SCHEME OF INSTRUCTION AND SYLLABI

Master of Engineering

A TWO-YEAR PG Program

in

M.E. (Structural Engineering)

(R–26 Regulation)

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

(Autonomous Institution under UGC, Affiliated to Osmania University)

DEPARTMENT OF CIVIL ENGINEERING

Accredited by NBA and NAAC-UGC

Chaitanya Bharathi (Post), Gandipet, Hyderabad–500075

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

OUR MOTTO: SWAYAM TEJASWIN BHAVA

VISION and MISSION of the INSTITUTE

Vision

To be a centre of excellence in technical education and research.

Mission

To address the emerging needs through quality technical education

and advanced research

VISION and MISSION of the Department of Civil Engineering

Vision

To strive for excellence in academics, research and consultancy in the field of Civil Engineering and contribute to the sustainable development of the country by producing quality Civil Engineers with professional and ethical values.

Mission

1. Maintaining high academic standards to develop analytical thinking and independent judgment among the students, so that they are fit for industry and higher studies.
2. Promoting skills and values among the students to prepare them as responsible global citizens who can solve complex problems.
3. Preparing the students as good individuals and team members with a professional attitude, ethics, and concern for the environment and zeal for lifelong learning who can contribute to society.

DEPARTMENT OF Civil ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PG)

PEO 1: Analyze and design structural systems in compliance with the guidelines of various codes.

PEO 2: Identify and employ sustainable, alternative, and cost-effective materials in construction with strict quality control practices in place.

PEO 3: Communicate effectively, and demonstrate leadership qualities and professional ethics.

PEO 4: Engage in life-long learning for career growth and to rise to societal needs.

PROGRAM OUTCOMES (PG)

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.

PO4: Formulate/refine the problem and apply suitable methods of solution that result in a sustainable outcome.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

M.E. (STRUCTURAL ENGINEERING)

SEMESTER – I

S. No.	Course Code	Title of Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	26CEC101	Advanced Structural Analysis	3	0	0	3	40	60	3
2	26CEC102	Theory of Elasticity	3	0	0	3	40	60	3
4	Program Specific Elective -I		3	0	0	3	40	60	3
5	Program Specific Elective -II		3	0	0	3	40	60	3
6	26MEM103	Research Methodology and IPR	2	0	0	2	40	60	2
7	Audit Course -I		2	0	0	2	-	50	Pass / Fail
PRACTICALS									
8	26CEC103	Structural Design Lab	0	0	3	-	50	-	1.5
9	26CEC104	Advanced Concrete Lab	0	0	3	-	50	-	1.5
10	26CEC105	Numerical Analysis Lab	0	0	2	-	50	-	1.0
TOTAL			16	0	9	-	350	350	18

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**

T: Tutorial **P: Practical/Mini Project /Dissertation** **SEE: Semester End Examination**

Course Code	Program Specific Elective -I	Course Code	Program Specific Elective -II
26CEE101	Theory of Plates and Shells	26CEE104	Design of Masonry Structures
26CEE102	Design of Advanced Concrete Structure	26CEE105	Advanced Concrete Technology
26CEE103	Project Planning & Management	26CEE106	Theory of Structural Stability

Audit Course- I and II

Course Code	Course
26EGA101	English for Research Paper Writing
26CEA101	Disaster Mitigation and Management
26 EEA101	Sanskrit for Technical Knowledge
26ECA101	Value Education
26EGA102	Constitution of India
26ADA101	Pedagogy Studies
26EGA103	Stress Management by Yoga
26EGA104	Personality Development through Life Enlightenment Skills

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

M.E. (STRUCTURAL ENGINEERING)

Semester II

Sl. No.	Course Code	Title of Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	26CEC106	Finite Element Method in Structural Engineering	3	0	0	3	40	60	3
2	26CEC107	Structural Dynamics	3	0	0	3	40	60	3
3	26CEC108	Planning & Design of Precast Structures	3	0	0	3	40	60	3
4	Program Specific Elective - III		3	0	0	3	40	60	3
5	Program Specific Elective - IV		3	0	0	3	40	60	3
PRACTICALS									
6	26CEC109	Model Testing Lab	0	0	2	-	50	-	1
7	26CEC110	Finite Element Method Lab	0	0	2	-	50	-	1
8	26CEC111	Mini Project with Seminar	0	0	2	-	50	-	1
TOTAL			15	0	6	-	350	300	18

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**

T: Tutorial **P: Practical/Mini Project /Dissertation** **SEE: Semester End Examination**

Course Code	Program Specific Elective -III	Course Code	Program Specific Elective - IV
26CEE107	Pre-Engineered Buildings	26CEE110	Design of Tall Buildings
26CEE108	Advanced Foundation Design	26CEE111	Repair & Retrofitting of Structures
26CEE109	Design of Hydraulic Structures	26CEE112	Design of Bridges

Audit Course- I and II	
Course Code	**Course**
26EGA101	English for Research Paper Writing
26CEA101	Disaster Mitigation and Management
26 EEA101	Sanskrit for Technical Knowledge
26ECA101	Value Education
26EGA102	Constitution of India
26ADA101	Pedagogy Studies
26EGA103	Stress Management by Yoga
26EGA104	Personality Development through Life Enlightenment Skills

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

M.E. (STRUCTURAL ENGINEERING)

SEMESTER – III

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
THEORY									
1	Program Specific Elective- V		3	0	0	3	40	60	3
2	Open Elective		3	0	0	3	40	60	3
3	Audit Course II		2	0	0	2	-	50	Pass / Fail
PRACTICALS									
3	26CEC112	Dissertation Phase- I	0	0	20	-	100	-	10
TOTAL			8	0	20	-	180	170	16

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**

T: Tutorial **P: Practical/Mini Project /Dissertation** **SEE: Semester End Examination**

Course Code	Program Specific Elective-V
26CEE113	Design of Steel-Concrete Composite Structures
26CEE114	Earthquake-Resistant Design of Structures
26CEE115	Design of Industrial Structures
OPEN ELECTIVES	
Course Code	**Course**
26CSO101	Business Analytics
26MEO101	Industrial Safety
26MEO102	Introduction to Optimization Techniques
26CEO101	Cost Management of Engineering Projects
26MEO103	Composite Materials
26EEO101	Waste to Energy

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

M.E. (STRUCTURAL ENGINEERING)

Semester IV

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
PRACTICALS									
1	26CEC113	Dissertation Phase-II	0	0	32	-	100	100	16
TOTAL			0	0	32	-	100	100	16

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**

T: Tutorial **P: Practical/Mini Project /Dissertation** **SEE: Semester End Examination**

Semester	I	II	III	IV	Total
Credits	18	18	16	16	**68**

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

(AICTE Model Curriculum with effect from AY 2023-24)

M.E. (STRUCTURAL ENGINEERING)

SEMESTER – I

S. No.	Course Code	Title of Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	26CEC101	Advanced Structural Analysis	3	0	0	3	40	60	3
2	26CEC102	Theory of Elasticity	3	0	0	3	40	60	3
4	Program Specific Elective -I		3	0	0	3	40	60	3
5	Program Specific Elective -II		3	0	0	3	40	60	3
6	26MEM103	Research Methodology and IPR	2	0	0	2	40	60	2
7	Audit Course -I		2	0	0	2	-	50	Pass / Fail
PRACTICALS									
8	26CEC103	Structural Design Lab	0	0	3	-	50	-	1.5
9	26CEC104	Advanced Concrete Lab	0	0	3	-	50	-	1.5
10	26CEC105	Numerical Analysis Lab	0	0	2	-	50	-	1.0
TOTAL			16	0	9	-	350	350	18

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**

T: Tutorial **P: Practical/Mini Project /Dissertation** **SEE: Semester End Examination**

Course Code	Program Specific Elective -I	Course Code	Program Specific Elective -II
26CEE101	Theory of Plates and Shells	26CEE104	Design of Masonry Structures
26CEE102	Design of Advanced Concrete Structure	26CEE105	Advanced Concrete Technology
26CEE103	Project Planning & Management	26CEE106	Theory of Structural Stability

Audit Course- I and II

Course Code	Course
26EGA101	English for Research Paper Writing
26CEA101	Disaster Mitigation and Management
26 EEA101	Sanskrit for Technical Knowledge
26ECA101	Value Education
26EGA102	Constitution of India
26ADA101	Pedagogy Studies
26EGA103	Stress Management by Yoga
26EGA104	Personality Development through Life Enlightenment Skills

26CEC101

ADVANCED STRUCTURAL ANALYSIS

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

To enable the student:

1. Gain knowledge of using matrix methods of structural analysis - stiffness and flexibility methods to analyze indeterminate beams.
2. Learn the basic concepts of analysis of redundant trusses using flexibility and stiffness methods.
3. Learn the basic concepts of the analysis of frames and grids using the stiffness method
4. To understand the deflection response of columns against compressive loads and inelastic buckling.
5. Understand the concepts of beams on elastic foundations with semi-infinite and infinite lengths

Course Outcomes:

After the completion of the course, the student will be able to

1. Analyze continuous beams using force and displacement approaches (flexibility & stiffness approaches) of matrix methods
2. Analyze pin-jointed indeterminate trusses by flexibility and stiffness methods.
3. Analyze rigid jointed plane frames and grids by the stiffness method.
4. Determine the capacity of a column due to local buckling and inelastic buckling.
5. Applies the concepts of (beams of semi-infinite and infinite lengths) an elastic foundation to field problems and analytical models.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	2	2	2
CO2	2	2	1	1
CO3	2	1	3	2
CO4	2	3	2	2
CO5	3	2	2	3

UNIT- I:

Introduction to matrix methods of structural analysis: Static and kinematic indeterminacies, Matrix formulations by force and displacement methods, Analysis of continuous beams by force and displacement methods with degree redundancy and freedom not exceeding three.

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UNIT- II:

Analysis of redundant trusses: by Flexibility and Stiffness approach with degree redundancy and freedom not exceeding three.

UNIT- III:

Analysis of rigid-jointed plane frames and grids: By using the stiffness approach with the degree of freedom not exceeding three.

UNIT- IV:

Column Buckling: Concept of Column Buckling - Deflection Response of Columns to Compressive Loads - Euler Buckling of Columns with General End Constraints - Local Buckling of Columns - Inelastic Buckling of Columns.

UNIT- V: Beam Columns

Beams on elastic foundation: Introduction-Modulus of foundation and basic equation - Beams of infinite length under concentrated and uniformly distributed loads- Analysis of semi-infinite beams making use of functions for infinite beams.

Text Books:

1. William Weaver and James M. Gere, "*Matrix Analysis of Framed Structures* ", CBS, 2004.
2. Devadas Menon," *Advanced Structural Analysis*", Narosa, 2009.
3. K. Jain, "*Advanced Structural Analysis*", Nem Chand & Bros.2015.

Suggested Reading:

1. R. C. Hibbler," *Structural Analysis*", Pearson, 2015.
2. P. Seshu," *Textbook of Finite Element Analysis*", PHI, 2003.

26CEC102

THEORY OF ELASTICITY

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course objectives:

To enable the student

1. To make the students understand the concepts of elasticity and equip them with the knowledge to independently handle the problems of elasticity.
2. To enhance the competency level and develop self-confidence through quality assignments in the theory of Elasticity and plasticity.
3. To inculcate the habit of researching and practicing in the field of elasticity.
4. To Analyse the stresses and displacements of elements within the elastic range and thereby to check the sufficiency of their strength, stiffness and stability.
5. To deal with the stresses and displacements of a structural in the shape of a bar, straight or curved, which is subjected to tension, compression, shear, bending or torsion.

Course Outcomes:

At the end of the course, the student will be able to:

1. Formulate differential equilibrium equations in 3D and transform stress components.
2. Analyze the problems of Plane Stress and Plane Strain.
3. Apply Airy's stress function for 2-D problems of elasticity in Cartesian Coordinates.
4. Apply Airy's stress function for 2-D problems of elasticity in Polar Coordinates.
5. Analyze prismatic bars of various cross sections under torsion using membrane analogy and energy methods.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	1	2	1
CO2	3	1	2	1
CO3	3	1	2	1
CO4	3	1	2	1
CO5	3	2	2	3

UNIT- I:

Definition of stress and strain: Notation of stresses in three dimensions – Generalized Hooks law. General Theorems: Differential equations of equilibrium in 3-D - Equations of Equilibrium in terms of displacements – Boundary Conditions - conditions of compatibility - Transformation of stress components under change of co- ordinate system.

UNIT- II:

Plane stress and plane strain: differential equations of equilibrium - boundary conditions – compatibility equations stresses on an oblique plane – Stress Invariants - principal stresses - stress ellipsoid-max shear stresses- Octahedral shear stress–Strain energy per unit volume - Strain of a line element - principal strains.

UNIT- III:

Two-dimensional problems in rectangular coordinates: Airy's Stress function Applications - solution by polynomials - Saint- Venant's principle - determination of displacements - bending of simple beams - gravity loading.

UNIT- IV:

Two-dimensional problems in polar coordinates: Airy's stress function - general solution of two-dimensional problem in polar coordinates - stress distribution symmetrical about an axis – Effect of hole on stress distribution in a plate in tension, Stresses in a circular disc under diametrical loading - strain components in polar coordinates

UNIT- V:

Torsion of Prismatic Bars: torsion of prismatic bars - bars with elliptical cross sections – other elementary solution - membrane analogy - torsion of rectangular bars-solution of torsion problems by energy method-use of soap films in solving torsion problems

Suggested Reading:

1. Timoshenko S. and Goodier, "*Theory of Elasticity*", Mc Graw hill Publications, 2015.
2. S. Singh, "*Theory of Elasticity*", Khanna Publishers, 2003

26CEE101

THEORY OF PLATES AND SHELLS
(PROGRAM SPECIFIC ELECTIVE-I)

Instruction	3 Hours per week
Duration	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
To enable the students to

1. Understand the analysis of thin rectangular plates under pure bending and also the classical solutions to plate problems using Navier's and Levy approaches.
2. Understand the analysis of axi-symmetric circular plates and know the application of approximate methods to rectangular plate problems.
3. Comprehend the stability analysis of thin rectangular plates and know the thermal analysis of rectangular and circular plates
4. Get acquainted with the classification of shells and analysis of thin shells using DKJ and Schorer's theories
5. Understand the membrane theory of shell analysis and determine the stresses & displacements in shells of different geometrical shapes subjected to dead and snow loads.

Course Outcomes: At the end of the course, the student will be

1. Analyze thin rectangular plates under pure bending and provide classical solutions to plate problems.
2. Analyze axi-symmetric circular plates and employ approximate methods to rectangular plate problems.
3. Analyze the plate problems for stability and thermal stresses.
4. Distinguish between different shell roofs and analyze thin shells by DKJ and Schorer's theories.
5. Able to perform the shell analysis using membrane theory.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	2	3	2	2
CO2	2	3	2	2
CO3	3	3	2	2
CO4	2	2	3	2
CO5	3	3	3	3

UNIT- I:

Static Analysis of Thin Plates: Introduction, Pure bending of plates, Relations between slope and curvature of slightly bent plates, Moment-curvature relations in pure bending. Strain energy in pure bending. Governing Differential Equation for a Rectangular Plate, Solution of simply supported rectangular plates under various loading conditions Viz. uniformly distributed load (full or partial) concentrated load by the Navier approach. Levy type solution for rectangular plates under U.D.L with all four edges simply supported or two opposite edges simply supported and the other two fixed.

UNIT- II:

Circular Plates: Analysis under axi-symmetric Loading, Governing Differential Equation in Polar Co-ordinates, uniformly loaded plates at Centre, Circular plates with circular holes at the center.

Approximate Methods of Analysis: Rayleigh-Ritz approach for Simple Cases like UDL and Point load in Rectangular Plates.

UNIT- III:

Buckling of Plates: Calculation of critical loads-buckling of simply supported rectangular plates-uniformly compressed in one and two directions with different edge conditions, and web crippling.

Thermal Stresses in Plates: Introduction, Stress-strain & displacement relations, Stress resultants, governing differential equations, simply supported rectangular plate subjected to an arbitrary temperature distribution, simply supported rectangular plate with temperature distribution varying over the thickness, Axi-symmetrically heated circular plates.

UNIT- IV:

Thin shells: Introduction**,** Definitions and classification of shell Surfaces, Space Curves, Shell Co-ordinates, Strain Displacement Relations, general behavior and common theories of shells, load resistance action of a shell, Assumptions in Shell Theory, Displacement Field Approximations, Stress Resultants, Equation of Equilibrium using Principle of Virtual Work, Boundary Conditions. DKJ and Schorer's theories

UNIT- V:

Static Analysis of Shells: Membrane Theory of Shells**,** Equilibrium equations for a differential shell element, Calculation of stresses and displacements due to dead loads and snow loads for circular cylindrical shell, Conical and Spherical Shells.

Text Books:

1. S. Timoshenko and W. Krieger," *Theory of Plates and Shells"*, McGraw-Hill Education, 2017.
2. C. Ugural Ansel, "*Stresses in Plates and Shells*", CRC Press,2009.

Suggested Reading:

1. K. Chandrashekhara, "*Theory of Plates*", Universities Press, 2000.
2. G. S. Ramaswamy, "*Design and Construction of Concrete Shells*", CBS, 2005.

26CEE102

DESIGN OF ADVANCED CONCRETE STRUCTURES
(PROGRAM SPECIFIC ELECTIVE-I)

Instruction	3 Hours per week
Duration	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

This course aims to

1. To make the students effectively analyse and design Curved and Deep Beams.
2. To enable the students learn the analysis and design procedures for bunkers and silos.
3. To make the student attain the detailed knowledge to understand the performance of flat slabs and design them using both DDM and EFM.
4. To make the students understand the structural behaviour of Raft, Pile and Machine foundations and be able to design them.
5. To make them understand and appreciate the importance of ductile detailing. The students should also be able to design solid shear walls.

Course outcomes:

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

1. Analyse and Design curved and deep beam as per the field requirements.
2. Evaluate the stresses in domes for various loads and design them.
3. Analyse and design Bunkers and Silos.
4. Evaluate structural behaviour of Raft, Pile and Machine foundations and design them.
5. Implement ductile detailing and also design solid shear walls.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	3	2	2
CO2	2	3	2	1
CO3	3	3	3	1
CO4	3	3	1	3
CO5	2	3	1	2

UNIT – I:

Beams curved in plan: Introduction – Design Principles – Structural Design of beams circular and semi- circular in plan, continuously and symmetrically supported, rectangular in cross-section. Deep Beams: Introduction – flexural and shear stresses in deep beams. – I.S. Code provisions – design of simply supported and continuous Deep beams.

UNIT – II:

Domes: Introduction - Bunkers and Silos: Introduction - Design principles and theories - IS Code provision - design of rectangular bunkers - design of cylindrical silos.

UNIT – III:

Flat Slabs: Introduction, components, IS code provisions, Design Methods, design for flexure and shear

UNIT – IV:

Pile foundations: Structural design of piles and pile caps with both odd and even number piles

UNIT – V:

Ductile Detailing: Ductile detailing of RCC beams and columns using IS: 13920 -2016 code Design of Shear Walls: Design and Detailing of Shear Walls considering shear wall- frame Interaction in a tall RC structure subjected to seismic loading.

Text Books:

1. N. Krishna Raju, "Advanced Reinforced Concrete Design", CBS Publishers, 2016.
2. H.J. Shah, "Reinforced Concrete", Charotar Publishers, 2025.

Suggested Reading:

1. P. C. Varghese, "Advanced Reinforced Concrete Design", PHI, 2005
2. B. C. Punmia, Ashok Kumar Jain," Comprehensive R.C.C. Designs", Laxmi Pub. 2005

With effect from the academic year 2026-27

26CEE103

PROJECT PLANNING AND MANAGEMENT
(PROGRAM SPECIFIC ELECTIVE-I)

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

To enable the student:

1. Understand the fundamentals of project planning and organization including project life cycle, feasibility studies, and organizational structures in construction projects.
2. Develop project schedules using network techniques such as Bar Charts, CPM, and PERT for effective time planning and sequencing of structural works.
3. Apply resource planning and cost control techniques for efficient utilization of manpower, materials, and equipment in construction projects.
4. Understand risk, quality, and contract management principles involved in structural project execution and construction safety.
5. Familiarize with modern project management tools and techniques including software-based scheduling, monitoring, and sustainable project management practices.

Course Outcomes:

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

1. Analyze project planning processes including feasibility studies, WBS development, and project documentation.
2. Apply CPM and PERT techniques to develop optimized construction schedules under deterministic and probabilistic conditions.
3. Evaluate resource allocation strategies and perform cost control using budgeting and earned value methods.
4. Assess risks, quality systems, and contractual procedures in structural project management.
5. Implement modern project management software tools for monitoring, reporting, and sustainable project execution.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	2	2	3	2
CO2	2	1	3	3
CO3	3	2	3	3
CO4	2	2	3	3
CO5	2	3	3	3

UNIT- I

Project Planning and Organization: Introduction to project management – Characteristics of construction and structural projects – Project life cycle – Feasibility studies – Project identification and formulation – Work Breakdown Structure (WBS) for structural projects – Organizational structures in construction industry – Roles and responsibilities of project manager – Project planning and documentation – Project information systems.

UNIT- II

Project Scheduling Techniques: Bar charts and milestone charts – Network techniques – Network fundamentals – Activity sequencing – Network construction – Critical Path Method (CPM) – Forward and backward pass computations – Float calculations – Time optimization – Program Evaluation and Review Technique (PERT) – Expected time calculation – Variance and probability of completion – Scheduling under uncertainty.

UNIT- III

Resource Planning and Cost Control: Resource planning for manpower, materials, and equipment – Resource allocation methods – Resource leveling and smoothing – Construction cost estimation – Budgeting and cost control – Cash flow forecasting – Earned Value Management (EVM) – Project monitoring and control – Time-cost trade-off analysis in structural works.

UNIT- IV

Project Risk, Quality, and Contract Management: Risk identification in structural projects – Risk analysis and mitigation strategies – Safety management in construction – Quality planning and quality assurance – Quality control in structural works – Contract management – Types of contracts in construction – Tendering process – Claims and dispute resolution methods – Legal aspects in structural project execution.

UNIT- V

Modern Project Management Tools and Techniques: Project management software concepts – Introduction to scheduling tools (Primavera / MS Project concepts) – Resource and cost tracking using software – Project tracking and reporting – Performance measurement – Project closure procedures – Case studies of structural engineering projects – Sustainable project management practices.

Text Books:

1. K. K. Chitkara, Construction Project Management: Planning, Scheduling and Controlling, 4th Edition, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 2019.
2. K. K. Sharma, Construction Project Management, Pearson Education India, 2011.
3. K. K. Chitkara, Project Planning and Control, Tata McGraw-Hill Education, New Delhi, 2009.

Suggested Reading:

1. *K. G. Krishnamurthy and S. V. Ravindra, Construction and Project Management, CBS Publishers & Distributors, 2017.*
2. *C. Alan Twort and J. Gordon Rees, Civil Engineering Project Management, 4th Edition, Elsevier, 2017.*
3. *Saleh A. Mubarak, Construction Project Scheduling and Control, 3rd Edition, John Wiley & Sons, 2015.*

ONLINE RESOURCE:

1. *https://onlinecourses.nptel.ac.in/noc26_mg77/preview.*
2. *https://nptel.ac.in/courses/110105167*

26CEE104

DESIGN OF MASONRY STRUCTURES
(PROGRAM SPECIFIC ELECTIVE-II)

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

To enable the student to understand the fundamental concepts of

1. Masonry materials and its mechanical properties.
2. Analysis and the behavior of structural masonry
3. Shear and flexural behavior of Reinforced and unreinforced masonry
4. Summarize construction practices, seismic behavior, specifications, for Design of masonry
5. Seismic evaluation and Retrofit of Masonry.

Course Outcomes:

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

1. Select appropriate masonry unit and mortar mixes for masonry construction.
2. Distinguish from a wide range of materials for their suitability to arrive at feasible and optimal solutions for masonry constructions.
3. Apply knowledge of structural masonry for advanced research and construction procedures.
4. Justify the design of masonry buildings for sustainable development.
5. Repair and strengthen the existing masonry structures for seismic loads

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	1	1	--	1
CO2	2	2	1	1
CO3	3	2	2	2
CO4	2	2	1	2
CO5	2	2	1	1

UNIT - I:

Introduction to Masonry construction - National and International perspective – Historical development, Modern masonry, Principles of masonry design, Masonry standards: IS 1905 and others. Material Properties - Masonry units: clay and concrete blocks, Mortar, grout and reinforcement, Bonding patterns, Shrinkage and differential movements.

UNIT - II:

Masonry in Compression - Prism strength, Eccentric loading, Kern distance. Masonry under Lateral loads - In- plane and out-of-plane loads, Analysis of perforated shear walls, Lateral force distribution - flexible and rigid diaphragms.

UNIT -III:

Behavior of Masonry-Shear and flexure-Combined bending and axial loads Reinforced and unreinforced masonry - Cyclic loading and ductility of shear walls for seismic design – Infill masonry.

UNIT - IV:

Structural design of Masonry - Working and Ultimate strength design - In- plane and out-of-plane design criteria for load-bearing and infills, connecting elements and ties - Consideration of seismic loads - Code provisions.

UNIT - V:

Seismic evaluation and Retrofit of Masonry - In-situ and non-destructive tests for masonry - properties - Repair and strengthening of existing masonry structures for seismic loads.

Text Books:

1. P. Dayaratnam and P. Sarah, "*Brick and Reinforced Brick Structures*", Oxford & IBH Publishing Co, 2017.
2. R.G.Drysdale, A.H. Hamid and L.R. Baker, "*Masonry Structures: Behavior & Design"*, Prentice Hall Hendry, 1994.
3. A.W. Hendry, B.P. Sinha and S. R. Davis, "*Design of Masonry Structures*", E & FN Spon, UK, 1997.

Suggested Reading:

1. S. Sahlin, "*Structural Masonry*", Prentice Hall, Englewood Cliffs, NJ, 1971.
2. R.S. Schneider and W.L. Dickey, "*Reinforced Masonry Design*", Prentice Hall, 3rd edition, 1994.

26CEE105

ADVANCED CONCRETE TECHNOLOGY
(PROGRAM SPECIFIC ELECTIVE-II)

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

To enable the student:

1. Understand the composition, hydration mechanisms, and properties of cement, aggregates, and admixtures influencing concrete performance.
2. Analyze the behavior of fresh and hardened concrete including workability, strength relationships, creep, shrinkage, and durability parameters.
3. Evaluate the requirements, properties, and design considerations of high-performance and high-strength concretes.
4. Assess the characteristics, production methods, and applications of various special concretes used in modern construction.
5. Apply mix design procedures and advanced testing techniques for evaluating durability and performance of reinforced concrete structures.
6.

Course Outcomes:

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

1. Explain the chemistry of cement hydration, aggregate properties, grading methods, and the role of admixtures in concrete.
2. Analyze the properties of fresh and hardened concrete including workability, strength relationships, creep, shrinkage, and maturity concepts.
3. Evaluate the performance requirements and design considerations for high-performance concrete and high-strength concrete.
4. Evaluate the suitability and applications of special concretes such as self-compacting, fiber reinforced, geo-polymer, reactive powder, and 3D printed concrete.
5. Design concrete mixes using BIS and ACI methods and evaluate durability and performance using non-destructive and microstructural analysis techniques.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	2	1	3	1
CO2	3	1	3	2
CO3	3	2	3	3
CO4	2	1	3	2
CO5	3	2	3	3

UNIT- I

Concrete Making Materials: Bogue's compounds - Hydration process - Types of cement - Aggregates Mineral and Chemical Characterization of aggregates - Gradation curves - Fullers Curve - Grading Evaluation and Specifications - Alkali silica reaction - Admixtures: mineral and chemical admixtures - Secondary Pozzolanic Reaction due to mineral admixtures – Efficiency Concept.

UNIT- II

Fresh and Hardened Concrete: Fresh concrete - Workability tests on concrete- Workability tests on Self Compacting Concretes - segregation and bleeding. Hardened Concrete - Abram's law - Gel- space ratio - Maturity concept - Stress Strain behavior, Creep and Shrinkage.

UNIT- III

High Performance and High Strength Concretes: High performance concrete - Requirements and properties of high-performance concrete - Design considerations – High strength concrete – Design considerations

UNIT- IV

Special Concretes: Light weight concrete - Self Compacting concrete - Polymer concrete Fiber reinforced concrete – Reactive powder concrete - Bacterial concrete-Geo-polymer concrete – Requirements and guidelines- Advantages and Applications – Porous pavement – White Topping – Roller compacted concrete. Concrete 3D Printing.

UNIT- V

Concrete Mix Design: Quality control - Quality assurance - Quality audit - Mix design by various methods - BIS method - ACI method Mix Design of self-compacting concrete by IS 10262 -2019.

Performance Evaluation of Reinforced Concrete Members: Durability of concrete & Corrosion tests - Resistivity of concrete - Half Cell Potential - Rapid Chloride Penetration Test - Macro cell Corrosion - Effects of concrete exposed to acidic environment - Durability Factor - Accelerated Corrosion Cracking Test - Non-destructive evaluation of concrete structures – Rebound Hammer, Ultrasonic Pulse Velocity - Evaluation of Dynamic Shear & Young's Modulus - XRD & SEM Analysis, Fourier Transform Infrared Spectroscopy.

Text Books:

1. *Properties of Concrete*, A. M. Neville, 5th Edition, 2012, Pearson Education
2. *Concrete Microstructure, Properties and Materials*, P. K. Mehta and Paulo J. M. Monteiro, 4th Edition, 2013, McGraw-Hill
3. *Concrete Technology*, M. L. Gambhir, 6th Edition, 2025, Tata McGraw-Hill Pres

Suggested Reading:

1. *Corrosion of Steel in Concrete*, P. Schiessel, 1st Edition, 1988, Chapman & Hall.
2. *Concrete Making Materials*, Sandor Popovics, 2nd Edition, 1992, Hemisphere Publishing Corporation.
3. *Aggregates in Concrete*, Mark Alexander & Sydney Mindess, 2nd Edition, 2025, Taylor & Francis.
4. *Cement Based Composites*, Andrzej M. Brandt, 2nd Edition, 2005, CRC Press / Taylor & Francis.

ONLINE RESOURCE:

https://nptel.ac.in/courses/105106176.

23CEE106

THEORY OF STRUCTURAL STABILITY
(PROGRAM SPECIFIC ELECTIVE-II)

Instruction	3 Hours per week
Duration	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

To enable the student

1. Learn the fundamentals of elastic and inelastic buckling of columns and general principles of elastic stability of framed structures
2. Knows a mathematical treatment to the stability problems of discrete and continuous systems using Eigen value solutions
3. Understand the bucking of thin-walled members considering torsion, warping, axial loading and combined bending and torsion
4. Grasp the concepts of lateral buckling of beams and applying energy methods
5. Comprehend the concepts of buckling of rectangular plates for simply supported edge condition and also combination of simply supported and other edge condition.

Course Outcomes:

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

1. Applied the concepts of elastic and in elastic stability to columns and the concepts of elastic stability to frames.
2. Uses Eigen value solution to solve the stability problems of discrete and continuous systems
3. Analyses the buckling problems of this walled member including torsion, wrapping axial loading and bending.
4. Deals with the problems of lateral buckling of beams & applies energy methods
5. Solve the problems of buckling of rectangular plates with simply supported and other edge conditions

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	3	3	3
CO2	3	3	3	2
CO3	3	3	2	3
CO4	3	3	2	3
CO5	3	3	2	3

UNIT- I:

Buckling of Columns: Introduction - Methods of finding critical loads, critical loads for straight columns with different end conditions and loading. Inelastic buckling of axially loaded columns- Energy methods- Prismatic and Non-prismatic columns under discrete and distributed loadings - General Principles of elastic stability of framed structures.

UNIT- II:

Mathematical Treatment of Stability Problems - Critical loads for discrete systems – Discrete Eigen value problem - Buckling of continuous systems - Continuous Eigen value problem - Orthogonally relation - Methods of converting continuous Eigen value problem to a discrete problem.

UNIT- III:

Buckling of Thin-Walled Members of Open Cross Section - Torsion of thin-walled bars – Warping - Non- uniform torsion - Torsional buckling under axial loading - Combined bending and torsion buckling.

UNIT- IV:

Lateral Buckling of Beams - Beams under pure bending - Cantilever and simply supported beams of rectangular and I sections - I Beams under transverse loading - Energy methods - Solution of simple problems.

UNIT- V:

Buckling of Rectangular Plates - Plates simply supported on all edges and subjected to constant compression in one or two directions - Plates simply supported compression in one or two directions - Plates simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides.

Text Books:

1. Timoshenko and Gere, "*Theory of Elastic Stability*", 2nd Edition, Tata McGraw Hill, 2010.
2. Stephen H. Crandall, "*Engineering Analysis-A Survey of Numerical Procedures*", Krieger Publishing Co., 1986.
3. Bleich," *Buckling of Metal Structures*", McGraw Hill Book Co. New York, 1952.

Suggested Reading:

1. Alexander Chajes, "*Principles of Structural Stability Theory*", Prentice Hall Inc., 1974.
2. N.G.R Iyengar, "*Structural Stability of Columns and Plates"*, Ellis Horwood Ltd, 1988.
3. Coxhl, "*The Buckling of Plates and Shells",* H.L. Pergaman press, 1963.

With effect from the academic year 2026-27

26MEM103

RESEARCH METHODOLOGY AND IPR

Instruction	2 Hours per week
Duration	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Course Objectives:

To make the students to

1. Motivate to choose research as career
2. Formulate the research problem, prepare the research design
3. Identify various sources for literature review and data collection report writing
4. Equip with good methods to analyze the collected data
5. Know about IPR copyrights

Course Outcomes:

Upon completion of this course, students will be able to:

1. Define research problem, review and asses the quality of literature from various sources
2. Improve the style and format of writing a report for technical paper/ Journal report, understand and develop various research designs.
3. Collect the data by various methods: observation, interview, questionnaires.
4. Analyze problem by statistical techniques: ANOVA, F-test, and Chi-square.
5. Understand apply for patent and copyrights.

CO-PO Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	2	3
CO2	3	3	3	2	2	2
CO3	3	2	2	1	2	1
CO4	3	1	2	2	3	2
CO5	3	3	3	3	3	3

UNIT - I

Research Methodology: Research Methodology: Objectives and Motivation of Research, Types of Research, research approaches, Significance of Research, Research Methods verses Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Selection of Research Problem, Necessity of Defining the Problem

UNIT - II

Literature Survey Report writing: Literature Survey: Importance and purpose of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. Report writing: Meaning of interpretation, layout of research report, Types of reports, Mechanics of writing a report. Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal

UNIT- III

Research Design: Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Steps in sample design, types of sample designs.

UNIT - IV

Data Collection and Analysis: Data Collection: Methods of data collection, importance of Parametric, non parametric test, testing of variance of two normalpopulation, use of Chi-square, ANOVA, Ftest, z-test

UNIT - V

Patents and Copyright: Patent: Macro economic impact of the patent system,Patent document, How to protect

your inventions. Granting of patent, Rights ofa patent, how extensive is patent protection. Copyright: What is copyright. What is covered by copyright? How long does copyright last? Why protect copyright? Related Rights: what are related rights? Enforcement of IntellectualProperty Rights: Infringement of intellectual property rights, Case studies of patents and IP Protection

Text Books:

1. C.R Kothari, "Research Methodology, Methods & Technique"; NewAge International Publishers, 2004
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers , 2011
3. Y.P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Publs., Pvt., Ltd., New Delhi, 2004.

Suggested Reading:

1. Ajit Parulekar and Sarita D' Souza, "Indian Patents Law – Legal & Business Implications"; Macmillan India ltd , 2006
2. B. L.Wadehra; "Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications"; Universal law Publishing Pvt. Ltd., India2000.
3. P. Narayanan; "Law of Copyright and Industrial Designs"; Eastern law House, Delhi 2010.

23CEC103

STRUCTURAL DESIGN LAB

Instruction	3 Hours per week
Duration	3 Hours
SEE	50 Marks
CIE	
Credits	1.5

Course Objectives:

To enable the student

1. Learn the 3D structural modelling of buildings using analysis software.
2. Know the method of applying gravity, seismic, and wind loads using manual and software methods.
3. Grasp the concept of analysing structural elements using standard engineering principles.
4. Understand the concept of design isolated footings and reinforced concrete T-beams.
5. Learn the preparation of structural and reinforcement drawings as per standard practices.

Course Outcomes:

At the end of the course, student is able to

1. Develop 3D structural models using analysis software.
2. Apply gravity, seismic, and wind loads using manual and software methods.
3. Analyze reinforced concrete structural elements.
4. Design isolated footings and RC T-beams.
5. Prepare structural and reinforcement drawings.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	2	3	1
CO2	3	3	2	2
CO3	3	3	2	2
CO4	3	3	2	3
CO5	2	1	3	2

List of Experiments:

1. Development of a three-dimensional (3D) structural model of a building using structural analysis software.
2. Determination and application of gravity loads (dead load and imposed load) on a 3D building model using structural analysis software.
3. Evaluation and application of seismic loads on a 3D building model using the Equivalent Static Load Method (ESLM) using structural analysis software.
4. Manual calculation and application of wind loads on a building model.
5. Determination and application of wind loads on a 3D building model using structural analysis software.
6. Structural design of isolated footings using an Excel-based design sheet (group exercise).
7. Preparation of detailed structural drawings for a building.
8. Structural analysis of a reinforced concrete T-beam section using structural analysis software.
9. Structural design of a reinforced concrete T-beam using design software.
10. Preparation of detailed structural drawings for a reinforced concrete T-beam.

Text Books:

1. V. L. Shah and V. R. Karve, “Illustrated Design of Reinforced Concrete Buildings (Design of G+3 Storeyed Buildings + Earthquake Analysis & Design) “, Assorted Editorial; 8th edition (2017).
2. SP: 34 (1987),”Handbook on Concrete Reinforcement and Detailing”, Bureau of Indian Standards.

Suggested Reading:

1. IS: 456(2000),”Plain and Reinforced Concrete-Code of Practice”, Bureau of Indian Standards.
2. SP: 16 (1978),”Design Aids for Reinforced Concrete to IS456:1978", Bureau of Indian Standards
3. IS 1893(Part-1): 2016, “Criteria for Earthquake Resistant Design of Structures”, Bureau of Indian Standards

23CEC104

ADVANCED CONCRETE LAB

Instruction	3 Hours per week
Duration	3 Hours
SEE	50 Marks
CIE	0 Marks
Credits	1.5

Course Objectives:

To enable the student

1. To know the different concrete-making materials and their influence on the properties of conventional and special concretes
2. To understand the different tests for fresh and hardened state properties of conventional and special concretes
3. To study the different non-destructive tests on concrete
4. To comprehend the various durability tests for concrete

Course Outcomes:

At the end of the course, the student can

1. Design the mix proportions for ordinary, standard and high-strength grades of conventional and special concretes
2. Evaluate the fresh and hardened state properties of conventional concretes
3. Evaluate the fresh and hardened state properties of Self-Compacting concretes
4. Assess the condition of concrete using non-destructive tests
5. Determine the durability and corrosion characteristics of concrete through different tests

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	2	3	3	2
CO3	2	3	3	2
CO4	3	3	3	2
CO5	3	3	3	2

List of Experiments / Assignments:

1. Study on the effect of water-cement ratio on the properties of concrete.
2. Study on the effect of aggregate-powder ratio on the properties of concrete.
3. Study on the effect of fine aggregate-coarse aggregate ratio on the properties of concrete.
4. Mix design of Ordinary, Standard and High Strength grades of concrete as per IS: 10262 and determine the consistency.
5. Mix design of Self Compacting Concrete as per IS: 10262 & EFNARC guidelines and determine the fresh state properties using Slump-Flow Test, t500 test, V-Funnel test, L-Box test, Sieve segregation resistance test
6. Correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture.
7. Non-Destructive Testing (NDT) of Concrete:
    a. Rebound Hammer test
    b. Ultrasonic Pulse Velocity (UPV) test
8. Half-cell Potential test.

Text Book:

1. M. Neville," *Properties of concrete*", 5th Edition, Prentice Hall, 2012
2. M. S. Shetty, "Concrete *technology"*, S. Chand and Co., 2006

23CEC105

NUMERICAL ANALYSIS LAB

Instruction	3 Hours per week
Duration	2 Hours
SEE	50 Marks
CIE	0 Marks
Credits	1.0

Course Objectives:

To enable the student

1. Apply the stiffness method to analyse continuous beams and trusses and compute member forces, reactions, and displacements.
2. Design doubly reinforced concrete beams for flexure and shear and RC isolated footings for flexure, one-way shear, and two-way (punching) shear as per IS code.Design RC slabs and interpret moment–curvature relationships to assess ductility and post-yield behaviour of RC sections.
3. Simulate and analyse the dynamic response of MDOF systems and determine natural frequencies, mode shapes, and time-history responses.
4. Utilise MATLAB built-in functions to implement numerical methods, solve structural problems, and validate analytical results computationally

Course Outcomes:

At the end of the course, student is able to

1. Apply the stiffness method to analyse continuous beams and trusses and compute member forces, reactions, and displacements.
2. Design doubly reinforced concrete beams for flexure and shear and RC isolated footings for flexure, one-way shear, and two-way (punching) shear as per IS code.
3. Design RC slabs and interpret moment–curvature relationships to assess ductility and post-yield behaviour of RC sections.
4. Simulate and analyse the dynamic response of MDOF systems and determine natural frequencies, mode shapes, and time-history responses.
5. Utilise MATLAB built-in functions to implement numerical methods, solve structural problems, and validate analytical results computationally

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	**3**	2	**3**	**3**
CO2	2	2	**3**	**3**
CO3	2	2	**3**	2
CO4	**3**	2	**3**	**3**
CO5	**3**	1	2	**3**

List of experiments:

1. Analysis of a continuous beam using stiffness method.
2. Analysis of a truss using stiffness method
3. Design of a RC doubly reinforces beam for flexure.
4. Design of a RC doubly reinforces beam for shear.
5. Design of a RC isolated footing for flexure.
6. Design of a RC isolated footing for one way and two way shear.
7. Design of a RC slab.
8. Dynamic response of MDOF systems.
9. Moment curvature relationships for beams.
10. MATLAB built in functions.

Text Books:

1. Aslam Kassimali, "Matrix Analysis of Structures", Cengage Learning; 2nd edition (2011).
2. A.S. Meghre and S.K. Deshmukh, "Introduction to Matrix Methods of Structural Analysis", Charotar Publishing House; 3rd edition (2015).
3. R.C. Hibbeler, "Structural Analysis", Pearson; 10th edition (2017).
4. W. McGuire, R.H. Gallagher and R.D. Ziemian, "Matrix Structural Analysis", John Wiley & Sons; 2nd edition (2000).
5. S. Unnikrishna Pillai and Devdas Menon, "Reinforced Concrete Design", Tata McGraw-Hill; 3rd edition (2009).
6. N. Krishna Raju, "Design of Reinforced Concrete Structures", CBS Publishers & Distributors; 4th edition (2015).
7. B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, "Reinforced Concrete Design", Laxmi Publications; 11th edition (2006).
8. P.C. Varghese, "Limit State Design of Reinforced Concrete", PHI Learning; 2nd edition (2002).
9. Ray W. Clough and Joseph Penzien, "Dynamics of Structures", McGraw-Hill; 3rd edition (1995).
10. Anil K. Chopra, "Dynamics of Structures: Theory and Applications to Earthquake Engineering", Pearson; 4th edition (2012).
11. Roy R. Craig and Andrew Kurdila, "Fundamentals of Structural Dynamics", John Wiley & Sons; 2nd edition (2006).
12. A. Jain, "Dynamics of Structures with MATLAB® Applications", Pearson India; 1st edition (2016).
13. Milan Jirásek and Zdenek Bažant, "Inelastic Analysis of Structures", John Wiley & Sons (2002).
14. Jack Moehle, "Seismic Design of Reinforced Concrete Buildings", McGraw-Hill (2015).
15. K.D. Hjelmstad and E. Taciroglu, "Fundamentals of Structural Dynamics: Theory and Computation", Springer; 1st edition (2022).
16. Amos Gilat, "MATLAB: An Introduction with Applications", John Wiley & Sons; 6th edition (2017).
17. Steven C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers", McGraw-Hill; 7th edition (2015).
18. Desmond J. Higham and Nicholas J. Higham, "MATLAB Guide", SIAM; 3rd edition (2016).

Suggested Reading:

1. Dr. C. Caprani, "Structural Analysis IV — Matrix Stiffness Method", Lecture Notes (2011), available at: www.colincaprani.com.
2. NPTEL, "Matrix Method of Structural Analysis", Video Lectures, IIT Madras / IIT Roorkee, available at: www.nptel.ac.in.
3. NPTEL, "Advanced Structural Analysis", Video Lectures, IIT Bombay, available at: www.nptel.ac.in.
4. Bureau of Indian Standards, "IS 456 : 2000 — Plain and Reinforced Concrete — Code of Practice", BIS, New Delhi (2000, Reaffirmed 2021).
5. Bureau of Indian Standards, "SP 16 : 1980 — Design Aids for Reinforced Concrete to IS 456", BIS, New Delhi (1980, Reaffirmed 2014).
6. Bureau of Indian Standards, "SP 34 : 1987 — Handbook on Concrete Reinforcement and Detailing", BIS, New Delhi (1987, Reaffirmed 2016).
7. Bureau of Indian Standards, "IS 875 : Part 1 & Part 2 — Code of Practice for Design Loads (Dead Loads & Live Loads)", BIS, New Delhi (1987, Reaffirmed 2018).
8. MathWorks Inc., "MATLAB Documentation", available at: www.mathworks.com/help/matlab (Updated 2024).
9. MathWorks Inc., "MATLAB Onramp — Free Interactive Course", available at: www.mathworks.com/learn/tutorials/matlab-onramp.html (Updated 2024).

26EGA101

ENGLISH FOR RESEARCH PAPER WRITING
(Audit Course I and II - Common to all branches)

Instruction	2 Hours per week
Duration	2 Hours
SEE	50 Marks
CIE	0 Marks
Credits	Pass / Fail

Prerequisite:
Writing to express on science and technological concepts with good taste for research and development.

Course Objectives:
This course aims to:
1. Motivate learners for academic writing and thus encourage them for continuous professional updating and up-gradation.
2. Facilitate a practical understanding of the multiple purposes of Writing Research Papers and help them infer the benefits and limitations of research in science and technology.
3. Brainstorm and develop the content, formulating a structure and illustrating the format of writing a research paper.
4. Survey and select a theme/topic for a thorough reading and to writing a research paper.
5. Understand to implement the intricacies of writing and publishing a research paper.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Improve work performance and efficiency. Illustrate the nuances of research paper writing and draw conclusions on professional usefulness.
2. Classify different types of research papers and organize the format and citation of sources.
3. Explore various formats of APA, MLA and IEEE and set up for writing a research paper.
4. Draft paragraphs and write theme based thesis statements in a scientific manner.
5. Develop an original research paper while acquiring the knowledge of how and where to publish their papers.

CO-PO Articulation Matrix

CO's	PO1	PO2	PO3	PSO1	PSO2
CO 1	1	2	1	1	1
CO 2	1	1	1	1	1
CO 3	1	2	2	1	1
CO 4	1	2	1	1	1
CO 5	2	3	1	1	1

UNIT - I

Academic Writing: Meaning & Definition of a research paper; Purpose of a research paper - Scope, Benefits, Limitations and outcomes for professional development, An introduction to methods and Approaches of Research.

UNIT - II

Research Paper Format: Title - Abstract - Introduction - Discussion - Findings - Conclusion - Style of Indentation - Font size/Font types - Indexing - Citation of sources.

UNIT - III

Process of Writing a research paper, Writing to Draft a Format, Develop content, Adapting, Reviewing, Paraphrasing& Plagiarism Checks.

UNIT - IV

Choosing a topic - Thesis Statement - Outline - Organizing notes - Language of Research - Word order, Paragraphs - Writing first draft-Revising/Editing - The final draft and proof reading. Understanding APA, MLA, IEEE formats.

UNIT - V

Research Paper Publication Reputed Journals –Paid, Free and peer reviewed journals, National/International - ISSN No, No. of volumes, Scopus Index/UGC Journals. Getting Papers Published.

Text Books:

1. Kothari, C. R. and Gaurav, Garg, Research Methodology Methods and Techniques", 4thEdition, New Age International Publishers, New Delhi, 2019.
2. Ellison, Carroll. "Writing Research Papers", McGraw Hill's Concise Guide, 2010.
3. Lipson, Charles. "Cite Right: A Quick Guide to Citation Styles-- MLA, APA, Chicago, the Sciences, Professions, and More", 2nd Edition,. University of Chicago Press. Chicago, 2018.

Suggested Reading:

1. Day, Robert A. "How to Write and Publish a Scientific Paper", Cambridge University Press, 2006
2. Girden, E. R. "MLA Hand book for writers of Research Papers", 7th Edition, East West Press Pvt. Ltd, New Delhi, 2009
3. Bailey, Stephen. "Academic Writing: A Handbook for International Students", Routledge, 2018

Online Resources:

1. https://onlin://onlinecourses.nptel.ac.in/noc 18_mg13/preview
2. https://nptel.ac.in/courses/121/106/121106007/
3. https://www.classcentral.com/course/swayam-introduction-to-research-5221

Writing Tools:

1. https://owl.purdue.edu/owl_exercises/index.html - The Owl writing lab
2. https://www.turnitin.com/login_page.asp?lang=en_us – Turn tin software

26CEA101

DISASTER MITIGATION AND MANAGEMENT
(Audit Course I and II - Common to all branches)

Instruction	2 Hours per week
Duration	2 Hours
SEE	50 Marks
CIE	0 Marks
Credits	Pass / Fail

Course Objectives:

To enable the student

1. To equip the students with the basic knowledge of hazards, disasters, risks and vulnerabilities including natural, climatic and human induced factors and associated impacts
2. To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters
3. To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters
4. To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.
5. To equip the students with the knowledge of the chronological phases in a disaster management cycle and to create awareness about the disaster management framework and legislations in the context of national and global conventions

Course Outcomes:

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

1. Ability to analyze and critically examine existing programs in disaster management regarding vulnerability, risk and capacity at different levels
2. Ability to understand and choose the appropriate activities and tools and set up priorities to build a coherent and adapted disaster management plan
3. Ability to understand various mechanisms and consequences of human induced disasters for the participatory role of engineers in disaster management
4. To understand the impact on various elements affected by the disaster and to suggest and apply appropriate measures for the same
5. Develop an awareness of the chronological phases of disaster preparedness, response and relief operations for formulating effective disaster management plans and ability to understand various participatory approaches/strategies and their application in disaster management

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	2	3	2	1
CO2	3	3	2	2
CO3	2	3	3	2
CO4	3	3	2	3
CO5	3	2	2	3

UNIT- I:

Introduction: Basic definitions- Hazard, Disaster, Vulnerability, Risk, Resilience, Mitigation, Management; classification of types of disaster-Natural and manmade; International Decade for natural disaster reduction (IDNDR); International strategy for disaster reduction (ISDR), National disaster management authority (NDMA).

UNIT- II:

Natural Disasters: Hydro meteorological disasters: Causes, Early warning systems- monitoring and management, structural and non-structural measures for floods, drought and Tropical cyclones; Geographical based disasters: Tsunami generation, causes, zoning, Early warning systems- monitoring and management, structural and non-structural mitigation measures for earthquakes, tsunami, landslides, avalanches and forest fires. Case studies related to various hydro meteorological and geographical based disasters.

UNIT- III:

Human induced hazards: Chemical disaster- Causes, impacts and mitigation measures for chemical accidents, Risks and control measures in a chemical industry, chemical disaster management; Case studies related to various chemical industrial hazards eg: Bhopal gas tragedy; Management of chemical terrorismdisastersandbiologicaldisasters;RadiologicalEmergenciesandcase studies;Casestudiesrelatedtomajorpowerbreakdowns,fireaccidents,traffic accidents, oil spills and stampedes, disasters due to double cellar construction in multistoried buildings.

UNIT- IV:

Disaster Impacts: Disaster impacts- environmental, physical, social, ecological, economic, political, etc.; health, psycho-social issues; demographic aspects- gender, age, special needs; hazard locations; global and national disaster trends; climate change and urban disasters.

UNIT- V:

Concept of Disaster Policies and legislation for disaster risk reduction

Management: Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; risk analysis, vulnerability and capacity assessment; Post-disaster environmental response water, sanitation, food safety, waste management, disease control; Roles and responsibilities of government, community, local in situations, NGOs and other stakeholders;, DRR programmers in India and the activities of National Disaster Management Authority.

Text Books:

1. Pradeep Sahni*," Disaster Risk Reduction in South Asia*", Prentice Hall, 2003.
2. B. K. Singh,*" Handbook of Disaster Management*: *techniques &Guidelines*", Rajat Publication, 2008.
3. Ministry of Home Affairs". *Government of India, "National disaster management plan, Part I and II",*
4. K. K. Ghosh," *Disaster Management",* APH Publishing Corporation, 2006.

Suggested Reading:

1. http://www.indiaenvironmentportal.org.in/files/file/disaster_management_india1.pdf
2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs)
3. Hazards, Disasters and your community: A booklet for students and the community, Ministry of home affairs.

26EEA101

SANSKRIT FOR TECHNICAL KNOWLEDGE
(Audit Course I and II - Common to all branches)

Instruction	2 Hours per week
Duration	2 Hours
SEE	50 Marks
CIE	0 Marks
Credits	Pass / Fail

Course Objectives

1. To introduce Sanskrit as a structured language useful for logical thinking and algorithm design
2. To connect Sanskrit concepts with modern engineering domains (AI, circuits, structures, systems)
3. To develop computational and analytical skills using Sanskrit-based principles
4. To enable students to explore interdisciplinary applications for research and innovation

COURSE OUTCOMES

After completion, students will be able to:

1. Apply structured Sanskrit rules to improve logical and algorithmic thinking
2. Relate concepts from Sanskrit texts to modern Engineering principles
3. Develop simple computational models inspired by Sanskrit grammar/logics
4. Use Sanskrit-based frameworks in AI, coding logic, or system design
5. Identify interdisciplinary research opportunities combining Sanskrit & Engineering

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	2	1	2	1
CO2	2	1	2	2
CO3	3	1	2	3
CO4	2	2	2	2
CO5	3	2	2	2

UNIT–I:

Sanskrit as a Structured Language, Sanskrit as rule-based system -Basics: alphabets, word formation (only essentials) -Sandhi as data compression analogy -Samasa as modular design / block abstraction- Simple sentence formation (very minimal grammar)

UNIT–II:

Sanskrit & Computational Thinking Paninian grammar → rule engine / compiler design -Shiva Sutras encoding system, Binary concepts in Pingala (Chandas → digital logic) - Recursion & patterns in Sanskrit structures

UNIT–III: Sanskrit in Core Engineering Domains Civil / Mechanical: Sulba Sutras → geometry, measurements -Ancient construction logic → modular design. Electrical / ECE: Concept of energy (Agni, Surya) → symbolic + physical mapping -Wave & sound (Nada → signal analogy) Systems Thinking: Interconnectedness → system design philosophy

UNIT–IV:

Sanskrit & Modern Technology - Sanskrit & Artificial Intelligence (knowledge representation) - Natural Language Processing (NLP) -Formal languages & syntax -Command-based structures → programming analogy

UNIT–V:

Mini Applications & Case Studies- Case study: Sanskrit → Algorithm (simple flowchart) -Chandas → binary pattern generation-Design a simple rule-based system using Sanskrit logic -Mini presentation / activity

Text books :

1. Kapil Kapoor – Language, Linguistics and Literature- Indian Perspective ; Academic Foundation, New Delhi; 1994 (1st Edition); ISBN: 978-8171880577
2. Frits Staal : *A Reader on the Sanskrit Grammarians;* MIT Press / Motilal Banarsidass ; 1972 (Original); ISBN: 978-0262191340
3. George Gheverghese Joseph: The Crest of the Peacock"; Princeton University Press; 2000 (2nd Edition; widely used); ISBN: 978-0691135267
4. B.V. Subbarayappa: "Indian Scientific Heritage" – National Institute of Advanced Studies (NIAS), Bangalore; 2006 ISBN: 978-8185015026
5. – M. Krishnamachariar : "History of Sanskrit Literature"; Motilal Banarsidass Publishers; Reprint 1993 (Original: 1937, TTD Press); ISBN: 978-8120802841

Suggested reading:

1. Pingala. *Chandah Shastra* (various editions, Nirnaya Sagar Press / Chowkhamba)
2. Bharati, A., et al. *Natural Language Processing: A Paninian Perspective*, PHI, 1995
3. Selected IEEE / Springer Papers on Sanskrit & AI

26ECA101

VALUE EDUCATION
(Audit Course I and II - Common to all branches)

Instruction	2 Hours per week
Duration	2 Hours
SEE	50 Marks
CIE	0 Marks
Credits	Pass / Fail

Course Objectives:
This course aims to
1. Understand Value Education, Self-development and National development.
2. Imbibe good human values and Morals in students.
3. Cultivate individual and National character.

COURSE OUTCOMES
After the completion of this course, the student will be able to
1. Summarize classification of values and values for self-development.
2. Identify the importance of values in personal and professional life.
3. Apply the importance of social values for better career and relationships.
4. Analyze ethical issues in modern technology
5. Discuss concept of soul and reincarnation and promote responsible citizenship

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	3
CO2	2	2	2	2	3
CO3	2	2	2	2	3
CO4	2	2	2	2	3
CO5	2	2	2	2	3

UNIT - I
Human Values, Ethics and Morals: Concept of Values, Human Values, Indian concept of humanism, Values for self-development, Social values, Individual attitudes, Work ethics, Moral and non- moral behavior, Standards and Principles based on religion, Culture and Tradition.

\UNIT - II
Value Cultivation, and Self-Management: Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.

UNIT - III
Spiritual Outlook and Social Values: Personality and Behaviour Development, Scientific attitude and Spiritual (soul) outlook, Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, Avoiding fault finding in others, Reduction of anger, Forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance., Happiness Vs Suffering, Love for truth, Aware of self-destructive habits, Appreciation and co-operation.

UNIT - IV

Technology, Society, and Sustainability: Ethics in emerging technologies (AI, Data, 5G, IoT); Privacy and cybersecurity, Environmental ethics and sustainable development; Social responsibility of engineers, Policy and governance.

UNIT - V

Universal Values and Global Perspectives: Mind your mind, Self-control**,** Concept of soul, Science of Reincarnation, Concepts of Dharma and Karma, The qualities of Devine and Devilish, Satwic, Rajasic and Tamasic gunas. Global citizenship, Happiness and meaningful life.

TEXT BOOKS:

1. Chakroborty, S.K. "Values & Ethics for organizations Theory and practice", Oxford University Press, New Delhi, 1998.
2. Jaya Dayal Goyandaka, "Srimad Bhagavad Gita", with Sanskrit Text, Word meaning and Prose meaning, Gita Press, Gorakhpur, 2017.

REFERENCE BOOKS:

1. George Reynolds, Ethics in Information Technology, 6th Edition, Cengage Learning, 2018
2. Melanie Mitchell, Artificial Intelligence: A Guide for Thinking Humans, 1st Edition, Farrar, Straus and Giroux, 2019

26EGA102

CONSTITUTION OF INDIA
(Audit Course I and II -Common to all branches)

Instruction	2 Hours per week
Duration	2 Hours
SEE	50 Marks
CIE	0 Marks
Credits	Pass / Fail

Prerequisite: Knowledge on basics of the Constitution and the Government.

Course Objectives:

This course aims to:

1. The history of Indian Constitution and its role in the Indian democracy.
2. Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. Know the various Organs of Governance and Local Administration.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Understand the making of the Indian Constitution and its features.
2. Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.
3. Have an insight into various Organs of Governance - composition and functions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
5. Understand Electoral Process, special provisions.

CO-PO Articulation Matrix

COs	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO1	1	1	-	1	1
CO2	1	1	-	1	1
CO3	1	1	-	1	1
CO4	1	1	-	1	1
CO5	1	1	-	1	1

UNIT-I:

History of making of the Indian constitutions: History, Drafting Committee (Composition &Working).
Philosophy of the Indian Constitution: Preamble, Salient Features.

UNIT-II:

Contours of Constitutional Rights and Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-III:

Organs of Governance Parliament: Composition, Qualifications, Powers and Functions Union executives: President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions.

UNIT-IV:

Local Administration: District's Administration head: Role and importance. Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat Raj: Introduction, PRI: Zillah Panchayat, Elected Officials and their roles, CEO Zillah Panchayat: positions and role. **Block level**: Organizational Hierarchy (Different departments) Village level: role of elected and appointed officials. Importance of grass root democracy.

UNIT-V:

Election commission: Election Commission: Role and functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women**.**

Text Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Busi, S. N., Dr. B. R. Ambedkar, Framing of Indian Constitution'', 1st Edition, Ava Publishers, New Delhi, 2015.
3. Jain, M. P., "Indian Constitution Law", 7th Edition, Lexis Nexis, New Delhi, 2014.
4. Basu, D.D. "Introduction to the Constitution of India", Lexis Nexis, New Delhi., 2015.

Suggested Reading:

1. Bhargava, Rajeev. (ed), "Politics and Ethics of the Indian Constitution", OUP, 2008.
2. NCERT, Indian Constitution at Work, 1st Edition, Government of India, New Delhi 2006, reprinted in 2022.
3. Ravindra Sastry, V. (ed.), Indian Government & Politics, 2nd edition, Telugu Akademy, 2018.

Online Resources:

http://www.nptel.ac.in/courses/103107084/Script.pdf

26ADA101

PEDAGOGY STUDIES

(Audit Course I and II -Common to all branches)

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	0

COURSE OBJECTIVES:

1. To present the basic concepts of design and policies of pedagogy studies.
2. To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices.
3. To familiarize various theories of learning and their connection to teaching practice.
4. To create awareness about the practices followed by DFID, other agencies and other researchers.
5. To provide understanding of critical evidence gaps that guides the professional development.

COURSE OUTCOMES:

Upon completing this course, students will be able to:

1. Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.
2. Examine the effectiveness of pedagogical practices.
3. Understand the concept, characteristics and types of educational research and perspectives of research.
4. Describe the role of classroom practices, curriculum and barriers to learning.
5. Understand Research gaps and learn the future directions.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	1	1	1	1	1
CO 2	1	1	1	1	1
CO 3	2	2	2	2	2
CO 4	1	1	1	1	1
CO 5	2	2	2	2	2

UNIT I

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology-Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and searching.

UNIT II

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III

Evidence on the Effectiveness of Pedagogical Practices: Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and pedagogic strategies.

UNIT IV

Professional Development: alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.

UNIT-V

Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

TEXT BOOKS:

1. Ackers J, Hardman F, "Classroom Interaction in Kenyan Primary Schools, Compare", 31 (2): 245 – 261, 2001.
2. Agarwal M, "Curricular Reform in Schools: The importance of evaluation", Journal of Curriculum Studies, 36 (3): 361 – 379, 2004

26EGA103

STRESS MANAGEMENT BY YOGA
(Audit Course I and II - Common to all branches)

Instruction	2 Hours per week
Duration	2 Hours
SEE	50 Marks
CIE	0 Marks
Credits	Pass / Fail

Prerequisite: Knowledge on Yoga Practices.

Course Objectives:

This course aims to:

1. Create awareness about different types of stress and the role of yoga in the management of stress.
2. Promote positive health and overall well-being (Physical, mental, emotional, social and spiritual).
3. Prevent stress related health problems by yoga practice.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Understand yoga and its benefits.
2. Enhance Physical strength and flexibility.
3. Learn to relax and focus.
4. Relieve physical and mental tension through asanas
5. Improve work performance and efficiency

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	1	-	-	1
CO2	1	1	-	-	1
CO3	1	1	-	-	1
CO4	1	1	-	-	1
CO5	1	1	-	-	1

UNIT - I

Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali).

UNIT - II

Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT - III

Concept of Stress according to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress.

UNIT - IV

Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar

UNIT – V

Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama. Meditation techniques: Om Meditation - Cyclic meditation: Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

Text Books:

1. Janardhan, Swami, "Yogic Asanas for Group Training - Part-I": Yogabhyasi Mandal, Nagpur.
2. Vivikananda, Swami. "Rajayoga or Conquering the Internal Nature", Advaita Ashrama (Publication Department), Kolkata.
3. Nagendra H.R and R. Nagaratna, “Yoga Perspective in Stress Management”, Swami Vivekananda Yoga Prakashan, Bangalore.

Online Resources:

4. https://onlinecourses.nptel.ac.in/noc16_ge04/preview
5. https://freevideolectures.com/course/3539/indian-philosophy/11

26EGA104

PERSONALITY DEVELOPMENT THROUGH LIFE'S ENLIGHTENMENT SKILLS

(Audit Course I and II - Common to all branches)

Instruction	2 Hours per week
Duration	2 Hours
SEE	50 Marks
CIE	0 Marks
Credits	Pass / Fail

Prerequisite: Awareness on Personality Development.

Course Objectives:

This course aims to:

1. Learn to achieve the highest goal happily.
2. Become a person with stable mind, pleasing personality and determination.
3. Awake wisdom among themselves.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Practice emotional self regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality.

CO-PO Articulation Matrix

COs	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO1	1	1	-	1	1
CO2	1	1	-	1	1
CO3	1	1	-	1	1
CO4	1	1	-	1	1
CO5	1	1	-	1	1

UNIT - I

Neeti satakam – Holistic development of personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT - II

Neeti satakam – Holistic development of personality (cont'd) - Verses 52, 53, 59 (dont's) - Verses 71,73,75& 78 (do's) - Approach to day to day works and duties.

UNIT - III

Introduction to Bhagavad Geetha for Personality Development – Shrimad Bhagawad Geeta: Chapter 2–Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 –Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

UNIT - IV

Statements of basic knowledge – Shrimad Bhagawad Geeta: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

UNIT - V

Role of Bahgavadgeeta in the present scenario - Chapter 2 – Verses 17 - Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

Text Books:

1. Gopinath, P., "Bhartrihari's Three Satakam (Niti-sringar-vairagya)", Rashtriya Sanskrit Sansthanam, New Delhi, 2018.
2. Swarupananda, Swami, "Srimad Bhagavad Geeta", Advaita Ashram (Publication Dept), Kolkata, 2017.

Online Resources:

1. http://nptel.ac.in/downloads/109104115/

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

M.E. (STRUCTURAL ENGINEERING)

Semester II

Sl. No.	Course Code	Title of Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	26CEC106	Finite Element Method in Structural Engineering	3	0	0	3	40	60	3
2	26CEC107	Structural Dynamics	3	0	0	3	40	60	3
3	26CEC108	Planning and Design of Precast Structures	3	0	0	3	40	60	3
4	Program Specific Elective - III		3	0	0	3	40	60	3
5	Program Specific Elective - IV		3	0	0	3	40	60	3
PRACTICALS									
6	26CEC109	Model Testing Lab	0	0	2	-	50	-	1
7	26CEC110	Finite Element Method Lab	0	0	2	-	50	-	1
8	26CEC111	Mini Project with Seminar	0	0	2	-	50	-	1
TOTAL			15	0	6	-	350	300	18

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**

T: Tutorial **P: Practical/Mini Project /Dissertation** **SEE: Semester End Examination**

Course Code	Program Specific Elective -III	Course Code	Program Specific Elective - IV
26CEE107	Pre-Engineered Buildings	26CEE110	Design of Tall Buildings
26CEE108	Advanced Foundation Design	26CEE111	Repair & Retrofitting of Structures
26CEE109	Design of Hydraulic Structures	26CEE112	Design of Bridges

Audit Course- I and II	
Course Code	**Course**
26EGA101	English for Research Paper Writing
26CEA101	Disaster Mitigation and Management
26 EEA101	Sanskrit for Technical Knowledge
26ECA101	Value Education
26EGA102	Constitution of India
26ADA101	Pedagogy Studies
26EGA103	Stress Management by Yoga
26EGA104	Personality Development through Life Enlightenment Skills

26CEC106

FINITE ELEMENT METHOD IN STRUCTURAL ENGINEERING

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

To enable the student

1. Learn the fundamentals of Finite Element Method (FEM) and derive elasticity matrices for 2-D and 3-D elasticity problems.
2. Understand basic principles of minimum potential energy methods and variational formulation of FEM know the stiffness matrix formulations using bar element and analyze simple problems.
3. Understand the FEM formulation using truss, beam, and plane frame elements and analyze simple problems with kinematic indeterminacy not greater than 3.
4. Get familiarized with displacement models, Isoparametric elements and quadrilateral elements and know the formulation of global stiffness matrices.
5. Know the formulation of stiffness matrices for Axi-Symmetric elements, Tetrahedron elements.

Course Outcomes:

At the end of the course, student is able to

1. Revisit the fundamentals of FEM, elements of theory of elasticity.
2. Formulate FEM problem and stiffness for Bar Elements.
3. Analyze for trusses, beams and rigid jointed plane frames using FEM.
4. Formulate Global stiffness matrix, load matrix and analysis structures using 1st order triangular elements, isoparametric elements, and quadrilateral elements.
5. Formulate Axi-Symmetric and Tetra-Hedron elements and apply FEM procedure with the help of FEA software.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	2	3	3	1
CO3	3	3	3	2
CO4	3	3	2	1
CO5	3	2	2	1

UNIT - I:

Introduction to FEM: General description of the method, brief history of the method, applications of the method, advantages of the finite element method, steps in the finite element method. Types of elements; Types of forces, and Boundary conditions.

Strain displacement and stress- strain relations for 2-D and 3-D problems. Equations of equilibrium and compatibility conditions for 2-D and 3-D problems. Plane stress and plane strain situations and derivation of elasticity matrices (D).

UNIT - II:

Finite Element Formulation: Principle of minimum potential energy, Principle of virtual displacement, Global coordinate system, local coordinate system, Raleigh Ritz method, Weighted Residual method-Galerkin's method. Boundary Value Problems – With one element and two elements.

Bar Elements: Shape functions, stiffness matrix for a 2-noded bar element, axial bar subjected to point loads- constant cross section and varying cross section bar.

UNIT -III:

Truss Elements: Transformation matrix, Stiffness matrix of truss member in local and global axis, analysis of trusses with kinematic indeterminacy not exceeding three.

Beam Elements: Shape functions, beam element stiffness matrix, element load vector, and analysis of continuous beams with kinematic indeterminacy not exceeding three.

Plane Frame elements: Element stiffness matrix in local coordinates, Transformation or Rotation matrix, and stiffness matrix and load vector in global coordinates.

UNIT - IV:

Displacement models: Selection of displacement models, geometric invariance, conforming and non-conforming elements.

Triangular Elements (CST) and Rectangular Elements: Determination of strain-displacement matrix, shape functions, determination of element stiffness and load matrices, assembling global stiffness and load matrices. Problems with kinematic indeterminacy not exceeding three.

Iso-parametric elements: Iso-parametric concept, Iso-parametric, Sub parametric and Super parametric elements. Gauss Quadrature of numerical integration.

Quadrilateral elements: Construction of shape functions for 4 noded and 8noded elements, determination of stiffness matrix, and nodal load matrices for 4noded quadri lateral element.

UNIT - V:

Axi-symmetric elements: Strain-displacement relationship, stress-strain relationship, determination of stiffness matrix for 3-noded ring element and load matrices for body force and surface traction.

Tetrahedron elements: Volume coordinates, Strain-displacement matrix, and stiffness matrix.

Computer Implementation of FEM procedure, Pre-Processing, Post-Processing. Use of Commercial FEA software.

Text Books:

1. David V. Hutton," *Fundamentals of Finite Element Analysis*", McGraw Hill Education (India) Private Limited, Delhi, 2014.
2. P. N. Godbole," *Introduction to Finite Element Method"*, I. K. International Publishing House Pvt. Ltd. New Delhi, 2013.
3. P. Seshu, "*Finite Element Analysis*", Prentice Hall of India Private Limited, New Delhi, 2010.
4. T. R. Chandrupatla and A. D. Belegundu," *Introduction to Finite Elements in Engineering*", Prentice – Hall of India Private Limited, New Delhi, 2009.

Suggested Reading:

1. DarylL, Logan, *"A first course in the Finite Element Method*", Third Edition, Thomson Brook, Canada Limited, 2007.
2. R. D. Cook, R.D" *Concepts and Applications of Finite Element Analysis*", John Wiley and sons, 1981.
3. O. C. Zienkiewicz. And R. L. Taylor, "*The Finite Element Method*", Vol.1, McGraw Hill Company Limited, London, 1989.

26CEC107

STRUCTURAL DYNAMICS

Instruction	3 Hours per week
Duration	3 Hours
SEE	50 Marks
CIE	40 Marks
Credits	3

Course Objectives:

To enable the student

1. To make the student understand the importance of structural dynamics and appreciate its practical applications.
2. To make the student learn the process of formulation of equations of motion and generate their solutions.
3. To make the student well versed with modal analysis and make them develop the response by mode superposition.
4. To make him learn the methods of practical vibration analysis and also generate response considering the system as continuous systems.
5. To make him conversant with the numerical solutions to find the response of dynamic systems.

Course Outcomes:

At the end of the course, student is able to

1. Gains expertise and confidence to tackle field dynamic problems, especially in the field of earthquake and wind engineering.
2. Model any dynamic system and get its response.
3. Carryout modal analysis and can easily handle any software and can correctly interpret the results.
4. Use practical vibration analysis methods and obtain the dynamic parameters.
5. Apply numerical methods to get the dynamic response of the systems.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	2
CO3	2	3	3	2
CO4	3	2	2	1
CO5	3	3	2	2

UNIT - I:

Introduction to Structural Dynamics – Source of dynamic forces – Rotating machinery, wind and seismic forces, blast loads. **Methods of discretization**: Lumped mass Procedure and Consistent mass procedure.

Single Degree Freedom Systems – **Formulation of Equation of Motion**: D'Alembert's Principle, Method of Virtual Work, Hamilton's Principle. Generalized SDOF systems and Rigid Body assemblage. Influence of Gravity Forces and Ground Motion on equation of motion.

UNIT - II:

Single Degree of Freedom System: Response to Free Vibration with and without Damping, Logarithmic decrement. Response to Harmonic loading and impulsive loading. Dynamic magnification factor, phase angle and bandwidth. Response to General Dynamic loading using Duhamel's Integral - Fourier analysis for Periodic Loading.

UNIT - III:

Multiple Degree of Freedom System: Evaluation of structural property matrices – Formulation of MDOF equations of motion – Undamped free vibration – Solution of Eigen value problem for natural frequencies and mode shapes Analysis of dynamic response- Normal coordinates – Orthogonal properties of normal modes - Uncoupled equations of motion – Mode superposition procedure.

UNIT - IV:

Practical Vibration Analysis: Stodola Method–Fundamental mode analysis, Analysis for second and higher modes. Holtzer Method – basic procedure.

Continuous Systems: Flexural vibrations of beams- Elementary case - Derivation of governing differential equation of motion - Analysis of undamped free vibration of beams in flexure – Natural frequencies and mode shapes of simple beams with different end conditions.

UNIT - V:

Numerical Evaluation of Dynamic Response of linear (SDOF/MDOF) systems: Time stepping methods, Central difference method, Newmark's method and Wilson method.

Text Books:

1. Anil. K. Chopra," *Dynamics of Structures",* Pearson Education India, 2007.
2. Ray W. Clough, Joseph Penzin," *Dynamics of Structures*", CBS Publishing, 2015.
3. Mario Paz," *Structural Dynamics: Theory and Computation*", CBS Publishing, 2004.

Suggested Reading:

1. Pankaj Agarwal and Manish Shrikhande*," Earthquake Resistant Design of Structures"*, PHI, 2006.
2. Biggs," *Introduction to Structural Dynamics*", McGraw-Hill Education, 2013.

23CEC108

PLANNING, DESIGN AND CONSTRUCTION OF PRECAST STRUCTURES

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course objectives:
To enable the student

1. To introduce the fundamentals of precast and prefabricated construction systems, including planning, design, and erection practices.
2. To understand the production, quality control, and productivity aspects of Ready Mixed Concrete (RMC).
3. To familiarize students with modular construction concepts, coordination, and system-based building approaches.
4. To provide knowledge on the use of construction chemicals, admixtures, waterproofing, and corrosion protection techniques.
5. To develop understanding of modern insulated wall systems (EPS panels) including design, construction methodology, and cost analysis.

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

1. Explain and apply the principles of precast construction, including planning, fabrication, transportation, and erection processes.
2. Analyse and compare site-mixed concrete and Ready Mixed Concrete in terms of production, quality, and productivity.
3. Apply modular construction principles for efficient planning and execution of building projects.
4. Evaluate and select appropriate construction chemicals and admixtures for improving the durability and performance of structures.
5. Design and assess EPS core panel systems, including construction techniques, quality control, and cost estimation for multi-storey buildings.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	2	2	2	2
CO2	3	2	2	2
CO3	2	2	3	3
CO4	2	2	3	3
CO5	3	2	3	3

UNIT - I

Precast structures: Introduction to Prefabricated structures, Planning for pre-casting, Selection of equipment for fabrication, Transport and erection of prefabricated components, Quality measures, Design considerations of precast elements, Safety measure during erection.

UNIT – II:

Ready mixed Concrete: Production of Ready Mixed Concrete, Site mixed vs. Ready Mixed Concrete, Equipment for RMC plant, IS code provision for RMC, Quality measures of Ready Mixed Concrete, RMC Productivity analysis, Productivity analysis-Case study

UNIT – III:

Modular Construction Practices: Introduction to Modular Construction, Modular coordination, Modular Standardization, Modular System Building, Limitation and Advantages of Modular Construction

UNIT – IV:

Use Construction Chemicals, Admixtures, Water Proofing, Epoxy and Corrosion inhibitors in the construction industry – Mechanisms and advantages

UNIT V:

Insulated wall construction: Introduction to EPS Core Panel System, Design Philosophy and Methodology, Fabrication, Construction Sequence, Training Module and Manpower requirement, Plant and Machinery Requirement, Quality Control, Relevant Tests and General Maintenance, Cost Analysis and Detailed Estimate for a typical building of G+ 3storey., Case Study

Text Books:

1. Allen E, Iano, J, Fundamentals of Building Construction subscription E Book, Material and Method, John Wiley and Sons, 2011.
2. Cameron K. Andres, Ronald C. Smith, Principles and Practices of Commercial Construction, 8th Ed., Prentice Hall, 2009.

Suggested Reading:

1. Manual prepared by CSIR- CBRI ,2015
2. Precast Concrete Structures, Kim s Elliott, Butterworth – Heinemann, 2002

26CEE107

PRE-ENGINEERED BUILDINGS
(PROGRAM SPECIFIC ELECTIVE-III)

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Design of Steel Structures & Structural Analysis

Course Objectives:

To enable the student

1. Understand the concept, history, and advantages of Pre-Engineered Buildings (PEB).
2. Learn the components of PEB systems, including primary, secondary, bracing, and cladding elements.
3. Analyse PEB frames under different loading conditions as per relevant IS codes.
4. Gain knowledge of connection design, including bolted and welded connections.
5. Develop skills in modelling, analysis, and design of PEB structures using modern tools

Course Out comes:

1. Explain the fundamentals and applications of Pre-Engineered Buildings and compare them with conventional steel structures..
2. Identify and describe various components of PEB, including frames, bracing systems, and cladding elements..
3. Analyze PEB frames for different loads such as dead, live, wind, and seismic loads.
4. Design structural connections and base plates using appropriate design principles.
5. Develop and interpret structural models and design PEB elements using software tools and manual methods.

=CO-PO Articulation Matrix

COs	PO 1	PO 2	PO 3	PO 4
CO1	2	2	2	2
CO2	3	3	2	3
CO3	3	3	2	3
CO4	3	3	2	3
CO5	3	3	2	3

UNIT-I:

INTRODUCTION TO PRE-ENGINEERED BUILDINGS: Introduction – History - Advantages of PEB - Applications of PEB – Materials used for manufacturing of PEB. Difference between Conventional Steel Buildings and Pre-Engineered buildings.

UNIT-II:

PRE-ENGINEERED BUILDING COMPONENTS: Primary System: Main frames, Gable End Frame - Secondary frame system: Sizes and Properties of Purlins & Girts – Bracing System: Rod, angle, Portal, Pipe bracing – Sheeting and Cladding: Roof Sheeting and Wallsheeting – Accessories: Turbo Ventilators, Ridge vents, Sky Lights, Louvers, Insulation, Stair cases, Design of PEB frame under the influence of Dead, Live, Collateral, Wind, Seismic and Other applicable Loads. Serviceability Limits as per code. Design Parameters of PEB Frames - Depth of the section, Depth to Flange width ratios, Thickness of Flange to thickness of Web ratio. d/tw, bf/tf ratios of sections as per IS code. Section Sizes as per Manufacturing Limitations, Analysis and Design of Rigid Frames.

UNIT-III:

PEB FRAME CONNECTION DESIGN METHODOLOGY: Rigid Frame Moment Connection, Shear Connection, High strength bolts & grades, Lever arm, bolt Patten its effect on connection design, thickness of connection plate, Selection of governing forces for connection design.

UNIT-IV:

MEZZANINE FLOOR SYSTEMS: Design of Mezzanine Beams, Columns and joists – Mezzanine decking, Different types of Mezzanine Floor systems – Grating, Chequered plate and Rigid floor System, Types of base plate Pinned, Fixed, strength bolts, different types of bolts & grades, Lever arm, bolt Patten its effect on connection design, thickness of connection plate, base plate size, Selection of governing forces for base connection design & Anchor bolt.

UNIT-V:

ANALYSIS AND DESIGN OF PRE-ENGINEERED BUILDINGS: 2D and 3D Modelling of Portal Frames, Optimization Techniques, Comparison of software output with manual calculations. Design of Cold Formed Sections i.e., Purlins and Girts, Design of Roof Sheeting , trapezoidal , Standing seam sheeting, Welding technology, Manufacturing process , Erection Procedure

Textbooks:

1. Pre-Engineered Steel Building, K.S. Vivek and P.Vyshnavi, LAP Lamdert Academic Publishing.
2. Metal building systems: Design and Specifications, Third edition, Alexander Newman, McGraw- Hill Education

26CEE108

ADVANCED FOUNDATION DESIGN
(PROGRAM SPECIFIC ELECTIVE-III)

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

To enable the student to

1. Deal with field problems.
2. Understand the principle and evaluate bearing capacity and settlements of shallow foundations.
3. Understand the principles and design of pile foundations.
4. Understand the analysis of well foundations and design of well foundations.
5. Understand the concept of coffer dams and sheet piles.

Course Outcomes:

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

1. Decide the sustainability of soil strata for different projects.
2. Design shallow foundations by deciding the bearing capacity of the soil.
3. Analyze and design the pile foundation.
4. Understand analysis methods and design for a well foundation.
5. Interpret and implement the concepts of coffer dams and sheet piles.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	1	3	3
CO2	3	1	3	3
CO3	3	1	3	3
CO4	3	1	3	3
CO5	3	1	3	3

UNIT - I:

Soil exploration: Planning of Soil Exploration for different Projects, Methods of Subsurface exploration, Methods of boring along with various penetration tests.

UNIT - II:

Shallow Foundation: Requirements for satisfactory performance of foundations, Methods of Estimating bearing capacity by Terzaghi's, Meyerhof, Hansen's, IS code theories and plate load test, settlements of footings, proportioning of footings using field test data.

UNIT - III:

Pile Foundations: Estimation of load carrying capacity of single and pile group under various loading conditions by Static, Dynamic methods and pile load test, settlement of pile foundation, code provisions, design of single pile and pile groups, Negative skin friction.

UNIT - IV:

Well Foundations: Types, components, construction methods, design methods (IS and IRC) approaches, check for stability, base pressure, side pressure and deflection, Elastic theory and ultimate Resistance methods.

UNIT - V:

Coffer Dams, various types, construction methods of various types of coffer dams, analysis and design of flexible sheet piles for cohesive and cohesion less oils, Open cuts, sheeting and bracing systems in shallow and deep open cuts in different soil types.

References:

1. N. P. Kurian," *Design of Foundation System"*, Narosa Publishing House, 2006.
2. J. E. Bowles," *Foundation Analysis and Design*, Tata Mc Graw Hill New York, 2017.

Suggested Reading:

1. Swami Saran, "*Analysis and Design of Substructures*", Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi, 2008.
2. Braja M Das," *Principles of foundation engineering*", **Cengage** India Private Ltd., 2017.

26CEE109

DESIGN OF HYDRAULIC STRUCTURES
(PROGRAM SPECIFIC ELECTIVE-III)

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
To enable the student:
1. To understand the forces, stability, and failure mechanisms of gravity dams.
2. To gain knowledge of site investigation techniques, including seismic and resistivity methods.
3. To analyze and design gravity dams under static and seismic loading conditions.
4. To understand the hydraulic jump phenomenon and design of energy dissipators.
5. To learn the design principles of weirs and diversion headworks, including impervious floor design.

Course Outcomes:
At the end of the course, student will be able to
1. Analyze forces acting on gravity dams and assess their stability.
2. Perform structural and seismic analysis of gravity dams.
3. Design gravity dam sections considering stability and stress distribution.
4. Design energy dissipators and stilling basins based on hydraulic principles.
5. Design weirs and their components, including impervious floors and protection works.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	1	2	2
CO2	3	2	3	2
CO3	3	2	3	3
CO4	2	1	2	3
CO5	3	2	3	3

Unit I:

Hydraulic Analysis of Gravity Dams: Advanced topics in design and construction of Gravity dams, Investigation area for a dam construction, Stages of investigations, subsurface investigation: Seismic measurements and Resistivity measurements, Gravity Dam parameters. Forces acting on Gravity Dams, Failure of Gravity Dam

Unit II:

Structural Design of Gravity Dams: Classification of loading for design, Load combinations Seismic analysis, Class of Earthquake, Dynamic analysis of gravity dams under earthquake loading, Finite element method for stability analysis, Safety criteria, Gravity Design: Assumptions in design and Internal stress distribution, Determination of Profile of a Gravity Dam: Design and Reinforcement Detailing of the section.

Unit III:

Design of Energy Dissipator: Hydraulic Jump phenomenon, Momentum Principle, Loss of Energy, Location and Profile of Hydraulic Jump, Normal Depth, End Depth, Forms of the hydraulic Jump, Energy Dissipators, Design criteria of stilling basin with horizontal apron, Design and Detailing of RCC floor.

Unit IV:

Design of Weir: Diversion headwork, Location of canal headwork, Components of diversion headwork, Types of weir, Failure of weirs, Criteria for the Design, Design of impervious floor by Khosla's Theory, Exit Gradient, Design of vertical drop weir: Calculation for various elevations, Design of weir wall, impervious floor and protection works on upstream and downstream.

Unit V:

Cross Drainage Works: Types of cross drainage works: Aqueduct, Syphon aqueduct, Super passage, Syphon Super passage, Level crossing, Factors affecting suitability of aqueduct, Features of design of siphon aqueduct: Hydraulic design and structural design.

Essential Reading:

1. Varshney, Hydraullic and Irrigation Structures.
2. P. N. Modi, Irrigation Water Resources and Water Power Engineering.

Supplementary Reading:

1. K.R. Arora, Irrigation Water Power and Water Resources Engineering

26CEE110

DESIGN OF TALL BUILDINGS PROGRAM
(PROGRAM SPECIFIC ELECTIVE-IV)

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
To make the student learn**:**

1. The difference between normal building and tall building and the types of foundations for tall buildings
2. Various methods of calculating lateral forces (both wind forces and seismic/ earth quake forces) on the tall buildings
3. The provisions of relevant IS codes (IS:875 - Part-3, IS:1893 - Part-1) in calculating the lateral forces mentioned above, on tall buildings
4. Various structural systems usually considered for the functional design of the tall buildings
5. The concept of performance-based design in resisting seismic forces on tall buildings

Course outcomes:
The student can

1. Understand the loads acting on the tall buildings.
2. Learn the concept of analysis of high rise building for wind loads
3. Learn the concept of analysis of high rise building for seismic loads
4. Learn the different structural systems for high rise buildings
5. Learn the assessment of nonlinear performance of the structures

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	2	2	1	3
CO2	2	2	1	2
CO3	2	2	1	2
CO4	2	2	1	2
CO5	2	2	1	2

UNIT-I

Introduction: Importance of Lateral Loads for high rise buildings, types of foundations for tall buildings. Second order effects of gravity loading, Creep and shrinkage in columns, Differential shortening of columns, Floor levelling problems, Panel zone effects, P-Delta effects

UNIT-II

Wind Loads: Introduction to wind loads, characteristics of wind, Computation of wind loads on buildings as per IS code, Principles of analysis, Introduction to Computational Fluid Dynamics, Wind Tunnel testing.

UNIT-III

Seismic Loads: Introduction to Earthquakes, Characteristics of Earthquake, Computation of seismic loads on tall buildings – Equivalent static load method, Response Spectrum Method. Vibration Control – active control & passive control. Liquefaction effects, Introduction to Time history Analysis

UNIT – IV

Structural systems: Necessity of special structural systems for tall buildings, Structural Systems for **Steel Buildings -** Braced frames, Staggered Truss System, Eccentric Bracing System, Outrigger Belt truss system, Tube Systems**;** Structural Systems for **Concrete Buildings -** shear walls, frame tube structures, bundled tube structures**;** Design of shear wall as per IS code

UNIT- V

Performance Based Design: Behavior of reinforced concrete members in bending-moment curvature relationship; Plastic hinge, Factors affecting rotation capacity of a section, Plastic moment - Redistribution of moments. Push over Analysis

Text Books:

1. Taranath B. S., "*Structural Analysis and Design of Tall Buildings*", McGraw-Hill Book Company, 988.
2. Simlu E, "*Wind Effect on Structures: An Introduction to Wind Engineering*", Wile and Sons, 1978.
3. Fintel, M, "*HandBook of Concrete Engineering*", Von Nostrand, 1974.
4. Emilio Rosen blueth, "*Design of Earthquake Resistant Structures*", Pentech Press Ltd., 1990.

Suggested Reading:

1. Schuellar, W, "*High Rise Building Structures*", John Wiley & SonInc, 1977.
2. Bryan Stafford Smith & Alex Coull, "*Tall Building Structures: Analysis &Design*", Wiley India Pvt Ltd, 1991.
3. Lynn S. Beedle, "*Advances in Tall Buildings*", CBS Publishers and Distributors Delhi, 1996.

26CEE111

REPAIR AND RETROFITTING OF STRUCTURE
(PROGRAM SPECIFIC ELECTIVE-III)

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

To enable the student

1. Gain knowledge of Distress and reasons for distress in concrete
2. Learns the basic concepts of serviceability and durability, corrosion etc.
3. Understand the concepts of different repair materials and their suitability
4. Understand the fundamental principles of retrofitting and rehabilitation
5. Learns the basic concepts of Structural health monitoring.

Course Outcomes:

At the end of the course, student is able to

1. Identify reasons for distress and suggest remedial measures
2. Analyze the causes for corrosion and identify the durability factors for the safety of structures
3. Identify and suggest various repair materials
4. Analyze and suggest the retrofitting methods
5. Identify the suitable Tests required for SHM

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	2	2	3	2
CO2	2	1	3	2
CO3	3	3	3	1
CO4	2	2	1	1
CO5	1	2	2	1

UNIT - I

Maintenance: Repair and rehabilitation - Facets of maintenance - Importance of maintenance various aspects of inspection – Assessment procedure for evaluating damaged structure - Causes of deterioration. Repair Strategies: Causes of distress in concrete structures – Construction and design failures - Condition assessment and distress- diagnostic techniques - Assessment procedure for inspection and evaluating a damaged structure.

UNIT - II

Serviceability and durability of concrete: Quality assurance for concrete construction - Concrete properties – Strength - Permeability – Thermal properties and cracking. – Effects due to climate - Temperature - Chemicals - Corrosion – Design and construction errors – Effects of cover thickness and cracking.

UNIT - III

Materials and techniques for repair: Special concretes and mortar - Concrete chemicals - Special elements for accelerated strength gain - Expansive cement - Polymer concrete - Sulphur infiltrated concrete - Ferro cement - Fibre reinforced concrete - Bacterial concrete – Rust eliminators and polymers coating for rebars during repair – Foamed concrete - Mortar and dry pack – Vacuum concrete - Gunite and shot Crete - Epoxy injection - Mortar repair for cracks - Shoring and underpinning-Methods of corrosion protection - Corrosion inhibitors – Corrosion resistant steels - Coating and cathodic protection.

UNIT - IV

Repair, rehabilitation and retrofitting techniques: Repairs to overcome low member strength - Deflection - Cracking - Chemical disruption - Weathering corrosion - Wear - Fire - Leakage and marine exposure - Repair of structure – Common types of repairs – Repair in concrete structures – Repairs in under water structures – Guniting – Shot create–Underpinning - Strengthening of structures – Strengthening methods – Retrofitting – Jacketing.

UNIT – V

Health monitoring and demolition techniques: Long term health monitoring techniques - Engineered demolition techniques for dilapidated structures - Use of sensors – Building instrumentation.

Text Books:

1. Barry A. Richardson, “Defects and Deterioration in Buildings”, E & FN Spon Press, London, 1991.
2. J. H. Bungey, “Testing of Concrete in Structures”, Chapman and Hall, New York,1989.
3. A.R. Santakumar, “Concrete Technology”, Oxford University Press, New Delhi, 2006.
4. B.L. Gupta and Amit Gupta, ‘Maintenance and Repair of Civil Structures”, Standard Publications, New Delhi, 2010.
5. Peter H. Emmons, “Concrete Repair and Maintenance Illustrated”, RS Means, John Wiley & Sons, New York, 1981.

Suggested Reading:

1. W.H. Ransom, “Building Failures: Diagnosis and Avoidance”, E & FN Spon Press, London, 1992.
2. P.K. Mehta and P.J.M. Monteiro, “Concrete - Microstructure, Properties and Materials”, McGraw- Hill, New York, 2014.
3. N. Jackson and R.K, Dhir, “Civil Engineering Materials”, Basingstoke, Macmillan, London, 1988.

26CEE112

DESIGN OF BRIDGES
(PROGRAM SPECIFIC ELECTIVE-IV)

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

To enable the student

1. The student should be able to design simple bridges individually and be an effective contributor in design groups while working on large projects.
2. To make the student conversant with the latest design procedures in the box culverts.
3. To make the student conversant with the latest developments in steel bridge engineering.
4. The student should have a fair familiarity with the design of long-span flexible bridges.
5. To make the students conversant with the design of structural components in sub-structures.

Course Outcomes:

1. Design slab and T beam bridges and gets well versed with lateral load distribution for T girders.
2. Acquire sound knowledge about various structural actions of box girder bridges. He also gets the ability to analyze box girders
3. Get thorough knowledge in Railway loadings and can design both Plate girder and Truss girder bridges with ease and efficiency.
4. Get comprehensive idea about long span flexible bridges and the problems associated with them. He gets to know the
5. Understand bridge foundations and also acquires knowledge about various construction techniques.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	2	2	1	3
CO2	2	2	1	3
CO3	2	2	1	2
CO4	2	2	1	2
CO5	2	2	1	2

UNIT – I

Introduction: Types of bridges – Materials of construction, Planning and layout, Hydraulic design, Provisions of IRC-6 and IRC-21, Design of slab bridges, Design of T-girder bridges, Lateral load distribution in T-beam slab bridges – Courbon's method, Guyon Massenet method – Design of slabs subjected to concentration loads using Pigeaud's curves.

UNIT – II

Box girder bridges – various structural actions, Methods of analysis, Beamson elastic foundation method, grillage method and space frame analysis, Shear lagand Edge stiffing effects–Provisions of IRC-18 and IRC-21, Design of simply supported single cell PSC box girder bridge.

UNIT – III

Steel bridges and composite bridges - Bridge rules and Bridge code of RDSO, Truss girder steel rail way bridgesDesign of stringer beams, cross girders and truss system, Wind load effects Design of composite bridges as per IRC-22

UNIT – IV

Long span flexible bridges – suspension bridges and cable stayed bridges – stiffening girders and stress, towers, cables – Importance of wind and aerodynamic stability. Bearings – Types of bearing, Design of elastomeric bearings

UNIT – V:

Sub structure – Piers and towers – Types of forces, Stability analysis of solid type piers, Types of bridge foundations and their design principles, Construction techniques – Cast in-situ, Prefabricated, Incremental launching and Free cantilever construction techniques.

Text Books:

1. Wai-Fah Chen Lian Duan , “Bridge Engineering Handbook”,, CRC Press, USA,2000
2. R. M. Barker and J. A. Puckett, John Wiley & Sons, “Design of Highway Bridges”, New York,1997
3. P. P. Xanthakos, John Wiley & Sons, “Theory and Design of Bridges”, New York,1994

Suggested Reading:

1. Raja Gopalan, “Bridge Superstructure”–Narosa Publishing–2010. N.
2. Krishnam Raju, “Design of Bridges” Oxford and IBH Publishing 2010.
3. Johnson Victor, “Essentials of Bridge Engineering”, Oxford & IBH Publishers, Sixth edition 2018

26CEC109

MODEL TESTING LAB

Instruction	2 Hours per week
Duration	2 Hours
SEE	50 Marks
CIE	
Credits	1.0

Course Objectives:

To enable the student to

1. To understand the under-reinforced and over reinforced failure of RC beam.
2. To study the shear and bond characteristics in RC members
3. To comprehend the strengthening techniques for structural members.
4. To understand the load-carrying capacity of columns.

Course Outcomes:

At the end of the course, the student can

1. Distinguish the failure behaviour of under-reinforced and over-reinforced beams.
2. Apply the retrofitting techniques for RC members and evaluate its characteristics.
3. Determination of shear capacity of RC beams with and without shear reinforcement.
4. Determine the behaviour of columns under compression
5. Evaluate the dynamic response of a building model using a shake table.

CO-PO Articulation Matrix

COs	PO 1	PO 2	PO 3	PO 4
CO1	2	3	3	2
CO2	2	2	3	2
CO3	2	3	2	2
CO4	3	2	2	2
CO5	2	2	2	2

List of Experiments:

1. Evaluation of the flexural capacity of an under-reinforced RC beam
2. Evaluation of the flexural capacity of an over-reinforced RC beam
3. Determination of shear capacity of RC beams with and without shear reinforcement
4. Determination of flexural characteristics of RC beam retrofitted with the fibre wrapping technique
5. Evaluate the confinement effect of fibre wraps on the compressive strength of concrete
6. Estimation of load-carrying capacity of an axially loaded RC column
7. Evaluation of the dynamic response of the building model using a shake-table setup.
8. Determination of pull-out strength of reinforcement embedded in concrete

26CEC110

FINITE ELEMENT METHOD LAB

Instruction	2 Hours per week
Duration	2 Hours
SEE	50 Marks
CIE	---
Credits	1.0

Course Objectives:

To enable the student

1. Analyse bars, plane trusses, beams and plane frames using 1D elements
2. Analyse plates using 2D elements
3. Analyse solid beams using 3D elements

Course Outcomes:

At the end of the course, student is able to

1. Apply FEM to analyze bars, trusses, beams and plane frames using 1D elements.
2. Analyze structural behavior of plate (with and without holes) using 2D elements in FEM
3. Evaluate solid structures and thermal problems using 3D elements in FEM
4. Demonstrate proficiency in using FEM software for modeling, meshing, solving, and interpreting engineering problems

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	2	2	3	2
CO2	2	2	3	3
CO3	3	2	3	3
CO4	2	3	3	2

List of Experiments:

The following problems are to be solved using any Finite Element software:

1. Uniform bars with axial loads using 1D elements
2. Stepped bars with axial loads using 1D elements
3. Plane trusses using 1D elements
4. Beams using 1D elements
5. Plane frames using 1D elements
6. Plates without hole using 2D elements
7. Plates with hole using 2D elements
8. Solid beam using 3D elements
9. Thermal Analysis of beams
10. Circular disc under diametrical loading

E-resources:

- **https://www.ansys.com/en-in/academic/learning-resources**

23CEC111

MINI PROJECT WITH SEMINAR

Instruction	2 Hours per week
Duration	2 Hours
SEE	50 Marks
CIE	
Credits	1

Outcomes:

Students are able to

1. Formulate a specific problem and give solution.
2. Develop model/models either theoretical/practical/numerical form.
3. Solve, interpret/correlate the results and discussions.
4. Conclude the results obtained.
5. Write the documentation in standard format.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	2	2	--
CO2	2	2	1	1
CO3	2	1	3	2
CO4	2	3	2	2
CO5	2	2	1	3

Guidelines:

1. As part of the curriculum in the II- semester of the programme, each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
2. Each student will be allotted to a faculty supervisor for mentoring.
3. Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original.
4. Mini projects shall have interdisciplinary/ industry relevance.
5. The students can select a mathematical modelling based/Experimental investigations or Numerical modeling.
6. All the investigations are clearly stated and documented with the reasons/explanations.
7. The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and references.

Department committee:

Supervisor and two faculty coordinators Guidelines for awarding

Evaluation by	Max. Marks	Evaluation Criteria / Parameter
Supervisor	20	Progress and Review
	05	Report
Department Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

M.E. (STRUCTURAL ENGINEERING)

SEMESTER – III

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
THEORY									
1	Program Specific Elective- V		3	0	0	3	40	60	3
2	Open Elective		3	0	0	3	40	60	3
3	Audit Course II		2	0	0	2	-	50	Pass / Fail
PRACTICALS									
3	26CEC112	Dissertation Phase- I	0	0	20	-	100	-	10
TOTAL			8	0	20	-	180	170	16

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**

T: Tutorial **P: Practical/Mini Project /Dissertation** **SEE: Semester End Examination**

Course Code	Program Specific Elective-V
26CEE113	Design of Steel-Concrete Composite Structures
26CEE114	Earthquake-Resistant Design of Structures
26CEE115	Design of Industrial Structures
OPEN ELECTIVES	
Course Code	**Course**
26CSO101	Business Analytics
26MEO101	Industrial Safety
26MEO102	Introduction to Optimization Techniques
26CEO101	Cost Management of Engineering Projects
26MEO103	Composite Materials
26EEO101	Waste to Energy
26MEO104	Alternative Energy Sources
26MEO105	Computational Fluid Dynamics

26CEE 113

DESIGN OF STEEL-CONCRETE COMPOSITE STRUCTURES
(PROGRAM SPECIFIC ELECTIVE-V)

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Design of Reinforced Concrete Structures; Design of Steel Structures

Course Objectives:

At the end of the course, a student will be able to:

1. Introduce the fundamental concepts of composite structures, including composite beams, shear connectors, and the behaviour of full and partial composite action.
2. Develop the ability to analyse composite beam behaviour by determining neutral axis locations, shear stud strength, and deflection characteristics under loading.
3. Provide knowledge on the design and strength evaluation of axially loaded composite columns, including squat columns and column stability behaviour.
4. Evaluate the flexural strength and axial load–moment interaction behaviour of composite beam-columns and composite columns.
5. Familiarise students with the behaviour, design principles, and modern applications of composite walls based on experimental studies and current design provisions.

Course Outcomes:

At the end of the course, a student will be able to:

1. Decide the composite action whether it is partial or full.
2. Calculate the deflection and moment of inertia of composite beam
3. Design the capacity of axially loaded composite column
4. Develop P-M curve for composite column
5. Design the composite wall using codal provision

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	2	1	3	2
CO2	3	1	3	2
CO3	3	1	3	3
CO4	3	2	3	3
CO5	3	2	3	3

UNIT – I

Introduction and Full and Partial Composite Action

Introduce composite beams, including shear studs and the definition of composite action. Differentiate between full and partial composite action. Determine the location of a beam's neutral axis/axes depending on the level of composite action. Calculate shear stud strength and understand strength modifiers.

UNIT – II

Composite Beams – Deflections

Discuss composite beam deflections and various methods for calculating the moment of inertia of a composite beam. Overview of using AISC design tables to estimate beam deflections.

UNIT – III

Axially loaded Composite Columns

Introduce composite columns including the strength of squat composite columns, columns under only axial load, and developing column curves.

UNIT – IV

Flexural and P-M Interaction for Composite Columns

Discuss beam-column composite elements, including the flexural capacity of composite columns and the effect of concurrent axial and moment loads on composite behaviour.

UNIT – V

Composite Walls

Introduce composite walls including the genesis of composite walls and recent applications. Experimental behavior of composite walls and current design provisions for composite walls.

Text Books:

1. Roger P. Johnson (Author), Yong C. Wang (Contributor) Composite Structures of Steel and Concrete: Willey Blackwell 4th Edition 2018
2. Qing Quan Liang, Analysis and Design of Steel and Composite Structures CRC Press, Taylor and Francis Group, 2015

Suggested Reading:

1. IS:11384-1985. Code of Practice for Composite Construction in Structural Steel and Concrete
2. Segui, W.T. (2017). LRFD Steel Design. 6th Edition, Brooks/Cole Publishing Company, Pacific Grove, California.
3. AISC (2016). Steel Construction Manual, Fifteenth Edition, American Institute of Steel Construction, Chicago, IL.

26CEE114

EARTHQUAKE RESISTANT DESIGN OF STRUCTURES
(PROGRAM SPECIFIC ELECTIVE-V)

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

To enable the student to understand the basics of

1. Seismology and ground motion
2. Basic design principle of seismology and equal energy principles
3. Analysis and design of Equivalent static analysis, response spectrum analysis etc.,
4. Seismic behavior and design of RC elements
5. Joint connections in structures and principles of SDMF

Course Outcomes:

At the end of the course, student is able to

1. Analyze the basic aspects of seismology and behavior of structural components during ground motion.
2. Analyze and design the structural components using capacity-based design.
3. Model and Design the structures using time history analysis.
4. Analyze and Design seismic resistant structures using codal provisions.
5. Analyze and design the joints and SDMF for RC structures.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	3	1	2
CO2	3	3	1	2
CO3	3	3	1	2
CO4	3	3	1	2
CO5	3	3	1	2

UNIT – I

Basic Concepts: Seismic performance of structures and structural components during earthquakes; Ground motion parameters; Response spectrum, design spectrum.

UNIT – II

Seismic Design Philosophy: Concept of strength, over strength and ductility, Concept of equal displacement and equal energy principles, capacity design; seismic design consideration in buildings with irregularities.

UNIT – III

Seismic Analysis of Buildings: Equivalent static analysis, response spectrum analysis, mode superposition method; Time history analysis; modelling concept of reinforced concrete building.

UNIT – IV

Seismic Design of Building Components: Seismic resistant properties of reinforced concrete; Seismic behavior and design of linear reinforced concrete elements; Seismic behavior of planar reinforced concrete elements, codal provisions.

UNIT – V

Seismic Provisions for Structural Steel Buildings: Materials, connections, joints and fasters; Columns, ordinary, intermediate and special moment resisting frame; concentrically and eccentrically braced frames.

Text Books:

1. Pauley, T. and Priestley, M.J.N "Seismic Design of Reinforced Concrete 1992and Masonry Buildings", John-Wiley & Sons.
2. Drysdale, R.G. Hamid, A. H. and Baker, L.R "Masonry Structure: 1994Behaviour and Design", Prentice Hall, Englewood Cliffs.
3. Schneider, R.R. and Dickey, W.L. "Reinforced Masonry Design", 3rd Ed., 1994, Prentice Hall.

Suggested Reading:

1. Edmund Booth, "Concrete Structure in earthquake regions – Design & 1994Analysis" Longman Scientific & Technical.
2. "Seismic Evaluation and retrofit of concrete building – Vol. I & II", 1996, Applied Technology Council, California, ATC 40.

26CEE115

DESIGN OF INDUSTRIAL STRUCTURES
(PROGRAM SPECIFIC ELECTIVE- V)

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

To enable the student

1. To impart a broad knowledge in load calculations for gantry girders and detailed design of gantry girder cross-section.
2. To make the student well versed with the loading theories and design procedures in bunkers and silos.
3. The student should know about various accessories of steel chimneys and get a thorough knowledge of the design and stability aspects.
4. The student should know the advantages of cold-formed sections and the problems associated with them. A thorough knowledge
5. The student will be made to learn the fire models, fire engineering design of steel structures and mechanical properties of steel at elevated temperatures. A detailed knowledge of fire resistance and fire performance assessment for steel will be imparted.

Course Outcomes:

1. The student gets the ability to compute design loads and design Steel Gantry Girders for various complex situations.
2. The student can analyze and design bunkers and silos and can effectively get them executed with the knowledge acquired during the course.
3. The student, with his sound knowledge acquired, can proportion various accessories of steel chimneys and be able to design chimneys along with foundations.
4. The student gets clear understanding of cold formed sections and the related difficulties and problems. He gets the ability to design various structural components using cold formed sections.
5. The student is conversant with the fire effects on structures and has sound knowledge in fire models, fire engineering design.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	3	1	2
CO2	3	3	1	2
CO3	3	2	1	2
CO4	2	2	1	1
CO5	2	3	2	2

UNIT - I:

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.

UNIT - II:

Bunkers and Silos: introduction - general design principles- design theories Janssen's Theory and Airy's Theory - Detailed design of bunkers and silos as per IS 9178 – Part I & II.

UNIT - III:

Steel 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.

UNIT-IV:

Design of Cold Formed Sections : Introduction to cold formed structures, advantages, stiffened and un stiffened elements, local buckling and post buckling strength, shear lag and flange curling, unusually wide flange section, short span sections, members subjected to axial tension, compression and bending, design of beams and columns. Use of cold formed sections in pre – engineered Buildings.

UNIT – V:

Fire Resistant Design: Introduction, design curves and fire models, fire engineering design of steel structures – calculation approach, Calculation of temperature rise in steel members, mechanical properties of steel at elevated temperatures, time to reach limiting temperature, passive protection for steel work, fire resistance and fire performance assessment for steel.

Text Books:

1. B. C. Punmia, Jain Ashok Kr., Jain Arun Kr, "*Design of Steel Structure*", Lakshmi Publishers, 2015.
2. Ram Chandra," *Design of Steel Structures*", Standard Publishers, 2009.
3. Subramanian," *Design of Steel Structures*", Oxford University Press, 2016.

Suggested Reading:

1. G. J. Hancock, T. M. Murray and D. S. Ellifritt," *Cold – formed steel structures to the AISC Specification*", Marcel Dekker, Inc. New York.
2. B. Davison and G. W. Owens," *Steel designers manual", the steel construction institute*, Wiley Blackwell,2016

23CSO101

BUSINESS ANALYTICS

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

PRE-REQUISITES: Basic of programming, basic mathematics**.**

COURSE OBJECTIVES: This course aims to

1. Understanding the basic concepts of business analytics and applications.
2. Study various business analytics methods including predictive, prescriptive and descriptive analytics.
3. Prepare the students to model business data using various data mining, decision making methods.

COURSE OUTCOMES: After completion of this course, students will be able to

1. Identify and describe complex business problems in terms of analytical models.
2. Apply appropriate analytical methods to solve business problems and interpret the resulting metrics and measures to achieve stated objectives.
3. Illustrate descriptive, predictive and prescriptive analytics methods and techniques.
4. Model business data using data mining, forecasting, decision tree, and clustering techniques.
5. Design and evaluate viable data-driven solutions to complex business decision-making problems.

CO-PO ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4
CO1	3	2	1	2
CO2	3	2	2	2
CO3	2	2	2	3
CO4	2	3	2	3
CO5	3	3	3	3

UNIT - I

Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, Generative AI , LLMs and Explainable AI (XAI) in business analytics, framework for decision making, challenges in data driven decision making and future.

UNIT - II

Descriptive Analytics: Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization.

UNIT - III

Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

UNIT - IV

Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble methods, Random Forest, XGBoost. Clustering: Distance and similarity measures used in clustering, Clustering algorithms, K-Means, Prescriptive Analytics- Linear Programming (LP) and LP model building.

UNIT-V

Six Sigma: Introduction, origin, 3-Sigma Vs Six-Sigma process,cost of poor quality, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox.

TEXTBOOKS:

1. U Dinesh Kumar, "Business Analytics", Wiley Publications, 2nd Edition, 2022
2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles,Concepts, and Applications with SAS", Associate Publishers, 2015

SUGGESTED READINGS:

1. S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making",6th Edition, Cengage, 2020.

ONLINE RESOURCES:

1. Coursera – Business Analytics Specialization (University of Pennsylvania, Wharton): https://www.coursera.org/specializations/business-analytics
2. NPTEL – Business Analytics and Data Mining (IIT Roorkee): https://nptel.ac.in/courses/110107106
3. edX – Data Science and Analytics MicroMasters (MIT): https://www.edx.org/micromasters/mitx-statistics-and-data-science

26MEO101

INDUSTRIAL SAFETY

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course aims to cover:

1. Causes for industrial accidents, preventive steps to be taken, Factories act 1948 and 5S Techniques.
2. Fundamental concepts of Maintenance Engineering.
3. About Safety in advanced manufacturing systems.
4. The basic concepts and importance of fault tracing.
5. The steps involved in periodic and preventive maintenance of various industrial equipments.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Identify causes of industrial accidents and recommend preventive measures.
2. Select appropriate tools and practices for various maintenance procedures.
3. Apply different Safety measures in advanced manufacturing systems.
4. Diagnose faults in equipment such as machine tools, IC engines, and boilers.
5. Implement periodic and preventive maintenance for industrial equipment including motors, pumps, air compressors, and machine tools.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	2	2	1	1
CO 2	3	3	2	2	1	1
CO 3	3	3	2	2	1	1
CO 4	3	3	2	2	1	1
CO 5	3	3	3	2	1	1

UNIT - I

SAFETY MANAGEMENT CONCEPTS AND INDUSTRIAL SAFETY PRACTICES

Industrial Safety & Legal Aspects: Industrial accidents – causes, types, consequences, and preventive measures. Mechanical and electrical hazards and their control. Fire hazards, prevention and firefighting meth-ods. Safety color codes and safety signage. Salient provisions of the Factories Act 1948 related to health, safety, and welfare.
Safety Audit: Types of safety audits – audit methodology, preparation of audit checklists, Non-Conformity Re-porting (NCR). Analysis and interpretation of accident records and safety reports.
5S Techniques: Introduction, objectives, and elements of 5S (Sort, Set in order, Shine, Standardize, Sustain). Benefits of 5S in enhancing workplace safety, productivity, and efficiency.

UNIT - II

Fundamentals of Maintenance Engineering: Definition and objectives of maintenance engineering. Primary and secondary functions and responsibilities of the maintenance department. Types of maintenance (preventive, predictive, breakdown, corrective) and their applications. Tools and equipment used in maintenance activities. Maintenance cost and its relationship with replacement decisions and economy. Concept of service life and fac-tors affecting the lifespan of equipment.

UNIT- III

Safety in advanced manufacturing systems: Machine safety in CNC, robotics, and Flexible Manufacturing Systems (FMS). Human–machine interaction safety. Safety in Industry 4.0 environments including cyber-physical systems, smart factories, and digital twins. Safety in additive manufacturing (powder handling and laser safety). Safety in material handling systems (conveyors, cranes, AGVs) and manufacturing processes (welding, casting, forging, machining). Electrical safety in automation and Lockout/Tagout (LOTO) procedures.

UNIT - IV

Fault Tracing: Concept and importance of fault tracing. Decision tree approach – need, structure, and applications. Sequence of fault-finding activities and systematic troubleshooting procedures. Development and representation of fault diagnosis using decision trees. Fault tracing in industrial equipment including machine tools, pumps, air compressors, internal combustion engines, boilers, and electrical motors. Types of faults in machine tools and their general causes.

UNIT - V

Maintenance and Condition Monitoring

Periodic and Preventive Maintenance: Periodic inspection, concept and need. Cleaning, servicing, and overhauling of mechanical components and electrical motors. Common motor faults and remedies. Preventive maintenance definition, steps, and advantages. Maintenance procedures for machine tools, pumps, air compressors, and DG sets.

Condition monitoring and basic concepts of Proactive maintenance for Industry 4.0.

Text Books:

1. L. M. Deshmukh, Industrial Safety Management, McGraw Hill Education, New Delhi, 1st Edition, 2010.
2. M.R. Sahoo, Industrial Safety Engineering, RK Publications, New Delhi, 1st Edition, 2015.
3. H. P. Garg, “Industrial Maintenance”, S. Chand and Company, may 1987.
4. Das Akhil Kumar, Principles of Industrial Safety Management Understanding the Ws of Safety at Work, Second edition, PHI Learning Pvt Ltd, Jan 2020

Suggested Reading:

1. Parth B. Shah, Industrial Safety and Maintenance Engineering, Technical publications, 2021.
2. Higgins & Morrow, “Maintenance Engineering Handbook”, McGraw-Hill Education Eighth Edition, February 2014.
3. M.P. Poonia, S.C. Sharma, Khanna Publishing House - Technology & Engineering, year 2019.

26MEO102

INTRODUCTION TO OPTIMIZATION TECHNIQUES

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course aims to

1. Understand the LPP models.
2. Understand the Transportation and Assignment techniques.
3. Understand the procedure of Project Management along with CPM and PERT techniques.
4. Understand the concepts of queuing theory and inventory models.
5. Understand sequencing techniques.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Formulate a linear programming problems (LPP).
2. Build and solve Transportation Models and Assignment Models.
3. Apply project management techniques like CPM and PERT to plan and execute project successfully.
4. Apply queuing and inventory concepts in industrial applications.
5. Apply sequencing models in industries.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	1	3	1	2	2
CO 2	3	1	3	1	2	2
CO 3	1	1	3	2	3	2
CO 4	2	1	3	2	2	3
CO 5	2	1	3	2	2	3

UNIT - I

Operations Research: Definition, Scope, Models, Linear Programming Problems (LPP), Formulation, Graphical Method, and Simplex Method.

UNIT - II

Transportation Models: Finding an initial feasible solution, North West corner method, Least cost method, Vogel's approximation method, Finding the optimal solution, Special cases in transportation problems, Unbalanced transportation problem, Degeneracyin transportation, Profit maximization in transportation.

UNIT- III

Project Management: Definition, Procedure and objectives of project management, Differences between PERT and CPM, Rules for drawing network diagram, Scheduling the activities, Fulkerson's rule, Earliest and lat-est times, Determination of ES and EF times in forward path, LS & LF times in backward path, Determination of critical path, Duration of the project, Free float, Independent float and total float.

UNIT - IV

Queuing Theory and Inventory: Kendols notation, Single server models, Inventory control, Deterministic inventory models, Probabilistic inventory control models.

UNIT - V

Sequencing Models: Introduction, Objectives, General assumptions, Processing 'n' jobs through two machines, Processing 'n' jobs through three machines**.**

Text Books:

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.

Suggested Reading:

1. Hitler Libermann, Operations Research, McGraw Hill Pub, 2009.
2. Harvey M Wagner, Principles of Operations Research, Prentice Hall of India,2010.

26CEO101

COST MANAGEMENT OF ENGINEERING PROJECTS
(OPEN ELECTIVE – Common to All Branches)

Instruction	3 Hours per week
Duration	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

This course aims to:

6. To enable the students to understand the concepts of Project management.
7. To provide knowledge on concepts of Project Planning and scheduling.
8. To create an awareness on Project Monitoring and Cost Analysis
9. To provide adequate knowledge to the students on Recourse Management Costing-Variance Analysis
10. To train the students with the concepts of Budgetary Control for cost management and to provide basic platform on Quantitative techniques for cost management.

Course Outcomes:

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

6. Acquire in-depth knowledge about the concepts of project management and understand the principles of project management
7. Determine the critical path of a typical project using CPM and PERT techniques.
8. Prepare a work break down plan and perform linear scheduling using various methods.
9. Solve problems of resource scheduling and levelling using network diagrams.
10. Learn the concepts of budgetary control and apply quantitative techniques for optimizing project cost

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	1	1	--	1
CO2	1	2	1	1
CO3	1	1	1	1
CO4	2	2	1	1
CO5	--	1	1	1

UNIT- I:
Project Management: Introduction to project managements, stakeholders, roles, responsibilities and functional relationships. Principles of project management, objectives and project management system. Project team, organization, roles, and responsibilities. Concepts of project planning, monitoring, staffing, scheduling and controlling.

UNIT- II:
Project Planning and Scheduling: Introduction for project planning, defining activities and their interdependency, time and resource estimation. Work break down structure. Linear scheduling methods-bar charts, Line of Balance (LOB), their limitations. Principles, definitions of network-based scheduling methods: CPM, PERT. Network representation, network analysis-forward and backward passes.

UNIT- III:

Project Monitoring and Cost Analysis: introduction-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, Time cost trade off Crashing project schedules, its impact on time on time, cost. Project direct and indirect costs.

UNIT- IV:

Resources Management and Costing-Variance Analysis: Planning, Enterprise Resource Planning, Resource scheduling and levelling. Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis

Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement

UNIT- V:

Boundary Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

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

Text Books:

1. Charles T Horngren "Cost Accounting A Managerial Emphasis", Pearson Education; 14 edition (2012),
2. Charles T. Horngren and George Foster, "Advanced Management Accounting" Prentice-Hall; 6th Revised edition (1 February1987)
3. Robert S Kaplan Anthony A. Atkinson, "Management & Cost Accounting", Pearson; 2 edition (18 October1996)

Suggested Reading:

1. *K. K Chitkara, "Construction Project Management: Planning, scheduling and controlling", Tata McGrawHill Education. (2004).*
2. *Kumar Neeraj Jha "Construction Project Management Theory and Practice", Pearson Education India; 2 edition (2015).*

26MEO103

COMPOSITE MATERIALS

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aims to

1. Provide concepts of Composite materials and their constituents.
2. Explain the Classification of the reinforcements and matrix materials.
3. Provide Fabrication methods of metal matrix composites.
4. Explain manufacturing of Polymer matrix composites.
5. Elucidate Failure mechanisms in composite materials.

Course Outcomes:
Upon completion of this course, students will be able to:

1. Understand composite materials and their reinforcements.
2. Summarize micro-mechanics approach as applied to UD lamina.
3. Apply fabrication methods of metal, ceramic and carbon matrix composites.
4. Apply fabrication methods of polymer matrix composites..
5. Analyze the lamina and laminate from failure perspective.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	1	3	1	-	3
CO 2	3	1	3	1	-	3
CO 3	3	1	3	1	-	3
CO 4	3	1	3	1	-	3
CO 5	3	1	3	1	-	3

UNIT - I

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

UNIT - II

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

UNIT- III

Processing of Metal Matrix Composites: Casting - Solid State diffusion technique, Cladding - Hot iso-static pressing. Properties and applications.
Processing of Ceramic Matrix Composites: Liquid Metal Infiltration - Liquid phase sintering.
Processing of Carbon - Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT - IV

Processing 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.

UNIT - V

Strength: Lamina Failure Criteria, strength ratio, maximum stress criteria, maximum strain criteria, interactive failure criteria and hygrothermal failure. Laminate first ply failure -insight strength**.**

Text Books:

1. K.K.Chawla, "Composite Materials- Science and Engineering", 4th edition, Springer Verlag, 2019.
2. Materials Science and Engineering: An Introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
3. R.M. Jones. Mechanics of Composite Materials. 2 nd ed. CRC Press. 2018.

Suggested Reading:

1. Deborah D.L. Chung, "Composite Materials Science and Applications" 2nd edition, Springer Verlag, 2010.
2. Sanjay K. Mazumdar, "Composites Manufacturing- materials, product and process engineering", 1st edition, CRC press, 2002.
3. Daniel Gay, "Composite Materials Design and Applications" 3rd edition, CRC press, 2015.

23EEO101

WASTE to ENERGY

(Common All Branches)

Instruction	**3L Hours per week**
Duration of SE	**3 Hours**
SEE	**60 Marks**
CIE	**40 Marks**
Credits	**3**

Prerequisite: Students should have prior knowledge of Energy Conversions.

Course Objectives:

This course aims to:

1. **Know the various forms of waste.**
2. **Extraction of Energy from Waste.**
3. **Infer the Global and national scenario.**

Course Outcomes:

Upon completion of this course, students will be able to:

1. **Understand the concept of waste energy.**
2. **Explore the various Energy extraction options.**
3. **Describe the Energy Production methodology.**
4. **Explicate the Environmental implications.**
5. **Compare and contrast waste energy productions by case studies.**

CO-PO ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4
CO1	1	1	--	1
CO2	1	2	1	1
CO3	1	1	1	1
CO4	2	2	1	1
CO5	--	1	1	1

UNIT -I

Introduction: The Principles of Waste Management and Waste Utilization. Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source. Waste Sources & Characterization Waste production in different sectors such as domestic, industrial, agriculture, postconsumer, waste etc. Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization. Waste Selection criteria, Smart waste management systems (IoT-based monitoring).

UNIT -II

Energy Extraction Options: Landfill gas, collection and recovery. Refuse Derived Fuel (RDF) – fluff, briquettes, pellets. Alternate Fuel Resource (AFR) – production and use in Cement plants, Thermal power plants and Industrial boilers. Conversion of wastes fuel resources for other useful energy applications Energy from Plastic Wastes: Non-recyclable plastic wastes for energy recovery. Energy Recovery from waste and optimization of its use, benchmarking and standardization. Energy Analysis

UNIT -III

Energy production Methodologies: Collection, segregation, transportation and storage requirements. Location and Siting of 'Waste Energy' plants. Industry Specific Applications: In-house use: sugar, distillery, pharmaceuticals, Pulp and paper, refinery and petrochemical industry and any other industry. Centralized and Decentralized Energy production, distribution and use. Comparison of Centralized and decentralized systems and its operations

UNIT -IV

Environmental Implications: Environmental standards for Waste Energy Plant operations and gas clean-up. Savings on non-renewable fuel resources. Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms.

UNIT -V

Case Studies: Success/failures of waste energy Global Best Practices in Waste energy production distribution and use. Indian Scenario on Waste Energy production distribution and use in India. Success and Failures of Indian Waste Energy plants. Role of the Government in promoting 'Waste Energy ", Government policies & PPP models, Future trends: AI in waste management, circular economy

Textbooks:

1. "Industrial and Urban Waste Management in India", TERI Press.
2. Banwari Lal and Patwardhan, "Wealth from Waste: Trends and Technologies" TERI Press.
3. S.N Mukhopadhyay, "Fundamentals of waste and Environmental Engineering", TERIPress.
4. "Waste-to-Energy in Austria – White Book – Figures, Data Facts", 2nd edition, May 2010.

Suggested Reading:

1. CPCB Guidelines for Co-processing in Cement/Power/Steel Industry
2. Report of the task Force on Waste Energy, Niti Ayog (Formerly Planning Commission) 2014.
3. Municipal Solid Waste Management Manual, CPHEEO, 2016
4. Gazette Notification on Waste Management Rules 2016.

S.No	NPTEL Course Name	Instructor	Host Institute
1	Waste to Energy Conversion	Prof. P. Mondal	IIT Roorkee
Other Online Resources:			
1	https://nptel.ac.in/courses/103107125	-	-

26MEO104

ALTERNATIVE ENERGY SOURCES

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course aims to

1. Need and importance of non-conventional energy resources.
2. Extent of solar energy which can be utilized as energy resource.
3. Concept of wind energy and its merits and demerits.
4. Operating principles of geothermal energy and bio-energy.
5. Merits and demerits of tidal energy, wave energy and OTEC.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Understand the need for renewable energy sources in the context of environmental issues.
2. Apply the principles of solar energy for domestic and industrial usages.
3. Understand the working principle of wind power plants along with merits and demerits.
4. Describe the concepts of geothermal energy sources and biomass as a source of energy.
5. Explain the principles and impact of wave, tidal and OTEC plants on the environment.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	2	3	2	2	1
CO 2	3	2	3	1	1	2
CO 3	3	3	3	1	2	2
CO 4	3	2	3	1	1	2
CO 5	3	2	2	1	2	3

UNIT - I

Energy Sources: Energy characteristics, forms of energy, energy chain (route), energy sectors, Indian energy scenario, energy pricing in India, energy and environment, energy security, energy conservation and its importance, energy strategy for future, classification of energy sources, availability of conventional and non-conventional (renewable) energy sources, classification of RES - solar, wind, geothermal, bio-mass, ocean tidal, ocean wave and ocean thermal energy conversion (OTEC), advantages and limitations of conventional and renewable energy sources.

UNIT - II

Solar Energy: Solar radiation, solar thermal collectors, working of flat plate and concentrating (focusing) solar collectors and their limitations, comparison of flat plate and focusing collectors, applications of solar collectors - water heating, space heating, low temperature power generation, solar cookers, water pumping, SODIS, solar thermal power plant, advantages and limitations of solar energy systems, PV materials, PV cells and their manufacturing, space based solar power (SBSP), solar satellite system, advantages and disadvantages of SBSP..

UNIT- III

Wind Energy: Sources of wind, merits and demerits of wind energy, site selection for wind energy conversion system, wind turbine (wind mill), classification of wind mills, working principle horizontal axis and vertical axis windmills, horizontal vs vertical axis windmills, power extracted from the wind, effect of velocity on power generation, new developments and problems in operating large wind power generators.

UNIT - IV

Geothermal Energy: Layers in earth, resources of geothermal energy, hydrothermal, petrothermal and geopressure resources, advantages, disadvantages, applications and environmental effects of geothermal energy sources**.**

Biomass Energy: Resources, biogas and its composition, process of biogas generation, wet process and dry process, raw materials available for biogas fermentation, economical, social, environmental and health benefits of biogas utilization, selection of site and constructional techniques of a biogas plant, working of KVIC, Praga-thi design, Janata and Deenbandu biogas plants, common operational problems, causes and remedies relating to a biogas plant.

UNIT - V

Tidal power: Tidal systems, site selection for tidal power plant, schematic layout of tidal power house, principle of operation of single basin and double basin tidal plants, advantages and disadvantages of tidal power.

Wave energy - Differences between tides and waves, advantages and disadvantages of wave power, problems associated with wave energy collection, working principle of wave energy conversion devices.

Ocean thermal energy conversion (OTEC) - OTEC power plants, location, open cycle and closed cycle OTEC plants, advantages, limitations and applications of OTEC, environmental impact of OTEC plants.

Text Books:

1. S. Hasan Saeed and D.K. Sharma, —Non Conventional Energy Resources‖, S.K. Kataria & Sons, New Delhi, 2017.
2. Dr. R.K. Singal, —Non Conventional Energy Resources‖, S.K. Kataria & Sons, New Delhi, 2005.

Suggested Reading:

1. K. M. Mittal, —Non-Conventional Energy Systems‖, Wheeler Publishing Co. Ltd, New Delhi, 2003.
2. Shali Habibulla, —Non-Conventional Energy Sources‖, State Institute of Vocational Education, Hyderabad, 2005
3. G.D. Rai, —Non Conventional Energy Sources‖, Khanna Publishers, New Delhi, 2011.

26MEO105

COMPUTATIONAL FLUID DYNAMICS

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course aims to

1. Basic equations and concept of CFD.
2. Concept of PDEs and finite difference methods.
3. Crank-Nihcolson, Implicit and Explicit methods & Jacobi, Gauss Seidel and ADI methods.
4. Various types of grid generation and errors in numerical solution.
5. Importance of FVM.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Derive CFD governing equations and turbulence models.
2. Apply different PDEs and know the importance of Taylor series of expansion.
3. Solve simultaneous linear equations with various methods.
4. Understand errors, stability, consistency and develop O,H and C grid generated models.
5. Utilize FVM for heat transfer problems.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	1	3	1	2	2
CO 2	3	1	3	1	2	2
CO 3	3	1	3	1	2	3
CO 4	3	1	3	1	2	3
CO 5	3	1	3	1	2	3

UNIT - I

Governing Equations: Continuity, Momentum and Energy equations, Navier Stokes equations, Reynolds and Favre averaged N – S equations. Introduction to turbulence, Turbulence models-mixing length model, K-å tur-bulence Model.

UNIT - II

Classification of PDEs: Elliptic, parabolic and hyperbolic equations, Initial and boundary conditions. Concepts of Finite difference methods – forward, backward and central difference, explicit, Implicit and Crank Nicholson.

UNIT- III

Finite Difference Solutions: Solution of simultaneous linear equations: Jacobi, Gauss Seidel, TDMA, ADI, solution for viscous incompressible flow using Vorticity Stream function method, MAC method.

UNIT - IV

Grid Generation: Grid Generation- Types of grid O,H,C. Coordinate transformation, Unstructured grid generation, Errors, Consistency, Stability analysis by von Neumann. Convergence criteria.

UNIT - V

Finite Volume Method: Introduction to Finite Volume Method, Finite volume formulations for diffusion equation, convection diffusion equation, Staggered grids SIMPLE and SIMPLE R Algorithms.

Text Books:

1. P.S. Ghoshdastidar, Computational Fluid Dynamics and Heat Transfer, Cengage, 2017.
2. John D. Anderson, "Computational Fluid Dynamics", McGraw-Hill Inc., 2018.
3. H. K. Versteeg and Malala Shekara, "Introduction to Finite Volume Method", Pearson, 2015

Suggested Reading:

1. K. Muralidhar and T. Sundararajan T., "Computational Fluid flow and Heat transfer", Narosa Publishing House, 2003.
2. S.V. Patankar, "Numerical Heat transfer and Fluid flow", Hemisphere Publishing Company, New York, 1980.

26CEC112

DISSERTATION PHASE-I

Instruction	20 Hours per week
Duration	Presentation and Viva
SEE	100 Marks
CIE	
Credits	10

Prerequisites: Students should have prior Domain-specific knowledge, Research Methodology

Course Objectives:

1. To provide students with hands-on experience in design and analysis in the field of structural Engineering.
2. To help students develop a thorough understanding of the practical applications of civil engineering in real-world scenarios.
3. To develop students' ability to analyze and design civil engineering structures using appropriate software.
4. To enhance students' communication and teamwork skills through group projects and presentations.
5. To expose students to the latest trends and technologies in the field of civil engineering through guest lectures and industry visits.

Course Outcomes:

At the end of the course:

1. Students will be exposed to self-learning various topics.
2. Students will learn to survey the literature such as books, national/ international refereed Journals and contact resource persons for the selected topic of research.
3. Students will learn to write technical reports.
4. Students will develop oral and written communication skills to present. 5. Student will defend their work in front of technically qualified audience.
5. The Student will be able to carry out the dissertation/ Research work independently.

Guidelines:

1. The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
2. Seminar should be based on the area in which the candidate has undertaken the dissertation work.
3. The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report.
4. The work has to be presented in front of the committee consists of Head, Chairperson-BoS, Supervisor and Project coordinator.
5. The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	2	2	--
CO2	2	2	1	1
CO3	2	1	3	2
CO4	2	3	2	2
CO5	3	2	2	3

Guidelines for the award of Marks:		**Max. Marks:100**
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Project Status / Review(s)
	20	Report
Department Committee	10	Relevance of the Topic
	10	PPT Preparation(s)
	10	Presentation(s)
	10	Question and Answers
	10	Report Preparation

Note: Department committee has to assess the progress of the student for every two weeks.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

M.E. (STRUCTURAL ENGINEERING)

Semester IV

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
PRACTICALS									
1	26CEC113	Dissertation Phase-II	0	0	32	-	100	100	16
TOTAL			0	0	32	-	100	100	16

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**

T: Tutorial **P: Practical/Mini Project /Dissertation** **SEE: Semester End Examination**

26CEC113

DISSERTATION PHASE-II

Instruction	32 Hours per week
Duration	Viva
SEE	100 Marks
CIE	100 Marks
Credits	16

Course Objectives:

1. To provide students with advanced technical knowledge and skills in structural engineering and allied fields to undertake complex industrial projects.
2. To help students develop a deep understanding of industrial project management, including project planning, execution, and evaluation.
3. To develop students' research methodology skills and the ability to conduct independent research related to power systems and power electronics.
4. To expose students to the latest trends and technologies in the field of civil engineering with a special reference to structural engineering through guest lectures and industry visits.
5. To instill in students a sense of responsibility towards safety, environmental issues, and ethical practices in the industrial setting.

Course Outcomes:

At the end of the course

1. Students will be able to use different experimental techniques and will be able to use different software/computational/analytical tools.
2. Students will be able to design and develop an experimental set up/ equipment/test rig.
3. Students will be able to conduct tests on existing setups/equipment and draw logical conclusions from the results after analyzing them.
4. Students will be able to either work in a research environment or in an industrial environment.
5. Students will be conversant with technical report writing and will be able to present and convince their topic of study to the engineering community.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	3	2	2	--
CO2	2	2	1	1
CO3	2	1	3	2
CO4	2	3	2	2
CO5	3	2	2	3

Guidelines:

1. It is a continuation of Project work started in semester III.
2. The student has to submit the report in prescribed format and also present a seminar.
3. The dissertation should be presented in standard format as provided by the department.
4. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
5. The report must bring out the conclusions of the work and future scope for the study.

The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner (HoD and BoS Chair Person) guide/co-guide.

The candidate has to be in regular contact with his/her guide/co-guide.

Guidelines for awarding marks in CIE: Max. Marks:100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Department Review Committee	05	Review 1
	10	Review 2
	10	Review 3
	15	Final presentation with the draft copy of the report standard format
	10	Submission of the report in a standard format
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format

Guidelines for awarding marks in SEE: (Max. Marks: 100) Max. Marks: 100

Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Internal Examiner (s) together	20	Power Point Presentation
	40	Quality of thesis and evaluation
	20	Quality of the project Innovations Applications Live Research Projects Scope for future study Application to society
	20	Viva-Voce