Jharkhand University of Technology Ranchi

Master of Technology

Course Structure & Syllabus

Department of Civil Engineering

December 2021

Specialization – Structural engineering

(With effect from Academic Year 2021-22)

Model Curriculumfor Postgraduate DegreeCourses of Civil Engineering Department of JUT 2021 Onwards

December 2021

Specialization – Structural engineering

M.Tech. In CE with Specialization in Structural Engineering (SemesterI)

Sl. No	Course Type	Subject code	Course Name	
1.	Core1	CEST1101	AdvancedStructuralAnalysis	3
2.	Core2		AdvancedSolidMechanics	3
3.	Program Elective-I	1. CEST1103 2. CEST1104 3. CEST1105 4. CEST1106 5. CEST1107	**Elective–I** 1. TheoryofThinPlates andShells 2. TheoryandApplicationsofCementComposites 3. TheoryofStructuralStability 4. Earthquake resistant design 5. Advanced concrete structure	3
4.	Elective-II	1. CEST1108 2. CEST1109 3. CEST1110 4. CEST1111 5. CEST1112	**Elective–II** 2. StructuralHealthMonitoring 3. Structural Optimization 4. Limit state design of structure 5. Fracture Mechanics	3
5.	Program Elective-III	1. CEST1113 2. CEST1114 3. CEST1115 4. CEST1116 5. CEST1117	**Elective–III** 1. DesignofPrestressedConcreteStructures 2. AnalysisofLaminatedComposite Plates 3. FractureMechanicsofConcrete Structures 4. DesignofPlates andShells 5.Maintenance And Rehabilitation Of Structures	3
6.	Core Lab I	CEST1201	Structural Design Lab	
7.	Core Lab II	CEST1202	Advanced Concrete Lab	2
8.	Compulsory Paper	RM 110C	ResearchMethodologyandIPR	2
9.	**A10001** **A10002** **A10003** **A10004**	**Audit I**	English for research paper writing Professional ethics Constitution of India Stress management by yoga	-
			Total credit	**21**

M. Tech. in CE with Specialization in Structural Engineering (SemesterII)

Sr. No	Course Type	Subject code	Course Name	Credit
1.	CoreIII	CEST2101	FEMinCivilEngineering(CEST2101)	3
2.	CoreIV	CEST2102	Structural Dynamics	3
3.	Program ElectiveIV	1. CEST2103 2. CEST2104 3. CEST2105 4. CEST2106 5. CEST2107	**Elective–IV** 1. AdvancedSteelDesign 2. DesignofFormwork 3. DesignofHigh-RiseStructures 4. DesignofMasonryStructures 5. Bridge engineering	3
4.	Program ElectiveV	1. CEST2108 2. CEST2109 3. CEST2110 4. CEST2111 5. CEST2112	**Elective–-V** 1. DesignofAdvancedConcrete Structures 2. STABILITY OF STRUCTURES 3. SoilStructureInteraction 4. DesignofIndustrialStructure 5. Concrete technology	3
5.	OpenElective I	1. CEST2113 **2. CEST2114** 3. CEST2115 **4. CEST2116** 5. CEST2117 **6. CEST2118**	1.BusinessAnalytics 2.**IndustrialSafety** 3.OperationsResearch 4.**CostManagementofEngineeringProjects** 5.Composite Materials 6.**WastetoEnergy**	3
6.	Core Lab III	CEST2201	ModelTestingLab	2
7.	Core Lab IV	CEST2202	NumericalAnalysisLab(CEST2202)	2
8.	Core	CEST2203	MiniProject	2
9.	**Audit II**	**A20001** **A20002** **A20003** **A20004**	Disaster management Value education Soft skills Personality development through life enlightenment skills	-
Total credit				**21**

M.Tech. In CE with Specialization in Structural Engineering (Semester III)

Sr No	Course Type	Code	Course Name	redit
1.	Dissertation	CEST3201	DissertationPhase–I	10
			Total credit	**10**

M.Tech. in CE with Specialization in Structural Engineering (SemesterIV)

Sr. No	Course Type	Code	Course Name	redit
1.	Dissertation	CEST 4201	DissertationPhase–II	16
			Total credit	**16**

SemesterI

Core 1 - CEST1101: Advanced Structural Analysis
(Credits-3:0:0= 3)

SyllabusContents:

Influence Coefficients: Physical Significance, Effects of Settlements, Temperature Change and Lack of Fit.

Stiffness Method applied to Large Frames: Local Coordinates and Global Coordinates.

Stiffness Matrix Assembly of Structures: Stiffness Matrix in Global Coordinates, Boundary Conditions, Solution of Stiffness Matrix Equations, Calculation of Reactions and Member Forces.

Applications to Simple Problems: Beams, Plane Trusses and Plane Rigid Jointed Frames by Structure Approach and Member Approach.

Boundary Value Problems (BVP): Approximate Solution of Boundary Value Problems, Modified Galerk in Method for One-Dimensional BVP

Linear Element: Shape Functions, Solution for Poisson's Equation, General One Dimensional Equilibrium Problem.

References:

1. Matrix AnalysisofFramed Structures, WeaverandGere.
2. TheFiniteElementMethod,Lewis P.E.and WardJ.P.,Addison-WesleyPublicationCo.
3. ComputerMethodsinStructuralAnalysis, MeekJ.L.,E andFNSpanPublication.
4. The FiniteElementMethod, DesaiandAble,CBSPublication.

Core 2 - CEST1102: AdvancedSolidMechanics
(Credits-3:0:0= 3)

Syllabus Contents:

Introduction toElasticity: Displacement, StrainandStressFields, ConstitutiveRelations, CartesianTensorsand EquationsofElasticity.

Strain and Stress Field: Elementary Concept of Strain, Stain at a Point ,Principal Strains and Principal Axes, Compatibility Conditions, Stress at a Point, Stress Components on an Arbitrary Plane, Differential Equations of Equilibrium, Hydrostatic and Deviatory Components.

Equations of Elasticity: Equations of Equilibrium, Stress- Strain relations, Strain Displacement and Compatibility Relations, Boundary Value Problems.

Two-Dimensional Problems of Elasticity: Plane Stress and Plane Strain Problems, Airy's stress Function, Two-Dimensional Problemsin Polar Coordinates.

Torsion of Prismatic Bars: Saint Venant's Method, Prandtl's Membrane Analogy, Torsion of Rectangular Bar.

Plastic Deformation: Strain Hardening, Idealized Stress- Strain curve, Yield Criteria, von Mises Yield Criterion, Tresca Yield Criterion, Plastic Stress-Strain Relations, Isotropic Hardening.

References:

1. Theory of Elasticity,Timo shenko S.andGoodierJ.N.,McGrawHill,1961.
2. Elasticity, Sadd M.H.,Elsevier,2005.
3. EngineeringSolid Mechanics, RagabA.R., BayoumiS.E.,CRCPress,1999.
4. Computational Elasticity, Ameen M., Narosa,2005.
5. Solid Mechanics, Kazimi S. M. A., Tata Mc GrawHill,1994.
6. Advanced Mechanics of Solids, Srinath L.S., Tata McGrawHill,2000.

Program Elective I - CEST1103: TheoryofThinPlatesandShells
(Credits-3:0:0= 3)

SyllabusContents:

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.

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.

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.

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

Shells of Revolution: with Bending R**esistance**-Cylindrical and Conical Shells, Application to Pipes and Pressure Vessels.

ThermalStressesinPlate/ Shell

References:

1. Theory of Plates and Shells, Timoshenko S. and KriegerW.,McGrawHill.
2. Stresses in Plates and Shells, Ugural Ansel C., Mc Graw Hill.
3. Thin Elastic Shells, KrausH., John Wiley and Sons.
4. Theory of Plates, Chandra shekhara K., Universities Press.
5. Design and Construction of Concrete Shells, Ramaswamy G.S.

Program ElectiveI-CEST1104: Theory and Applications of Cement Composites

(Credits- 3:0:0=3)

SyllabusContent:

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.

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.

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.

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

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

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

ReferenceBooks:

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

ProgramElectiveI-CEST1105: TheoryofStructuralStability
(Credits- 3:0:0= 3)

SyllabusContents:

Criteria for Design of Structures: Stability, Strength, and Stiffness, Classical Concept of Stability of Discrete and Continuous Systems, Linear and nonlinear behavior.

Stability of Columns: Axial and Flexural Buckling, Lateral Bracing of Columns, Combined Axial, Flexural and Torsion Buckling.

Stability of Frames: Member Buckling versus Global Buckling, Slenderness Ratio of Frame Members.

Stability of Beams: lateral torsion buckling.

Stability of Plates: axial flexural buckling, shear flexural buckling, buckling under combined loads.

Introduction to Inelastic Buckling and Dynamic Stability.

ReferenceBooks:

1. Theoryofelasticstability,TimoshenkoandGere,TataMc GrawHill,1981
2. Principles of Structural Stability Theory, Alexander Chajes, Prentice Hall,New Jersey.
3. Structural Stability of columnsand plates, Iyengar,N.G.R.,Easter nwest pressPvt. Ltd.
4. Strength of Metal Structures, Bleich F. Bucking, Tata Mc Graw Hill, NewYork.

Program Elective I-CEST1106: EARTHQUAKE RESISTANCE DESIGN

Elements of Seismology: Definitions of Magnitude, Intensity, Epicenter, etc., general features of tectonic of seismic regions, Seismographs.

Theory of Vibrations: Free vibrations of single degree, two degree and multiple degree freedom systems. Computation of dynamic response to time dependent forces.Vibration isolation.Vibration absorbers.

Principles of Earthquake Resistant Design Response spectrum theory. Brief introduction to accelerographs and S.R.R.'s.Nature of dynamic loading resulting from earthquakes. Application of Response spectrum

Theory to a seismic design to structures. Resistance of structural elements- and structures for dynamic loads, design criteria-strength and deflection. Ductility and absorption of energy

Dynamic Properties of Soils

Remedial measures and management of earthquake disaster

Reference:

1. Introduction to Indian Standard Codes IS: 1893 - 1984 and IS: 4326 – 1993
2. Earthquake resistance design of structure by Duggal- Oxford University Press.
3. Dynamics of structure by Clough R.W. and Penzin J. McGraw Hill Civil Engineering Series
4. Earthquake Resistant Design by David J. Downik, John Wiley and Sons Publication

Program ElectiveI-CEST1107: Advanced concrete structure

Course Content:

The nature of concrete, stress-strain relationship of concrete, stress-strain relationship of reinforcing steel, stress block parameters.

Failure criteria of concrete. Behavior of concrete flexural members, general equations for calculation of moment capacities at ultimate limit state and at limit state of local damage, flexural rigidity, calculation of deflection, redistribution of moments, design examples.

Axially loaded compression members, combined axial load and uniaxial bending. Interaction diagrams, combined axial load and biaxial bending, slender compression members, design example using IS: 456-2000.

Shear cracking of ordinary reinforced concrete members, web reinforcement, design examples, shear in tapered beams. Development length of reinforcement, anchorage.

Significance of Torsion, Torsional resistance of concrete beams, reinforcement for torsion, design examples. General principles, effective depths, detailing of reinforcement, design of main reinforcement, design of transverse reinforcement, conditions at loads and at supports. Yield line theory.

References:

1. Varghese P. C, Design of Reinforced Concrete Structures, Prentice Hall of India, 2004.
2. Varghese, P. C, Advanced Reinforced Concrete Design, Prentice Hall of India, 2005.
3. Unnikrishna Pillai and DevdasMenon ,Reinforced Concrete Design, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2006.
4. N. Krishna Raju, R. N. Pranesh, Reinforced Concrete Design: Principles and Practice, New Age International Pvt. Ltd. Publishers, 2009.
5. Sinha. N. C. and Roy S. K., Fundamentals of Reinforced Concrete, S. Chand and Company Limited, New Delhi, 2003

ProgramElectiveII–CEST1108: NumericalMethodsinCivilEngineering (Credits-3:0:0= 3)

SyllabusContents:

Fundamentals o f Numerical Methods: Error Analysis, Polynomial Approximations and Interpolations, and extrapolation.

Solution of Nonlinear Algebraic and Transcendental Equations: Bisection, False Position, Newton-Raphson, Successive approximation method, Iterative methods

Elements of Matrix Algebra: Solution of Systems of Linear Equations, Eigen Value Problems, Jacobi's method, Gauss-seidal method, successive over relaxation method.

Numerical Differentiation & Integration: Solution of Ordinary and Partial Differential Equations.

Finite Difference scheme: Implicit & Explicit scheme, Two point boundary value problem.

Correlation and Regression Analysis: Correlation- Scatter diagram, Karl Pearson coefficient of correlation, Limits of correlation coefficient; Regression –Lines of regression, Regression curves, Regression coefficient, Differences between correlation and regression analysis.

ReferenceBooks:

1. An Introduction to Numerical Analysis, Atkinson K.E., J. Wiley and Sons,1989.
2. TheoryandProblemsofNumericalAnalysis,ScheidF,McGrawHillBookCompany,(ShaumSeries),1988.
3. Introductory Methods of Numerical Analysis, Sastry S.S, Prentice HallofIndia,1998.

Program ElectiveII–CEST1109: Structural Health Monitoring
(Credits-3:0:0= 3)

Syllabus Contents:

Structural Health: Factors affecting Health of Structures, Causes of Distress, Regular Maintenance.
Structural Health Monitoring: Concepts, Various Measures, Structural Safety in Alteration.
Structural Audit: Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures.
Static Field Testing: Types of Static Tests, Simulation and Loading Methods, NDT and semi destructive testing, corrosion monitoring techniques.
Dynamic Field Testing: Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring.
Introduction to Repairs and Rehabilitations of Structures: Case Studies (Site Visits),electro–mechanical impedance(EMI) technique, adaptations of EMI technique.

ReferenceBooks:

1. Structural Health Monitoring, Daniel Balageas, Claus Peter Fritzen, Alfredo Güemes ,John
2. WileyandSons,2006.
3. Health MonitoringofStructuralMaterialsand ComponentsMethodswithApplications, DouglasEAdams,JohnWileyand Sons,2007.
4. Structural Health Monitoring and IntelligentInfrastructure,Vol1,J.P.Ou,H.Liand Z.D. Duan, Taylorand Francis Group, London,UK,2006.
5. Structural Health Monitoring withWaferActive Sensors,Victor Giurglutiu, Academic PressInc,2007.

Program ElectiveII–CEST1110: Structural Optimization
(Credits-3:0::0= 3)

SyllabusContents:

Introduction: Simultaneous Failure Mode and Design, Classical External Problems.
Calculus of Variation: Variational Principles with Constraints,
Linear Programming, Integer Programming, Nonlinear Programming, Dynamic Programming,
Geometric Programming and Stochastic Programming.
Applications: Structural Steel and Concrete Members, Trusses and Frames.
Design: FrequencyConstraint, DesignofLayouts.

ReferenceBooks:

1. ElementsofStructuralOptimization,Haftka,RaphaelT.,Gürdal,Zafer,Springer.
2. Variational methods for Structural optimization, Cherkaev Andrej, Springer

Program Elective II: CEST1111: Limit State Design of Structures

Introduction: Stress-Strain relationship; Fully Plastic moment and Plastic hinge, Simple cases of Plastic collapse: Simply supported and Fixed beams, Portal frames
Basic theorems: Principle of virtual work; Partial, Complete and Over-complete collapses. Upper bound, lower bound and uniqueness theorems
Design: Trial and Error method, combined mechanisms, plastic moment distribution Deflection: Moment-curvature relations, simple beams and portal frames. Deflection at collapse Minimum weight design: characteristic strength, partial factor of safety
Shear and Torsion, simply reinforced, doubly reinforced and Tee beams
Serviceability requirements: Deflection – long and short term deflections
Compression members: Axially loaded, short columns, slender columns, combined bending and axial forces, biaxial bending, and use of SP-16
Design of slabs in flexure failure: Yield line theory, work method, equilibrium method, strip method

References:
1. NEAL B. G.: Plastic method of Structural Analysis
2. PUNMIA B. C.: Limit State Design

ProgramElectiveII– CEST1112: Fracture Mechanics

Course Content:
Definition of stress intensity factor, Fracture toughness - Energy release rate, Critical Energy release rate - Crack mouth opening displacement, R-Curve and J integral - Basic reasons for fracture mechanics approach for concrete, Limitations of linear elastic fracture mechanics for concrete. Non-linear fracture method - Fracture energy and size effect.

Reference Books:
1. David Broek, Elementary Engineering Fracture Mechanics, Sijthoff and Noordhaff, Alphen Aan Den Rijn, The Netherlands, 2001.
2. Analysis of Concrete Structure by Fracture Mechanics, Ed L. Elfgren and S.P. Shah, Proc of Rilem Workshop, Chapman and Hall, London, 2001.
3. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India, 2009.
4. K. Ramesh, e-Book on Engineering Fracture Mechanics, IIT Madras, 2007.
5. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, Wiley, India, 5th Edition, 2014.

Program ElectiveIII-CEST1113: Design of Pre stressed Concrete Structures
(Credits- 3:0:0= 3)

Introduction to pre stressed concrete: types of pre stressing, stems and devices, materials, losses in pre stress. Analysis of PSClexural members: basic concepts, stresses at transfer and service loads, ultimate strength in flexure, code provisions.

Statically determinatePSC beams: design for ultimate and serviceability limit states for flexure, analysis and design for shear and torsion, code provisions.

Transmission of pre stress in pre tensioned members; Anchorage zone stresses for post tensioned members.

Statically indeterminate structures-Analysis and design-continuous beams and frames, Choice of cable profile.

Composite construction with precast PSC beams and cast in situ RC slab-Analysis and design, creep and shrinkage effects. Partial pre stressing -principles, analysis and design concepts, crack-width calculations

Analysisanddesign ofprestressedconcrete pipes,columnswithmoments.

References:

1. DesignofPrestressedConcreteStructures,LinT.Y.,AsiaPublishingHouse, 1955.
2. Prestressed Concrete, Krishnaraju N.,TataMcGrawHill,NewDelhi,1981.
3. LimitedStateDesignofPrestressedConcrete,GuyanY.,AppliedSciencePublishers,1972.
4. IS:1343-CodeofPracticeforPrestressedConcrete
5. IRC:112

Program ElectiveIII-CEST1114: Analytical and Finite Element Analysis of Laminated Composite Plates
(Credits-3:0:0= 3)

Syllabus Contents:

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.

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, Analytical Solutions for Bending of Rectangular Laminated Plates Using FSDT.

Finite Element Solutions for Bending of Rectangular Laminated Plates using CLPT.

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

Finite Element Solutions for Bending of Rectangular Laminated Plates using FSDT.

Finite Element Model, C^0 Element Formulation, Post Computation of Stresses.

Analysis of Rectangular Composite Plates using Analytical Methods.

References:

1. MechanicsofLaminated CompositesPlatesand Shells,ReddyJ.N.,CRC Press.

Program Elective III– CEST1115: Fracture Mechanics of Concrete Structures
(Credits- 3:0:0= 3)

SyllabusContents:

Introduction: Basic Fracture Mechanics, Crackina Structure, Mechanisms of Fracture and Crack Growth, Cleavage Fracture, Ductile Fracture, Fatigue Cracking, Environment assisted Cracking, Service Failure Analysis.

Stress at CrackTip: Stress at Crack Tip, Linear Elastic Fracture Mechanics, Griffith's Criteria, Stress Intensity Factors, Crack Tip Plastic Zone, Erwin's Plastic Zone Correction, R curves, Compliance, J Integral, Concept of CTOD and CMD.

Material Models: General Concepts, Crack Models, Band Models, Models based on Continuum Damage Mechanics, Applications to High Strength Concrete, Fibre Reinforced Concrete, Crack Concepts and Numerical Modeling.

ReferenceBooks:

1. Fracture Mechanics,SuriC.T.andJinZ.H.,1st Edition,ElsevierAcademicPress,2012.
2. Elementary Engineering Fracture Mechanics, Broek David,3rdRev.Ed.Springer,1982.
3.Fracture Mechanics of Concrete Structures–Theory and Applications, ElfgreenL., RILEM Report,ChapmanandHall,1989.
4.Fracture Mechanics–ApplicationstoConcrete,Victor,LiC.,BazantZ.P.,ACISP118,ACI Detroit,1989

Program ElectiveIII-CEST1116: Design of Plates and Shells
(Credits- 3:0:0= 3)

SyllabusContents:

Thin plates with small deflection; assumptions, governing differential equations and various boundary conditions.

Simply supported rectangular plates - Navier solution with various types of loads, rectangular plates with various boundary conditions - Levy's method, Axi-symmetric circular plates.

Approximate methods for plates like finite difference and energy methods.

Shells: structural behavior, classification, translational and rotational shells hyperbolic paraboloid- elliptic paraboloid- Gaussian curvature.

Membrane theory of shells- cylindrical shells- shells of revolution.

ReferenceBooks:

1. Theory of Plates and Shells, Timoshenko and Woinowsky- Krieger S.,Tata Mc Graw Hill Edition,2010.
2. Designand ConstructionofConcreteShellRoofs,RamaswamyG.S.,1stEdition,2005.
3. DesignofReinforcedConcrete Shells&FoldedPlate,VargheseP.C.,1st Edition,PHI.
4. Design of Plate and Shell Structures, Jawad Maan H., Springer Science.

ProgramElectiveIII-CEST1117: MAINTENANCE AND REHABILITATION OF STRUCTURES

SyllabusContents:

Quality assurance for concrete construction as built concrete properties strength, permeability, thermal properties and cracking. Effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection Definitions: Maintenance, repair and rehabilitation, Facets of and importance of Maintenance Preventive measures on various aspects Inspection, Assessment procedure for evaluating a damaged structure causes of deterioration-testing techniques. Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fiber reinforced concrete. Rust eliminators and polymers coating for rebars during foamed concrete, mortar repair for cracks, shoring and underpinning.

ReferenceBooks:

1. Raikar, R.N., Learning from failures – Deficiencies in Design, Construction and Service – R&D Centre (SDCPL), Raikar Bhavan, 1987.
2. Allen R.T., and Edwards S.C, Repairs of Concrete Structures, Blaike and Sons, U.K.1987.

RMC 1101	**Compulsory paper**	**Research Methodology & IPR**	**2**

Course Content

Unit-1: Research Problem and Scope for Solution: 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-2: Format: Effective literature studies approaches, analysis, Plagiarism, Research ethics. 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-3: Process And Development: 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-4: Patent Rights: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit-5: New Developments In IPR: 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. Stuart Melville and Wayne Goddard, "*Research methodology: an introduction for science & engineering students*"
2. Wayne Goddard and Stuart Melville, "*Research Methodology: An Introduction*"
3. Ranjit Kumar, 2nd Edition, "*Research Methodology: A Stepby Step Guide for beginners*"

Reference Books:

1. Halbert, "*Resisting Intellectual Property*", Taylor & Francis Ltd ,2007.
2. Mayall, "*Industrial Design*", McGraw Hill, 1992.
3. Niebel, "*Product Design*", McGraw Hill, 1974.
4. Asimov, "*Introduction to Design*", Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " *Intellectual Property in New Technological Age*", 2016.
6. T. Ramappa, "*Intellectual Property Rights Under WTO*", S. Chand, 2008

Semester II

Core 3 –CEST2101: Finite Element Method in Civil Engineering

(Credits- 3:0:0 = 3)

Syllabus Contents:

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.

Types: Triangular Elements, Rectangular Elements, Three-Dimensional Elements, Isoparametric Formulation, Axi-Symmetric Elements, Numerical Integration, Gaussian Quadrature

Discretization of a Continuum, Elements, Strains, Stresses, Constitutive, Relations, Hooke's Law, Formulation of Stiffness Matrix, Boundary Conditions, Solution Algorithms

Method of Weighted Residuals: Galerkin, Finite Element Method, Application to Structural Elements, Interpolation Functions, Compatibility and Completeness Requirements, Polynomial Forms, Applications.

Application of FEM: i) Solid Mechanics. ii) Seepage Analysis, iii) Foundation Analysis

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.
7. K.J. Bathe, Finite element procedures, PHI Ltd., 1996.
8. David M Potts and LidijaZdravkovic, "Finite Element Analysis in Geotechnical
9. Engineering Theory and Apllication", Thomas Telford. 1999

Core 4 – CEST2102: Structural Dynamics

(Credits - 3:0:0 = 3)

Syllabus Contents:

Introduction: Objectives, Importance of Vibration Analysis, Nature of Exciting Forces, Mathematical Modeling of Dynamic Systems.

Single Degree of Freedom System: Free andForced Vibration with and without Damping, Response to Harmonic Loading, Response to General Dynamic Loading using Duhamel's Integral, Fourier Analysis for Periodic Loading, State Space Solution for Response.

Numerical Solution to Response using Newmark Method and Wilson Method, Numerical Solution for State Space Response using Direct Integration.

Multiple Degree of Freedom System (Lumped parameter): Two Degree of Freedom System, Multiple Degree of Freedom System, Inverse Iteration Method for Determination of Natural Frequencies and Mode Shapes, Dynamic Response by Modal Superposition Method, Direct Integration of Equation of Motion.

Multiple Degree of Freedom System (Distributed Mass and Load): Single Span Beams, Free and Forced Vibration, Generalized Single Degree of Freedom System.

Special Topics in Structural Dynamics(Concepts only): Dynamic Effects of Wind Loading, Moving Loads, Vibrations caused by Traffic, Blasting and Pile Driving, Foundations for Industrial Machinery, Base Isolation.

Reference Books:

1. Dynamics of Structures, Clough R. W. and Penzien J., Mc Graw Hill.
2. Structural Dynamics andIntroduction to Earthquake Engineering, Chopra A. K.
3. Vibration ofStructures - Application in Civil Engineering Design, Smith J. W., Chapman and Hall.
4. Dynamics of Structures, Humar J. L., Prentice Hall.
5. Structural Dynamics - Theory and Computation, Paz Mario, CBS Publication.
6. Dynamics of Structures, Hart and Wong.

Program Elective IV– CEST2103: Advanced Steel Design (Credits - 3:0:0 = 3)

Syllabus Contents:

Properties of Steel: Mechanical Properties, Hysteresis, Ductility.

Hot Rolled Sections: compactness and non-compactness, slenderness, residual stresses.

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

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

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

Method of Designs: Allowable Stress Design, Plastic Design, Load and Resistance Factor Design;

Strength Criteria: Beams - Flexure, Shear, Torsion, Columns - Moment Magnification Factor, Effective Length, PM Interaction, Biaxial Bending, Joint Panel Zones.

Drift Criteria: P Effect, Deformation Based Design;

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

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 J., ELBS.
4. Plastic Methods of Structural Analysis, Neal B. G., Chapman and Hall London.
5. IS 800: 2007 – General Construction in Steel - Code of Practice, BIS, 2007.
6. SP – 6 - HandbookofStructural Steel Detailing, BIS,1987

Program Elective IV – CEST2104: Design of Formwork
(Credits - 3:0:0 = 3)

Syllabus Content:

Introduction: Requirements and Selection of Formwork.

Formwork Materials- Timber, Plywood, Steel, Aluminium, Plastic, and Accessories. Horizontal and Vertical Formwork Supports.

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

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

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

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

Reference Books:

1. Formwork for Concrete Structures, Peurify, Mc Graw Hill India, 2015.
2. Formwork for Concrete Structures, Kumar NeerajJha, Tata McGraw Hill Education, 2012.
3. IS 14687: 1999, False workfor Concrete Structures - Guidelines, BIS.

Program Elective IV – CEST2105: Design of High-Rise Structures
(Credits - 3:0:0 = 3)

Syllabus Content:

Design of transmission/ TV tower, Mast and trestles: Configuration, bracing system, analysisand design for vertical transverse and longitudinal loads.

Analysis and Design of RC and Steel Chimney, Foundation design for varied soil strata.

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

Applicationof software in analysis and design.

Reference Books:

1. Structural Design of Multi-storeyed Buildings, Varyani U. H., 2nd Ed., SouthAsian Publishers,New Delhi, 2002.
2. Structural Analysis and Design of Tall Buildings, Taranath B. S., Mc Graw Hill, 1988.
3. Illustrated Design of Reinforced ConcreteBuildings(GF+3storeyed), Shah V. L. &Karve S. R., Structures Publications, Pune, 2013.
4. Design of Multi Storeyed Buildings, Vol. 1 & 2, CPWD Publications, 1976.
5. Tall Building Structures, Smith Byran S. and Coull Alex, Wiley India. 1991.
6. High Rise Building Structures, Wolfgang Schueller, Wiley., 1971.
7. Tall Chimneys, Manohar S. N., Tata Mc Graw Hill Publishing Company, New Delhi

Program Elective IV - CEST2106: Design of Masonry Structures
(Credits- 3:0:0 = 3)

Syllabus Contents:

Introduction: Historical Perspective, Masonry Materials, Masonry Design Approaches, Overview of Load Conditions, Compression Behavior of Masonry, Masonry Wall Configurations, Distribution of Lateral Forces.

Flexural Strength of Reinforced Masonry Members: In plane and Out-of-plane Loading.

Interactions: Structural Wall, Columns and Pilasters, Retaining Wall, Pier and Foundation.

Shear Strength and Ductility of Reinforced Masonry Members.

Prestressed Masonry - Stability of Walls, Coupling of Masonry Walls, Openings, Columns, Beams.

Elastic and Inelastic Analysis, Modeling Techniques, Static Push Over Analysis and use of Capacity Design Spectra.

Reference Books:

1. Design of Reinforced Masonry Structures, Narendra Taly, ICC, 2nd Edn,
2. Masonry Structures: Behavior and Design, Hamid Ahmad A. and Drysdale Robert G., 1994.
3. Mechanics of Masonry Structures, Editor: Maurizio Angelillo, 2014.
4. Earthquake-resistant Design of Masonry Buildings,Tomaevi Miha, Imperial College Press, 1999.

Program Elective IV– CEST2107: BRIDGE ENGINEERING
(Credits - 3:0:0 = 3)

Syllabus Contents:

General Considerations: Types of bridges, economic spans, aesthetics, selection of suitable type of bridge

Design Loads and their Distribution: IRC loads, railway loading, analysis of deck slab for IRC loads, load distribution among longitudinal beams of a bridge.

Design of Superstructure: Design of balanced cantilever concrete bridge. Introduction to R.C. arch bridge, Prestressed concrete bridge and box girder bridge. Design of lattice girder Railway Bridge

Design of Substructure: Different types of foundations, their choice and method of construction. Design of well foundation. Design of piers and Abutments. Various types of bearings and their Design.

Construction Methods: Introduction to construction methods, erection of bridge super structures, cantilever construction.

Reference Books:

1. Ponnuswamy, S., Bridge Engineering, Tata McGraw – Hill, New Delhi, 1997.
2. Victor, D. J., Essentials of Bridge Engineering, Oxford and IBH Publishers Co., New Delhi, 1980.
3. N. Rajagopalan, Bridge Superstructure, Narosa Publishing House, New Delhi, 2006.
4. Jagadeesh. T. R. and Jayaram. M. A., Design of Bridge Structures, Prentice Hall of India Pvt. Ltd., 2004.
5. Raina. V. K., Concrete Bridge Practice, Tata McGraw Hill Publishing Company, New Delhi, 1991.

Program Elective V – CEST2108:Design of Advanced ConcreteStructures
(Credits - 3:0:0 = 3)

Syllabus Contents:

Design philosophy, Modeling of Loads, Material Characteristics.

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.

Steel Structures -- Stability Design, Torsional Buckling - Pure, Flexural and Lateral, Design OfBeam-Columns, Fatigue Resistant Design, IS code, AISC Standards and Eurocode.

References Books:

1. Reinforced Concrete Design, Pillai S. U. and MenonD., Tata McGraw-Hill, 3rd Ed, 1999.
2. Design of Steel Structures, SubramaniamN., Oxford University Press, 2008.
3. Reinforced Concrete Structures, Park R.andPaulayT. , 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, SalmonC. G., Johnson J. E. and Malhas F. A., Pearson Education, 5th Ed, 2009.
7. Design ofSteel Structures - Vol. II, Ramchandra. Standard Book House, Delhi.
8. Plastic Methods of Structural Analysis, Neal B.G., Chapman and Hall London.

Program Elective V–CEST2109: STABILITY OF STRUCTURES(Credits-3:0:0= 3)

Syllabus Contents:

Buckling of columns – introduction – concepts of stability – methods of Neutral Equilibrium – Euler column – Eigen value problem – Axially loaded column – Eccentrically loaded column , Energy principle – Raleigh Ritz method – Galerk in method – Numerical methods (New mark's difference and matrix methods) Beams and Beam columns – introduction – lateral buckling of beams – beam column with concentrated and distributed loads – effect of axial load on bending stiffness Buckling of frames – introduction – modes of buckling – critical load using various methods Neutral equilibrium – slope deflection equations, matrix method. Buckling of plates – Differential equation of plate bucklings – critical loan on plates for various boundary conditions – Energy method – Finite difference method.

References Books:

1. Timoshenko and Gere. Theory of elastic stability, McGraw Hill Book Company, 1981
2. Alexandar Chajes, Principles of Structural Stability Theory, Prentice Hall, New Jersey, 1980
3. Iyenger, N.G.R. Structural Stability of columns and plates, Affiliated East west press Pvt Ltd., 1990.
4. Bleich F. Buckling Strength of metal structures, McGraw Hill 1991.

Program Elective V–CEST2110: Soil Structure Interaction
(Credits- 3:0:0= 3)

SyllabusContents:

Critical Study of Conventional Methods of Foundation Design, Nature and Complexities of Soil Structure Interaction.

Application of Advanced Techniques of Analysis such as FEM and Finite Difference Method. Relaxation and Interaction for the Evaluation of Soil Structure Interaction for Different Types of Structure under various Conditions of Loading and Subsoil Characteristics.

Preparation of Comprehensive Design Oriented Computer Programs for Specific Problems, Interaction Problems based on Theory of Sub Grade Reaction Such as Beams, Footings, Rafts Etc.

Analysis of Different Types of Frame Structures Founded on Stratified Natural Deposits with Linear and Non-Linear Stress-Strain Characteristics.

Determination of Pile Capacities and Negative Skin Friction, Action of Group of Piles Considering Stress-Strain Characteristics of Real Soils, Anchor Piles and Determination of Pullout Resistance.

ReferenceBooks:

1. AnalyticalandComputerMethodsinFoundation,BowelsJ.E.,McGrawHillBookCo.,NewYork,1974.
2. NumericalMethodsinGeotechnicalEngineering,DesaiC.S.andChristianJ.T.,McGrawHillBookCo., NewYork.
3. Soil Structure Interaction-The real behavior of structures, Institution of Structural Engineers.
4. Elastic Analysis of Soil Foundation Interaction, Developments in Geotechnical Engg.Vol-17, Elsevier Scientific Publishing Company.
5. Elastic Analysis of Soil-Foundation Interaction, Selvadurai A.P.S., Elsevier Scientific PublishingCompany.
6. Analysis & Design of substructures, Swami Saran, Oxford& IBH Publishing Co. Pvt. Ltd.
7. Design of Foundation System-Principles & Practices, Kurian N.P.,Narosa Publishing

Program Elective V-CEST2111: Design of Industrial Structures
(Credits-3:0:0= 3)

Syllabus Contents:

Steel Gantry Girders–Introduction, loads acting on gantry girder, permissible stress, types of gantry girders and crane rails, crane data, maximum moments and shears, construction detail, design procedure.

Portal Frames–Design of portal rame with hinge base, design of portal frame with fixed base-Gable Structures–Light weight Structures

Steel Bunkers and Silos–Design of square bunker–Jansen's an dAiry'stheories– IS Code provisions–Design of side plates–Stiffeners–Hooper–Longitudinal beams Design of cylindrical silo–Side plates–Ring girder–stiffeners.

Chimneys–Introduction, dimensions of steel stacks, chimney lining, breech openings and access ladder, loading and load combinations, design considerations, stability consideration, design of base plate, design of foundation bolts, design of foundation.

Water Tanks–Design of rectangular riveted steel water tank–Tee covers–Plates–Stays–Longitudinal and transverse beams–Design of staging–Base plates–Foundation and anchor bolts.

Design of pressed steel water tank–Design of stays–Joints–Design of hemispherical bottom water tank–side plates–Bottom plates–joints–Ring girder–Design of staging and foundation.

ReferenceBooks:

1. Design of Steel Structure, Punmia B.C.,Jain Ashok Kr.,Jain Arun Kr.,2ndEd.,Lakshmi Publishers, 1998.
2. Design of Steel Structures, Ram Chandra,12thEd.,StandardPublishers,2009.
3. Design of Steel Structures, Subramaniyam.

Program ElectiveV–CEST2112: CONCRETE TECHNOLOGY

Syllabus Contents:

Concrete as a construction material: introduction, classification, properties, and grades, of concrete, concept of quality control

Concrete ingredients: Cement-different types and its applications, aggregates- classification, characteristics and properties, alkali-aggregate reaction, water- quality and curing, admixtures and mineral additives

Properties of fresh and hardened concrete: workability, segregation, bleeding, strength,elasticity, shrinkage, creep, durability, acid attack, efflorescence, fire resistance, micro-cracking of concrete, Air entrained concrete, light weight and high densityconcrete.

Rheology of concrete: introduction, representation of rheological behavior, factors affecting rheological properties, mixture adjustment.

Mix design:High strength concrete andlight weight aggregate concrete.

ReferenceBooks:

1. P. Kumar Metha and Paulo J. M. Monteiro., Concrete: Microstructure, Properties and Materials, Mc Graw Hill, Fourth Edition, 2014.
2. John Newman and Ban Seng Choo, Advanced Concrete Technology Part 1 to 4, Butterworth-Heinemann, First Edition, 2003
3. Adam. M. Nevillie., Properties of Concrete, Wiley Publications, Fourth and Final Edition, 1996.
4. A. R. Santha kumar, Concrete Technology" Oxford University Press, 2006.
5. P. C. Aitcin, High Performance Concrete, E & FN SPON, 1998.

OPENELECTIVES: CEST2113: Business Analytic

Syllabus Contents:

Unit1:
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and Organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of Probability distribution and data modeling, sampling and estimation methods overview.

Unit2:
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression.
Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Unit3:
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuringcontribution of Business analytics, Managing Changes.
Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Unit4:
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression
Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.
Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, News vendor Model, Overbooking Model, Cash Budget Model.

Unit5:
Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Unit6:
Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytellingand Data journalism.

Reference:

1. BusinessanalyticsPrinciples,Concepts,andApplicationsbyMarcJ.Schniederjans,DaraG. Schniederjans, Christopher M.Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

OPENELECTIVES: CEST2114: Industrial Safety

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 act1948 for health and safety, washrooms, 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, I. Anyone machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. 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 :I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG)sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Reference:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H.P.Garg,S.ChandandCompany.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman &Hall London.

Open elective: CEST2115: Operation Research

Unit	Course Content	Contact Hours
1.	Optimization Techniques, Model Formulation, models, General L.R Formulation, SimplexTechniques, Sensitivity Analysis, Inventory Control Models	9
2.	Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplexmethod - sensitivity analysis - parametric programming	8
3.	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT	9
4.	Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.	10
5.	Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	8

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Open Elective: CEST2116: Cost Management of Engineering Projects

Unit	Course Content	Contact Hours
1.	Introduction and Overview of the Strategic Cost Management Process	4
2.	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.	8
3.	Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as a conglomeration of technical and non- technical 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	9
4.	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, 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.	10
5.	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	8

References:

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.

Open Elective: CEST2117: Composite Material

Unit	Course Content	Contact Hours
1.	**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.	4
2.	**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. Iso-strain and Iso-stress conditions.	8
3.	**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.	9
4.	**Manufacturing of Polymer Matrix Composites:** Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.	10
5.	**Strength:** Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hydrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.	8

References:

1. Material Science and Technology– Vol13– CompositesbyR.W.Cahn–VCH, West Germany.
2. Materials Scienceand Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, JohnWiley&Sons,NY,Indianedition,2007.
3. Hand BookofCompositeMaterials-ed-Lubin.
4. Composite Materials–K.K.Chawla.
5. Composite MaterialsScienceand Applications–DeborahD.L.Chung.
6. CompositeMaterialsDesignandApplications–DanialGay,SuongV.Hoa,andStephenW. Tasi.

Open Elective: CEST2118: Waste to Energy

Unit	Course Content	Contact Hours
1	Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors	4
2	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.	8
3	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.	9
4	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.	10
5	Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technologyand 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.	8

References:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.

Core Lab3–(CEST2201): Model Testing Lab
(Credits-0:0:4= 2)

Lab:2hrs/wk

Experiments:
Response of structures and its elements against extreme loading events.
Model Testing: Static –testing of plates, shells, and frames models.
Model Testing: Free and forced vibrations, Evaluation of dynamic modulus.
Beam vibrations, Vibration isolation, Shear wall building model, Time and frequency-domain study, Vibration Characteristics of RC Beams using Piezoelectric Sensors etc.

Core Lab 4–(CEST2202): Numerical Analysis Lab
(Credits- 0:0:4= 2)

Lab:2hrs/wk

Find the Roots of Non-Linear Equation Using Bisection Method.
Find the Roots of Non-Linear Equation Using Newton's Method.
Curve Fitting by Least Square Approximations.
Solve the System of Linear Equations Using Gauss-Elimination Method.
Solve the System of Linear Equations Using Gauss-Seidal Iteration Method.
Solve the System of Linear Equations Using Gauss-Jorden Method.
Integrate numerically using Trapezoidal Rule.
Integrate numerically using Simpson's Rules.
Numerical Solution of Ordinary Differential Equations By Euler's Method.
Numerical Solution of Ordinary Differential Equations By Runge-Kutta Method.

Core-(CEST2203): Mini Project
(Credits- 0:0:4= 2)

Lectures: 4hrs/wk

Guideline:

Mini Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.

End semester presentation should based on the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.

Continuous assessment of Mini Project at Mid Sem and End Sem will be monitored by the departmental committee.

Core-Dissertation I: CEST 3201
(Credits- 0:0:20= 10)

TeachingHours: 3hrs/week

Guideline:
Dissertation-I, will have mid semester presentation and end semester presentation. Mid semester Presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.

End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions and must bring out individuals contribution.

Continuous assessment of Dissertation–I and Dissertation–II at Mid Sem and End Sem will be monitored by the departmental committee.

Core-Dissertation: CEST 4201
(Credits-0:0:32= 16)

TeachingHours: 3hrs/week

Guideline:
Dissertation–II will be extension of the work on the topic identified in Dissertation–I.

Continuous assessment should be done of the work done by adopting the methodology decided involving numerical analysis/conduct experiments, collection and analysis of data, etc. There will be pre-submission seminar at the end of academic term. After the approval the student has to submit the detail report and external examiner is called for the viva-voce to assess along with guide.