, AISC Standards and Eurocode.

Text/Reference Books

1. Reinforced Concrete Design, Pillai S. U. and Menon D., Tata McGraw-Hill, 3rd Ed, 1999.
2. Design of Steel Structures, Subramaniam N., Oxford University Press, 2008.
3. Reinforced Concrete Structures, Park R. and Paulay T., John Wiley & Sons, 1995.
4. Advanced Reinforced Concrete Design, Varghese P. C., Prentice Hall of India, New Delhi.
5. Unified Theory of Concrete Structures, Hsu T. T. C. and Mo Y. L., John Wiley & Sons, 2010.
6. Steel Structures Design and Behavior Emphasizing Load and Resistance Factor Design, Salmon C. G., Johnson J. E. and Malhas F. A., Pearson Education, 5th Ed, 2009.
7. Design of Steel Structures - Vol. II, Ramchandra. Standard Book House, Delhi.
8. Plastic Methods of Structural Analysis, Neal B.G., Chapman and Hall London

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Semester - II

(Professional Elective - IV)

CEE4256	L-T-P-C
Fracture Analysis & Non-Destructive Testing	3-0-0-3
Prerequisite	----------

Objective: *The subject deals with nucleation, growth & propagation of cracks in civil engineering structures & systems. Non-destructive techniques (NDT) which are used to inspect & predict failures will also be dealt in this subject.*

Course Outcomes: *On completion of this course the students will be able to understand the fracture mechanism and NDT test carried out in civil engineering.*

Course Content

Module 01: Introduction

Griffith's theory of brittle failures; Irwin's stress intensity factors; linear elastic fracture Mechanics.

Module 02: Analysis of crack

The stress analysis of crack tips, macroscopic theories in crack extension, Fatigue crack propagation.

Module 03: Crack theory and its applications

Fatigue crack growth theories, crack closure, microscopic theories of fatigue crack growth; Application of theories of fracture mechanics in design & materials development.

Module 04: NDT

Non-destructive testing methods in Civil Engineering: dye penetrant, magnetic particle testing, Ultrasonic testing, radiographic testing & acoustic emission.

Text/Reference Books

1. Fracture Mechanics Fundamentals & Applications. T. L. Anderson. CRC Press.
   1994.
2. Elementary Engineering Fracture Mechanics. Brock D. Maritinus Nijhoff Publishers.1982.
3. Fracture & Fatigue Control in Structures. Rolfe S. T. & Barson J. M. PHI. 1977

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Semester - II

(Departmental Elective - III)

CEE4257	L-T-P-C
Seismic Design of Foundation	3-0-0-3
Prerequisite	----------

Objective: *To make students capable of analyzing & designing various types of structural foundation exhibiting ample safety under probable earthquakes.*

Course Outcomes: *On completion of this course the students will be able to: understand the design of foundations so that it does not fail during earthquakes; major focus will be on the design of deep foundations for lateral loads.*

Course Content

Module 01: Introduction

Elements of earthquake, Seismic loading.

Module 02: Soil properties

Soil properties for seismic design; Earth pressure under seismic condition.

Module 03: Earthquake parameters

Liquefaction of soil; determination of ground acceleration; Damping of soil.

Module 04: Design

Foundation design under earthquake loading; Seismic design of slopes. Seismic design of reinforced concrete mat footing.

Text/Reference Books

1. Seismic Design of Reinforced Concrete Buildings. Moehle J. Tata Mc-Graw Hill
2. Geotechnical Earthquake Engineering. Kramer S.L. Pearson Publications. 3rdEd. 2003.

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Semester - II

(Professional Elective - IV)

CEE4258 L-T-P-C
Advanced Pre-stressed Concrete Design 3-0-0-3
Prerequisite Pre-stressed Concrete Design

Objective: *The objective of this course is to: illustrate principle of prestressing analysis, and design of prestressed concrete structures; analyze and design the pre-stressed concrete elements.*

Course Outcomes: *After the completion of the course, the student should be able to: Specify and characterize the materials required for prestressed concrete structures and various methods of prestressing; identify the various methods of prestressing; design the beams for shear, bond, and torsion; evaluate two-way prestressing & circular prestressing.*

Course Content

Module 01: Introduction

specification of materials, method of prestressing & losses of prestress. Concept of pre-tensioning & post-tensioning, minimum concrete grade.

Module 02: Analysis & design

Analysis & design of members for flexure, shear, bond & bearings. Cable layouts. Design of circular systems, domes & slabs. Stresses in anchorage zones of pre-tensioned & post-tensioned members, design of end block.

Module 03: Prestressing

Partial prestressing, two-way prestressing & circular prestressing. Design of pre-stressed bridges & continuous beams.

Text/Reference Books

1. Prestressed Concrete. Ramamrutham S. Dhanpat Rai & Sons Publication.1996.
2. Prestressed Concrete. Krishna Raju N. Tata McGraw-Hill Education. 2012.

Digital Material

1. Prestressed Concrete Design. Prof. A.K. Sengupta, IIT Madras. https://nptel.ac.in/courses/105/106/105106117/

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Semester - II

(Professional Elective - IV)

CEE4259	L-T-P-C
Repair and Rehabilitation of Structures	3-0-0-3
Prerequisite	Reinforced Concrete Structures

Objective: *The course seeks to recognize the mechanisms of degradation of concrete structures, provide the students with the knowledge of available techniques and their application for strengthening or upgrading existing structural systems. It also provides how to conduct field monitoring and non-destructive evaluation of concrete structures.*

Course Outcomes: *After the completion of the course, the student should be able to: understand the properties of fresh and hardened concrete; Know the strategies of maintenance and repair; understand the retrofitting strategies and techniques.*

Course Content

Module 01: Introduction

Deterioration of structures with aging; Need for rehabilitation. Effects due to climate, temperature, chemicals , wear and erosion , design and construction errors , corrosion mechanism , Effects of cover thickness and cracking, Method of corrosion production., corrosion inhibitors , corrosion resistant steels , coatings , cathodic production Distress in concrete /steel structures Types of damages; Sources or causes for damages; effects of damages; Case studies.

Module 02: Structural Health Monitoring

An overview of Structural Health Monitoring, Structural Health Monitoring and Smart Materials, Structural Health Monitoring versus Non-Destructive Testing, A broad overview of smart materials, Overview of Application potential of SHM.

Module 03: Maintenance and Repair Strategies

Special concrete and mortar, Concrete chemicals , special elements for accelerator, strength gain, expansive cement , polymer concrete , sulphur infiltrated concrete , ferro cement, fibre reinforced concrete. Shotcreting; Grouting; Epoxy-cement mortar injection; Crack ceiling.

Text/Reference Books

1. Diagnosis and treatment of structures in distress Raikar R.N. R&D Centre of Structural Designers & Consultants Pvt.Ltd. Mumbai, 1994.
2. Earthquake resistant design of structures Agarwal P. Shrikhande M. Prentice-Hall of India, 2006.
3. Handbook on Repair and Rehabilitation of RCC buildings, Published by CPWD, Delhi, 2002.

Digital Material

1. Repair & Rehabilitation of Structures Lecture Compilation. https://www.youtube.com/watch?v=i11zIlOeqfU

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Semester - II

(Professional Elective - IV)

CEE4260	L-T-P-C
Cost Management of Engineering Projects	3-0-0-3
Prerequisite	---

Objective: *The course will offer an overview of the Strategic Cost Management Process, cost concepts in decision-making and Quantitative techniques for cost management.*

Course Outcomes: *After the completion of the course, the student should be able to: understand Cost Management Process and apply the Quantitative techniques for cost management in engineering project.*

Course Content

Module 01: Introduction

Introduction and Overview of the Strategic Cost Management Process Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Module 02: Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance.

Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

Module 03: Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning,

Module 04: Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Module 05: Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Text/Reference Books

1. Cost Accounting: A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.