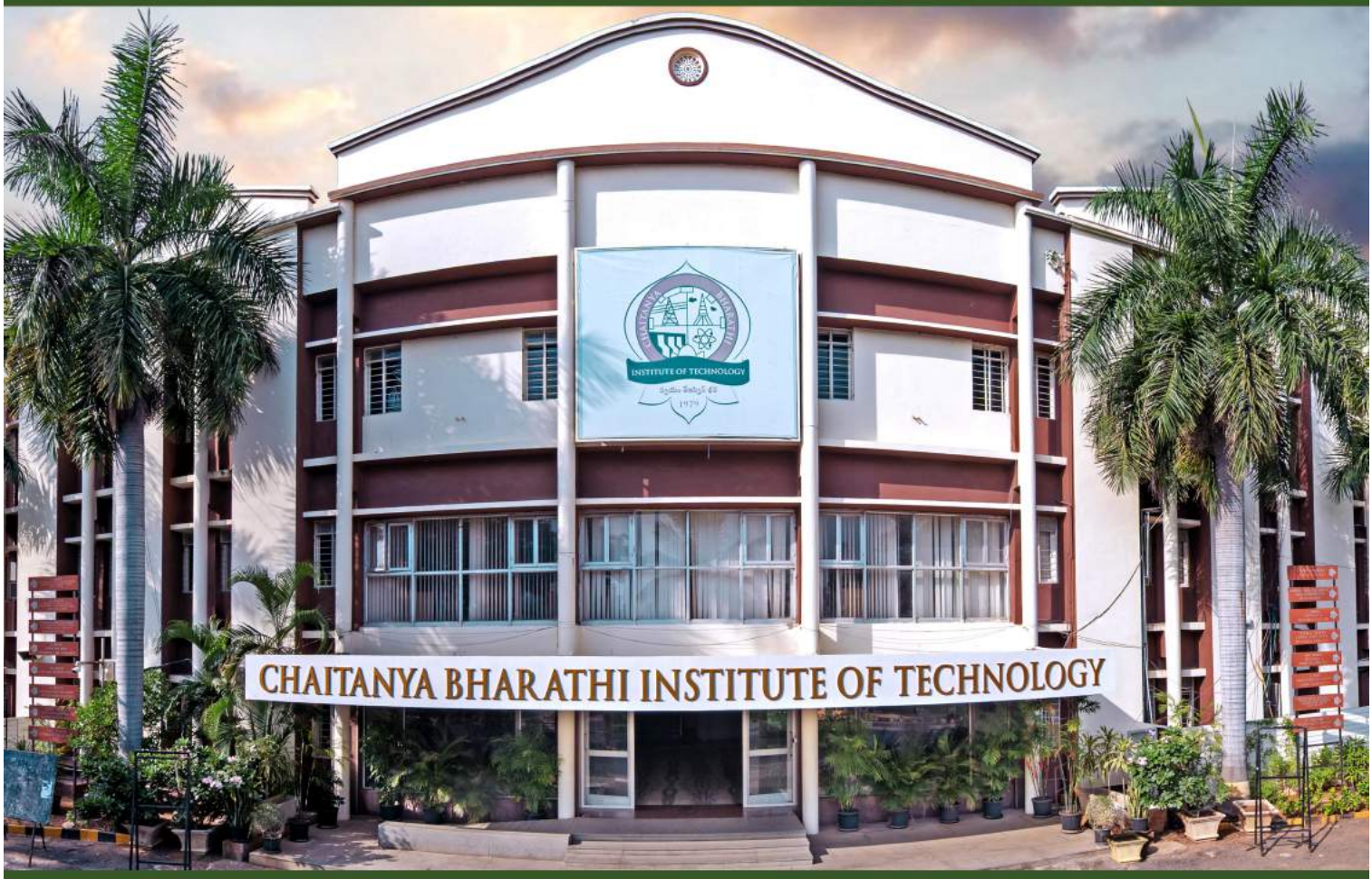
PG-R23 Curriculum
With effective from 2023-24

Civil Engineering - Structural Engineering

Scheme of Instruction and Syllabi of
M.E I to IV Semester of
Two Year Degree Course



CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
(An Autonomous Institute | Affiliated to Osmania University)
Accreditated by NBA & NAAC (A++)
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SCHEME OF INSTRUCTION AND SYLLABI

Master of Engineering

A TWO YEAR PG Program

in

M.E (Civil) (Structural Engineering)

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

(R–23 Regulation)

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

(Autonomous Institution under UGC, Affiliated to Osmania University)

Department of Electronics and Communication 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 DEPT. of Civil Engg.

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 professional attitude, ethics, and concern for 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 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 program

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

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	23CE C101	Advanced Structural Analysis	3	0	0	3	40	60	3
2	23CE C102	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	23ME M103	Research Methodology and IPR	2	0	0	2	30	45	2
7	Audit Course -I		2	0	0	2	-	50	Pass / Fail
PRACTICALS									
8	23CE C103	Structural Design Lab	0	0	3	-	50	-	1.5
9	23CE C104	Advanced Concrete Lab	0	0	3	-	50	-	1.5
TOTAL			16	0	6	-	290	335	17

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
23CE E101	Theory of Plates and Shells	23CE E104	Fracture Mechanics in Concrete Structures
23CE E102	Design of Hydraulic Structures	23CE E105	Structural Health Monitoring
23CE E103	Infrastructural Engineering & Management	23CE E106	Theory of Structural Stability
Audit Course- I and II			
Course Code	**Course**		

23EG A101	English for Research Paper Writing
23CE A101	Disaster Mitigation and Management
23EE A101	Sanskrit for Technical Knowledge
23EC A101	Value Education
23EG A102	Constitution of India
23AD A101	Pedagogy Studies
23EG A103	Stress Management by Yoga
23EG A104	Personality Development through Life Enlightenment Skills

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

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

M.E. (STRUCTURAL ENGINEERING)

SEMESTER – II

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	23CE C105	Finite Element Method	3	0	0	3	40	60	3
2	23CE C106	Structural Dynamics	3	0	0	3	40	60	3
3	23CE C107	Design of Advanced Concrete Structure	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	23CE C108	Modal Testing Lab	0	0	3	-	50	-	1.5
7	23CE C109	Numerical Analysis Lab	0	0	3	-	50	-	1.5
8	23CE C110	Mini Project with Seminar	0	0	2	-	50	-	1
TOTAL			14	0	8	-	350	300	19

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
23CE E107	Design of Advanced Steel structures	23CE E110	Design of Tall buildings
23CE E108	Repair and Retro fitting of Structure	23CE E111	Advanced Foundation Design
23CE C109	Design of masonry structures	23CE E112	Design of Industrial Structures
Audit Course- I and II			
Course Code	**Course**		

23EG A101	English for Research Paper Writing
23CE A101	Disaster Mitigation and Management
23EE A101	Sanskrit for Technical Knowledge
23EC A101	Value Education
23EG A102	Constitution of India
23ADA101	Pedagogy Studies
23EG A103	Stress Management by Yoga
23EG A104	Personality Development through Life Enlightenment Skills

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

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

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	23CEC111	Dissertation Phase- I	0	0	23	-	100	-	10
TOTAL			8	0	23	-	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
23CE E113	Design of Pre stressed Concrete Structures
23CE E114	Design of Bridges
23CE E115	Earthquake Resistant Design of Structures
OPEN ELECTIVES	
Course Code	**Course**
23CS O101	Business Analytics
23ME O101	Industrial Safety
23ME O102	Introduction to Optimization Techniques
23CE O101	Cost Management of Engineering Projects
23ME O103	Composite Materials
23EE O103	Waste to Energy

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

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

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	23CE C112	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**

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	23CE C101	Advanced Structural Analysis	3	0	0	3	40	60	3
2	23CE C102	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	23ME M103	Research Methodology and IPR	2	0	0	2	30	45	2
7	Audit Course -I		2	0	0	2	-	50	Pass / Fail
PRACTICALS									
8	23CE C103	Structural Design Lab	0	0	3	-	50	-	1.5
9	23CE C104	Advanced Concrete Lab	0	0	3	-	50	-	1.5
TOTAL			16	0	6	-	290	335	17

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

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

23CE C101

ADVANCED STRUCTURAL ANALYSIS

Instruction	3L 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 beams and trusses
2. Learns the basic concepts of analyze of frames and grids using flexibility methods.
3. Learns the basic concepts of analysis frames and slides using stiffness method
4. Understand the concepts of beams on elastic foundations with semi-infinite and infinite lengths
5. Grasps the fundamentals of solving boundary value problems using approximate methods

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

1. Analyze continuous beams and redundant trusses using force and displacement approaches (flexibility & stiffness approaches) of matrix methods
2. Analyze rigid jointed plane frames and grids by flexibility methods.
3. Analyze rigid jointed plane frames and grids by stiffness methods.
4. Applies the concepts of (beams of semi-infinite and infinite lengths) an elastic foundation to field problems and analytical models.
5. Solve the boundary value problems using approximate methods.

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 and redundant trusses by force and displacement methods with degree redundancy and freedom not exceeding three.

UNIT- II:

Analysis of rigid jointed plane frames and grids: by Flexibility approach with degree of redundancy not exceeding three**.**

UNIT- III:

Analysis of rigid jointed plane frames and grids: by Stiffness approach with degree of freedom not exceeding three.

UNIT- IV:

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.

UNIT- V:

Boundary Value Problems (BVP): Approximate Solution of Boundary Value Problems, Modified Galerkin Method for One-Dimensional BVP, Matrix Formulation of the Modified Galerkin Method.

TEXT BOOKS:

1. William Weaver and James M. Gere, "*Matrix Analysis 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," *Text Book of Finite Element Analysis*", PHI, 2003.

23CE C102

THEORY OF ELASTICITY

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

COURSE OBJECTIVES: This course aims to

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 the self-confidence through quality assignments in theory of Elasticity and plasticity.
3. To inculcate the habit of researching and practicing in the field of elasticity and plasticity.
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: After the completion of this 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/Polar Coordinates.
4. Analyze prismatic bars of various cross sections under torsion using membrane analogy and energy methods.
5. Apply concepts of plasticity and evaluate problems in Structural engineering.

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: Stress function Applications - solution by polynomials - Saint- Venant's principle - determination of displacements - bending of simple beams - gravity loading.

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- IV:

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

UNIT- V:

Theory of Plasticity: Introduction – Idealized Stress-Strain curve, concepts and assumptions - yield criterions – Von Mises Yield Criterion, Tresca Yield Criterion, Plastic Stress-strain relations- Principle of Normality and plastic potential.

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TEXT BOOKS:

1. Timoshenko S. and Goodier, "*Theory of Elasticity*", Mc Graw hill Publications, 2015.
2. J. Chakraborty," *Theory of Plasticity*", Mc Graw hill Publications, 2007.

SUGGESTED READING:

1. S. Singh, "*Theory of Elasticity*", Khanna Publishers, 2003

23CE E101

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

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

COURSE OBJECTIVES: This course aims 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 determining 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 to

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. Distinguishing between different shell roofs and analyze thin shells by DKJ and Schorer's theories.
5. 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 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 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.

23CE E102

DESIGN OF HYDRAULIC STRUCTURES
(PROGRAM SPECIFIC ELECTIVE-I)

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

COURSE OBJECTIVES: This course aims to

1. Demonstrate the importance of different hydraulic structures used widely for irrigation and hydro power generation.
2. Explain the concept of designing of gravity dam and reinforcement detailing for its section.
3. Describe the design of energy dissipater and horizontal apron.
4. Explain the concept of designing vertical drop weirs.
5. Understand the importance of aqueduct, syphon aqueduct, super passage, syphon Super passage, level crossing.

COURSE OUTCOMES: After the completion of this course, the student will be able to At the end of the course, the student will be able to

1. Understand and analyze forces acting on a gravity dam.
2. Analyze a gravity dam under dynamic loading such as earthquake.
3. Design of an Energy Dissipater with horizontal apron.
4. Investigate and design different components of vertical drop weir such as weir wall.
5. Explore different types of cross drainage work and design a Syphon aqueduct.

CO-PO Articulation Matrix

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

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 Dissipater: Hydraulic Jump phenomenon, Momentum Principle, Loss of Energy, Location and Profile of Hydraulic Jump, Normal Depth, End Depth, Forms of the hydraulic Jump, Energy Dissipaters, 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, Feature of design of siphon aqueduct: Hydraulic design and structural design.

TEXT BOOKS:

1. R. S. Varshney, Hydro Power Structures, Nem Chand & Bros, 2002.Revised Edition 2014.
2. P. N. Modi, Irrigation Water Resources and Water Power Engineering, Standard Book House, 2014.

SUGGESTED READING:

1. K. R. Arora, Irrigation Water Power and Water Resources Engineering, Standard Publisher Distributors, 2002

23CE E103

INFRASTRUCTURAL ENGINEERING & MANAGEMENT
(PROGRAM SPECIFIC ELECTIVE-I)

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

COURSE OBJECTIVES: This course aims to

1. To enable the student to understand the fundamental concepts of infrastructure management.
2. To study the concepts of planning for supply and demand of infrastructure
3. To make the students to understand the importance of Risk management framework for infrastructure projects
4. To understand the importance of contract laws & legal frame work in infrastructure project.
5. To get the knowledge on various risks involved in infrastructure project.

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

1. Understand the concept of basic infrastructure terminology and Indian scenario of infrastructure.
2. Understand infrastructure planning and forecast the demand and level of service of infrastructure
3. Develop a risk management framework for infrastructure project.
4. Understand the challenges in various risks involved in infrastructure project.
5. Apply the concepts contract laws and legal agreement in infrastructure project.

CO-PO Articulation Matrix

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

UNIT I
INTRODUCTION TO INFRASTRUCTURE

Definition of basic terminologies, role of infrastructure in economic development, types of infrastructure, measurement of infrastructure capacity, Indian scenario in respect of adequacy and quality

UNIT II
INFRASTRUCTURE PLANNING

Goals and objectives of infrastructure planning, identification and quantification of the casual factors are influencing the demand for infrastructure, review and application of techniques to estimate supply and demand for infrastructure, models to forecast the demand and level of service of infrastructure.

UNIT III
STRATEGIES FOR INFRASTRUCTURE PROJECTS

Risk management framework for infrastructure projects, shaping the planning phase of infrastructure projects to mitigate risks, designing sustainable contracts, sustainable development of infrastructure, innovative design and maintenance of infrastructure facilities

UNIT IV
CHALLENGES IN INFRASTRUCTURE PLA NNING

Mapping and facing the landscape of risks in infrastructure projects, economic and demand risks, socio-environmental risks, cultural risks in international, infrastructure projects, legal and contractual issues in infrastructure, challenges in construction and maintenance of infrastructure

UNIT V

CONTRACT LAWS & LEGAL FRAMEWORK OF CONSTRUCTION

Introduction contracts; Indian contract act-1872, provision of the act, classification of contracts, contract documents, types of contract, alternative dispute resolution methods-negotiations, mediations, conciliation, dispute resolution boards, arbitration, litigation.

Text Book:

1. Goodman, Alvin S. and Makar and Hastak. Infrastructure Planning Handbook: 2006.
2. Revelle, C.S., Whit latch, E.E. and Wright, J.R. Civil and Environmental Systems Engineering; Prentice Hall, 2004.

SUGGESTED READING:

1. 1. Hudson, W.R., Haas, R. and Uddin, W. Infrastructure Management; McGraw Hill, 1997.

23CE E104

FRACTURE MECHANICS OF CONCRETE STRUCTURES
(PROGRAM SPECIFIC ELECTIVE-II)

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

COURSE OBJECTIVES: This course aims to

1. To make the students understand the mechanisms of failure.
2. To impart knowledge on prediction, prevention and control of fracture in structural components with different materials.
3. To make the students know the background for damage tolerant design and various models.
4. To impart knowledge on nonlinear fracture mechanics, size effect and plasticity models for concrete.
5. To impart knowledge on crack growth, CTOD and CMOD using various models.

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

1. Predict the effects of crack like defects on the performance of civil engineering structures.
2. Employ modern numerical methods to determine critical crack sizes and fatigue crack propagation rates in engineering structures.
3. Know the behavior of concrete subjected to tension and compression failure
4. Select appropriate materials for engineering structures to insure damage tolerance.
5. Analyze the CTOD and CMOD problems using various models

CO-PO Articulation Matrix

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

UNIT- I:
Fracture mechanics principles:
Introduction and historical review, Sources of micro and macro cracks. Mechanisms of fracture and crack growth- Fracture mechanics approach to design - NDT and Various NDT methods used in fracture mechanics.

UNIT- II:
Plasticity effects: Plastic zone at crack tip - Irwin plastic zone correction- shape of the plastic zone- Dugdale's approach for size of the crack tip - Determination of Stress intensity factors - Cleavage fracture, ductile fracture, fatigue cracking, Environment assisted cracking, Quasi brittle materials.

UNIT- III:
Criteria for crack growth: crack resistance (R curves), compliance, Integral, nonlinear analysis, Review of concrete behavior in tension and compression, Basic frameworks for modelling of quasi-brittle materials.

UNIT- IV:
Nonlinear Fracture Mechanics: Discrete crack concept/Smeared crack concept, Size effect, Plasticity models for concrete – Associated and non- associated flow, Failure surfaces for quasi-brittle materials.

UNIT- V:
Concept of CTOD and CMD: Material models, crack models, band models, and models based on continuum damage mechanics - Principles of crack arrest Crack arrest in practice -FRC.

TEXT BOOKS:

1. David Broek, “Elementary Engineering Fracture Mechanics”,
2. Springer Netherlands,2011
3. Surendra P.Shah, Stuart E.Swartz, Chengsheng Ouyang, “Fracture Mechanics of Concrete: Applications of Fracture Mechanics to Concrete, Rock, and other Quasi-Brittle Materials”, John Wiley & Sons, 1995.
4. Karen Hellan , “Introduction to fracture mechanics” , McGraw Hill,2nd Edition
5. S.A. Meguid , “Engineering fracture mechanics” Elsevier Applied Science, 1989

SUGGESTED READING:

1. “Fracture mechanics of concrete structures – Theory and applications – Rilem Report” – Edited by L. Elfgreen – Chapman and Hall –1989.
2. “Fracture mechanics–applications to concrete”–Edited by Victor,
3. C. Li, & Z.P. Bazant – ACI SP 118.
4. S.Valliappan, “Continuum Mechanics Fundamentals”, Oxford IBH, N D. New Delhi, 1982.**23CE E105**

STRUCTURAL HEALTH MONITORING
(PROGRAM SPECIFIC ELECTIVE -II)

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

COURSE OBJECTIVES: This course aims to

1. Distress in the structure.
2. Assess the health of structure. Audit for structural health monitoring
3. Static and dynamic field tests.
4. Repairs, strategies for repairs and rehabilitation methods of the structure
5. Piezo–electric materials and other smart materials,

COURSE OUTCOMES: After the completion of this course, the student will be able to
At the end of the course, students will be able to

1. Appraise importance of Diagnosis the distress in the structure, develop an understanding the root causes and factors.
2. Assess the health of structure using static field methods.
3. Assess the health of structure using dynamic field tests.
4. Identify the locations for repairs and various repair methods, capable to suggest rehabilitation methods for structure
5. Adopt and implement EMI technique

CO-PO Articulation Matrix

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

UNIT- I:
Structural Health: Factors affecting Health of Structures, Causes of Distress, Regular Maintenance. Structural Health Monitoring**:** Concepts, Various Measures, Structural Safety in Alteration.

UNIT- II:
Structural Audit: Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures.

UNIT- III:
Static Field Testing: Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement.

UNIT- IV:
Dynamic Field Testing: Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring.

UNIT –V:
Introduction to Repairs and Rehabilitations of Structures: Case Studies (Site Visits), piezo–electric materials and other smart materials, electro– mechanical impedance (EMI) technique, adaptations of EMI technique.

TEXT BOOKS:

1. Daniel Balageas, Claus Peter Fritzen, Alfredo Güemes," *Structural Health Monitoring*", John Wiley and Sons, 2006.
2. Douglas E Adams,"*Health Monitoring of Structural Materials and Component Methods with Applications*", John Wiley and Sons, 2007.

SUGGESTED READING:

1. J. P. Ou, H. Li and Z. D. Duan,"*Structural Health Monitoring and Intelligent Infrastructure, Vol1"*, Taylor and Francis Group, London, UK, 2006.
2. Victor Giurglutiu,"*Structural Health Monitoring with Wafer Active Sensors*", Academic Press Inc, 2007.

23CE E106

THEORY OF STRUCTURAL STABILITY
(PROGRAM SPECIFIC ELECTIVE-II)

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

COURSE OBJECTIVES: This course aims to

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

1. Apply the concepts of elastic and in elastic stability to columns and the concepts of elastic stability to frames.
2. Use Eigen value solution to solve the stability problems of discrete and continuous systems
3. Analyze the buckling problems of this walled member including torsion, wrapping axial loading and bending.
4. Deal 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 loadsforstraightcolumnswithdifferentendconditionsandloading-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.

Audit Course- I and II	
Course Code	**Course**
23EG A101	English for Research Paper Writing
23CE A101	Disaster Mitigation and Management
23EE A101	Sanskrit for Technical Knowledge
23EC A101	Value Education
23EG A102	Constitution of India
23ADA101	Pedagogy Studies
23EG A103	Stress Management by Yoga
23EG A104	Personality Development through Life Enlightenment Skills

23MEM103

RESEARCH METHODOLOGY AND IPR

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

COURSE OBJECTIVES: This course aims 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: After the completion of this course, the student will be able to

At the end of the course, student 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

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

P. Narayanan; "Law of Copyright and Industrial Designs"; Eastern law House, Delhi 2010.

23EGA101

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

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

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

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

PO/PSO/CO	PO1	PO2	PO3	PO4
CO 1	2	2	1	2
CO 2	2	1	1	1
CO 3	1	1	1	1
CO 4	2	2	1	1
CO 5	2	3	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 Handbook 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

23CE A101

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

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

COURSE OBJECTIVES: This course aims to

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

1. Analyze and critically examine existing programs in disaster management regarding vulnerability, risk and capacity at different levels
2. Understand and choose the appropriate activities and tools and set up priorities to build a coherent and adapted disaster management plan
3. Understand various mechanisms and consequences of human induced disasters for the participatory role of engineers in disaster management
4. 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.

23EE A101

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

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

COURSE OBJECTIVES: This course aims to

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. To make the novice Learn the Sanskrit to develop the logic in mathematics, science & other subjects
3. To explore the huge knowledge from ancient Indian literature

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

1. Develop passion towards Sanskrit language
2. Decipher the latent engineering principles from Sanskrit literature
3. Correlate the technological concepts with the ancient Sanskrit history.
4. Develop knowledge for the technological progress
5. Explore the avenue for research in engineering with aid of Sanskrit

CO-PO Articulation Matrix

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

UNIT-I:

Introduction to Sanskrit language: Sanskrit Alphabets-vowels- consonants significance of Amarakosa-parts of speech-Morphology-creation of new words significance of synonyms-sandhi-samasa-sutras-active and passive voice-Past/ Present/Future Tense-syntax-Simple Sentences (elementary treatment only)

UNIT-II:

Role of Sanskrit in Basic sciences: Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba_sutram or baudhayana theorem (origination of pythogorous theorem)-value of pieMadhava's sine and cosine theory (origination of Taylor's series). The measurement system-time-mass- length-temp, Matter elasticity-optics- speed of light (origination of Michelson and merely theory).

UNIT-III:

Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering):

Building construction-soil testing-mortar-town planning-Machine definition crucible-furnace-air blower-Generation of electricity in a cell- magnetism- Solar system-Sun: The source of energy, the earth- Pingala chandasutram (origination of digital logic system)

UNIT-IV:

Role of Sanskrit in Engineering-II (Computer Science Engineering &Information Technology): Computer languages and the Sanskrit languages computer command words and the Vedic command words-analogy of pramana in memamsa with operators in computer language-Sanskrit analogy of physical sequence and logical sequence, programming.

UNIT-V:

Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering): Classification of plants-plants, the living-plants have senses- classification of living creatures' Chemical laboratory location and layout-equipment-distillation vessel kosthiyanthram-

TEXT BOOKS:

1. M Krishna machariar, "*History of Classical Sanskrit Literature"*, TTD Press, 1937.
2. *M.R. Kale, "A Higher Sanskrit Grammar: For the Use of School and College Students"*
3. Kapail Kapoor," *Language, Linguistics and Literature: The Indian Perspective*", ISBN-10: 8171880649, 1994.

SUGGESTED READING:

1. "*Pride of India, Sanskrit Bharati Publisher*", ISBN: 81-87276-27-4,2007
2. Shri Rama Verma, "*Vedas the source of ultimate science*", Nag publishers, ISBN:81-7081-618-1,2005

23EC A101

VALUE EDUCATION

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

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

COURSE OBJECTIVES: This course aims to

1. Understand the need and importance of Values for self-development and for National development.
2. Imbibe good human values and Morals
3. Cultivate individual and National character.

COURSE OUTCOMES: At the end of the course, students will be able to

1. Gain necessary Knowledge for self-development
2. Learn the importance of Human values and their application in day to day professional life.
3. Appreciate the need and importance of interpersonal skills for successful career and social life
4. Emphasize the role of personal and social responsibility of an individual for all-round growth.
5. Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universal brotherhood.

CO-PO Articulation Matrix

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

UNIT I:

Human Values, Ethics and Morals: Concept of Values, Indian concept of humanism, human values; 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 Behavior, 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 labor, True friendship, Universal brotherhood and religious tolerance.

UNIT IV:

Values in Holy Books: Self-management and Good health; and internal & external Cleanliness**,** Holy books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role of Women.

UNIT V:

Dharma, Karma and Guna: Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasicgunas.

TEXT BOOKS:

1. Chakroborty, S.K. "*Values & Ethics for organizations* Oxford University Press, New Delhi, 1998.

SUGGESTED READING:

1. Jaya Dayal Goyandaka, "*Srimad Bhagavad Gita", with Sanskrit Text"*, Word meaning and Prose meaning, Gita Press, Gorakhpur, 2017.

23EG A102

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

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. Have knowledge of the various Organs of Governance and Local Administration

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

At the end of the 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	PO1	PO2	PO3	PO4
CO1	--	--	--	1
CO2	--	--	--	1
CO3	--	--	--	1
CO4	--	--	--	1
CO5	--	--	--	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:

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

23ADA101

PEDAGOGY STUDIES
(Audit Course – 1 and 2)

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

COURSE OBJECTIVES: This course aims to

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: After the completion of this course, the student 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.

23EGA103

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	

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: After the completion of this course, the student will be able to
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	PO4
CO1	--	--	--	1
CO2	--	--	--	1
CO3	--	--	--	1
CO4	--	--	--	1
CO5	--	--	--	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:

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

23EG A104

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	0

COURSE OBJECTIVES: This course aims to

1. To learn to achieve the highest goal happily.
2. To become a person with stable mind, pleasing personality and determination.
3. To awaken wisdom among themselves.

COURSE OUTCOMES: After the completion of this course, the student will be able to At the end of the 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. To practice emotional self-regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality

CO-PO Articulation Matrix

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

UNIT-I: Neetisatakam - 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: Neetisatakam–Holistic development of personality (cont'd):Verses52, 53, 59 (dont's) - Verses 71, 73, 75 & 78 (do's) - Approach to day to day works and duties.

UNIT-III: Introduction to Bhagavadgeetha 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 - Chapter18–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 Bahgavad geeta 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/

23CE C103

STRUCTURAL DESIGN LAB

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

COURSE OBJECTIVES: This course aims to

1. Learn the principles of idealization of beam grids and frames for the given plan of a building
2. Know the methods of calculating loads on the building elements
3. Grasp the concepts of Analysis of building frames manually & also using software elements
4. Understand the concepts of design of building elements with a practical approach, and also concepts of grouping the designs.
5. Learn the professional practices of preparing structural drawings with good detailing.

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

1. Idealize beam grids and frames for the given plan of a building
2. Calculate loads on building elements for a given plan
3. Analyse building frames using a manual method and software
4. Design all structural elements of a given building with a practical approach and grouping the design.
5. Prepare structural drawings with good detailing, in a professional way.

CO-PO Articulation Matrix

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

Design Project:

Design and Detailed drawing of complete G +3 structures: Idealization of beam grid and frames for a given plan – Load calculations and preliminary design – Analysis of frames using software, manual check for at least one frame – Design of building elements using software – grouping of members – design of typical elements (manually) - detailing of reinforcement for various groups of elements–preparation of structural drawings– introduction to processional practices in drawing.

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*.

23CE C104

ADVANCED CONCRETE LAB

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

COURSE OBJECTIVES: This course aims to

1. Learn the principles of fundamental RCC and properties of materials.
2. Know the method of developing and calculating stress - strain curves for different grades of concretes.
3. Learn the correlation between the cube strength, cylindrical strength split tensile strength etc.,
4. Understand the concepts of cyclic loading and develop design of stress - strain curves for steel under cyclic loads.
5. Learn the mix design procedures for high strength concrete using different codes of practice.

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

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

1. Develop the stress - strain values for a given high strength concrete and checks its suitability for a purpose.
2. Interpret the correlation between the cube strength, cylindrical strength split tensile strength and modulus of rupture.
3. Suggest suitable grade and quality of steel for resisting cyclic loads.
4. Conduct suitable non-destructive test for the condition assessment of existing concrete members
5. Carryout the mix design procedure for high strength concrete using various codes
6. Take proper precaution to avoid flexural and shear failures in concrete beams
7. Analyze the beam for torsion and calculate the torsional forces and moments.

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
CO6	3	3	3	2
CO7	3	3	3	2

List of Experiments / Assignments:

1. Study of stress - strain curve of high strength concrete
2. Correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture.
3. Testing of steel element under cyclic loading.
4. Non-Destructive testing of existing concrete members.
5. Design of High strength concrete using ACI and IS code
6. Behavior of Beams under flexure / Shear
7. Behavior of Beams under Torsion (Demo)

Text Book:

1. M. Neville," *Properties of concrete*", 5th Edition, Prentice Hall, 2012

SUGGESTED READING:

1. M. S. Shetty, "Concrete *technology"*, S. Chand and Co., 2006.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

M.E. (STRUCTURAL ENGINEERING)

(With effect from the academic year 2023-24)

SEMESTER – II

S. No	Course Code	Title of Course	Scheme of Instruction Hours per week			Scheme of Examination Duration of SEE in Hours	Maximum Marks		Credits
			L	T	P		CIE	SEE	
THEORY									
1	23CE C105	Finite Element Method	3	0	0	3	40	60	3
2	23CE C106	Structural Dynamics	3	0	0	3	40	60	3
3	23CE C107	Design of Advanced Concrete Structure	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	23CE C108	Modal Testing Lab	0	0	3	-	50	-	1.5
7	23CE C109	Numerical Analysis Lab	0	0	3	-	50	-	1.5
8	23CE C110	Mini Project with Seminar	0	0	2	-	50	-	1
		TOTAL	14	0	8	-	350	300	19

L: Lecture T: Tutorial P: Practical

CIE - Continuous Internal Evaluation SEE - Semester External Evaluation

23CE C105

FINITE ELEMENT METHOD IN STRUCTURAL ENGINEERING

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

COURSE OBJECTIVES: This course aims to

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

1. Revisit the fundamentals of FEM and theory of elasticity.
2. Formulate FEM problem and stiffness matrix for bar elements.
3. Analyze for trusses, beams and rigid jointed plane frames using FEM.
4. Formulate Global stiffness matrix, load matrix and analyse structures using 1st order triangular elements, isoperimetric 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 quadrilateral 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.

23CE C106

STRUCTURAL DYNAMICS

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

COURSE OBJECTIVES: This course aims to

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

1. Gain 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'Alemberts'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 super position 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, Newmarks 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*", Mc Graw Hill Education, 2013.

23CE C107

DESIGN OF ADVANCED CONCRETE STRUCTURES

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

COURSE OBJECTIVES: This course aims to

1. To make the students effectively analyze and design Curved and Deep Beams.
2. To enable the students understand the nuances of internal stresses and design of Domes, and thoroughly 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 by both DDM and EFM.
4. To make the students understand the structural behavior 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 out Comes: At the end of the course, the student will be able to

1. Analyze and Design curved and deep beam as per the field requirements.
2. Evaluate the stresses in domes for various loads and design them.
3. Analyze and design Bunkers and Silos.
4. Evaluate structural behavior 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 - Stresses and forces in domes - design of spherical and conical domes.

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

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.

Raft Foundations: Definitions, Types – Design of Raft foundation, flat plate type and beam-slab type for buildings with column grids up to five by five.

UNIT - V:

Ductile Detailing: Ductile detailing of RCC beams and columns using IS: 13920 -1993 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, 2005.
2. H.J. Shah, "*Reinforced Concrete"*, Charotar Publishers, 2014.

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.

23CE E107

DESIGN OF ADVANCED STEEL STRUCTURES
(PROGRAM SPECIFIC ELECTIVE-III)

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

Note:
1. IS Codes required: IS 800, IS 802, IS805

COURSE OBJECTIVES: This course aims to
1. To understand the connections used in Structural steel and design using relevant codes.
2. To understand the advanced design concepts of Beam columns and Grillage foundations
3. Aware of advanced design concepts of Steel Tanks
4. To understand and visualize the design concepts of silos and bunkers.
5. To understand and visualize the design concepts of Transmission line towers

Course Out comes:
At the end of the course, the student will be able to
1. Understand behavior of structural steel, pressed steel and design philosophies of steel structures.
2. Analyze and design of grillage foundation.
3. Analyze and design of overhead steel and pressed steel water tanks.
4. Analyze and design of bunkers and silos.
5. Analyze and design of foundations of Transmission line towers overall arrangements and design of members of Transmission line towers.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
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:
Design of Bolted Connections: Rigid &Semi Rigid Connections.
Steel Columns: Effective Length; PM Interaction; Joint Panel Zones

UNIT – II:
Beam Columns: Introduction, Design for Uni-axial and Bi-axial bending as per IS 800: 2007
Grillage Foundations: Introduction, necessity of grillage foundations, various types, Design of Grillage foundations for axial loads under single and double columns by Limit State Method

UNIT - III:
Steel Tanks: Introduction, Types, loads, permissible stresses - detailed design of elevated rectangular mild steel and pressed steel tanks including staging by working stress method

UNIT - IV:
Bunkers and Silos: introduction - general design principles- design theories Janssen's Theory and Airy's Theory - Detailed design of bunkers and silos.

UNIT - V:

Transmission Line Towers: Classification, economical spacing and design loads-IS code provisions- Calculation of wind loads and permissible stresses Overall arrangement and design procedure - Detailed design including foundations.

TEXT BOOKS:

1. B.C. Punmia by "*Design of Steel Structures*" Laxmi Pub. –2015.
2. P. Dayaratnam by "*Design of Steel Structures*" S Chand Publications, 2012.

SUGGESTED READING:

1. I.C. Syal and S. Singh, by "*Design of Steel Structures*", StandardPub.-2009.
2. Ram Chandra, by "*Design of Steel Structures"*, Scientific Publishers, 2010.

23CE E108

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

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

COURSE OBJECTIVES: This course aims to

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: After the completion of this course, the student will be able to
At the end of the course, student will be 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.

23CE E109

DESIGN OF MASONRY STRUCTURES
(PROGRAM SPECIFIC ELECTIVE-III)

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

COURSE OBJECTIVES: This course aims to

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

23CE E110

DESIGN OF TALL BUILDINGS
(PROGRAM SPECIFIC ELECTIVE-IV)

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

COURSE OBJECTIVES: This course aims to

1. The difference between normal building and tall building and types of foundations for tall buildings
2. Various methods of calculation 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: After the completion of this course, the student will be able to

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.

23CE E111

ADVANCED FOUNDATION DESIGN
(PROGRAM SPECIFIC ELECTIVE-IV)

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

COURSE OBJECTIVES: This course aims 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: After the completion of this course, the student will be able to

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 Soil.
3. Analyze and design the pile foundation.
4. Understand analysis methods and design for 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.

23CE E112

DESIGN OF INDUSTRIAL STRUCTURES
(PROGRAM SPECIFIC ELECTIVE-IV)

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

COURSE OBJECTIVES: This course aims to

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 thorough knowledge in 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 about Fire resistance and fire performance assessment for steel will be imparted.

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

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

1. Compute design loads and design Steel Gantry Girders for various complex situations.
2. Analyze and design bunkers and silos and can effectively get them executed with the knowledge acquired during the course.
3. Evaluate various components of steel chimneys and design chimneys along with foundations.
4. Understanding the cold formed sections and the related difficulties and problems also design various structural components using cold formed sections.
5. Perform fire engineering design of steel structures and evaluate fire performance of steel

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. Dr.Ram Chandra," *Design of Steel Structures*", Standard Publishers, 2009.
3. N.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

23CE C108

MODAL TESTING LAB

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

COURSE OBJECTIVES: This course aims to

1. Learn to estimate natural frequencies and mode shapes of abeam.
2. Understand the evaluation process of dynamic response of a building model using shake table / mini shake table
3. Learn to compute the response of building models to wind loads, using wind tunnel setup.
4. Know the pattern of deflection and cracking in RC slab elements and portal frames under gravity loading.
5. Understands the use of Piezoelectric sensors in the determination of vibration characteristics of abeam

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

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

1. Estimate the natural frequencies and mode shapes of a beam.
2. Evaluate the dynamic response of a building model using shake table
3. Evaluate the response of building models under wind loads, using wind tunnel setup.
4. Determine the pattern of deflection and cracks in RC slab elements
5. Determine the pattern of deflection and cracks in portal frames subjected to gravity loading.

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
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. Estimation of natural frequencies and mode shapes of abeam.
2. Evaluation of dynamic response of building model using shake-table setup.
3. Evaluation of response of building models subjected to wind loads using wind tunnel setup.
4. Deflections and crack pattern study of RC slab elements subjected to static loading.
5. Deflections and crack patterns in portal frame subjected to gravity loading.
6. Demonstration of use of Piezoelectric Sensors for the determination of Vibration Characteristics of a beam.

23CE C109

NUMERICAL ANALYSIS LAB

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

Course Objectives:

To enable the student

1. Find Roots of non-linear equations by Bisection method and Newton's method.
2. Do curve fitting by least square approximations
3. Solve the system of Linear Equations using Gauss - Elimination/ Gauss - Seidal Iteration / Gauss - Jordan Method
4. To Integrate Numerically Using Trapezoidal and Simpson's Rules
5. To Find Numerical Solution of Ordinary Differential Equations by Euler's Method, Runge- Kutta Method.
6. Apply computational methods in engineering using MAT Lab program

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

1. Find roots of nonlinear equations by using numerical methods
2. Fit the given data in different curves
3. Solve system of linear equations by using direct and indirect methods
4. Integrate by using numerical methods
5. Find solution of first order ODE by numerical methods
6. Apply computational methods in engineering by using MAT Lab program

CO-PO Articulation Matrix

COs	PO1	PO2	PO3	PO4
CO1	1	1	3	2
CO2	1	1	3	2
CO3	1	1	3	2
CO4	1	1	3	2
CO5	1	1	3	2
CO6	1	1	3	2

List of Programs:

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

TEXT BOOKS:

1. Rudra Pratap," *Getting started with MATLAB: A quick Introduction for Scientists and Engineers*", Oxford University press, 2010.
2. Grewal B. S," *Numerical Methods in Engineering and Science with Programs in C, C++ & MATLAB*", Khanna Publishers, 2014.

SUGGESTED READING:

1. Dukkipati Rao V, "*Applied Numerical Methods using MATLAB"*, New Age International Pvt. Ltd. Publishers, 2011.

23CE C110

MINI PROJECT WITH SEMINAR

Instruction	2P Hours per week
Duration	2 Hours
SEE	0 Marks
CIE	50 Marks
Credits	1

COURSE OUTCOMES: After the completion of this course, the student will be 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 students 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 inter disciplinary/ 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)
(With effect from the academic year 2023-24)

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	23CEC111	Dissertation Phase- I	0	0	23	-	100	-	10
TOTAL			8	0	23	-	180	170	16

L: Lecture T: Tutorial P: Practical
CIE - Continuous Internal Evaluation SEE - Semester End Examination

Course Code	Program Specific Elective-V
23CE E113	Design of Prestressed Concrete Structures
23CE E114	Design of Bridges
23CE E115	Earthquake Resistant Design of Structures
OPEN ELECTIVES	
Course Code	**Course**
23CS O101	Business Analytics
23ME O101	Industrial Safety
23ME O102	Introduction to Optimization Techniques
23CE O101	Cost Management of Engineering Projects
23ME O103	Composite Materials
23EE O103	Waste to Energy

23CE E113

DESIGN OF PRESTRESSED CONCRETE STRUCTURES
(PROGRAM SPECIFIC ELECTIVE-V)

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

COURSE OBJECTIVES: This course aims to

1. Elements of prestressed concrete and systems of prestressing
2. Various Losses and their estimation in pre stressed concrete
3. Analysis and design of section for flexure and shear
4. Analysis and transfer of pre stress through end blocks
5. Analyze pre stressed slab and Partial pre stressing –principles

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

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

1. Understand the basic aspects of pre stressed concrete fundamentals, and calculate losses in the pre stressed concrete.
2. Analyze and design pre stressed concrete beam/girders.
3. Design pre stressed concrete end blocks and understand the mechanism of anchorage zones.
4. Analyze and Design continuous prestressed beams members.
5. Analyze and design slabs with partial and full prestressing, and also analyze the crack formations rationally

CO-PO Articulation Matrix

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

UNIT – I:

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

UNIT –II:

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

UNIT – III:

Transmission of Priestess in Pretension members; Anchorage zone stresses for post tensioned members.

UNIT – IV:

Staticallyindeterminatestructures-Analysisanddesign-continuousbeams and frames, choice of cable profile, linear transformation and concordance.

UNIT – V:

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

References:

1. T. Y. Lin, "*Design of Prestressed Concrete Structures*", Asia Publishing House, 2010.
2. N. Krishnaraju, "Prestressed *Concrete",* Tata McGraw Hill, New Delhi, 2018.

SUGGESTED READING:

1. Y. Guyan, "*Limit State Design of Pre stressed Concrete*", Applied Science Publishers, 1972.
2. IS: 1343- Code of Practice for Prestressed Concrete5. IRC: 112

23CE E114

DESIGN OF BRIDGES
(PROGRAM SPECIFIC ELECTIVE-V)

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

COURSE OBJECTIVES: This course aims to

To impart the knowledge in various design principles of Bridge Engineering,

1. The student should be able to design simple bridges individually and be 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 the steel bridges engineering.
4. The student should have a fair familiarity with design of long span flexible bridges.
5. To make the students conversant with the design of structural components in sub-structures.

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

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 bridges– Design 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.

References:

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.
2. N. Krishnam Raju, "*Design of Bridges"* Oxford and IBH Publishing 2010.
3. Johnson Victor, "*Essentials of Bridge Engineering*", Oxford & IBH Publishers, Sixth edition 2018.

23CE E 115

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

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

COURSE OBJECTIVES: This course aims to

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: After the completion of this course, the student will be able to
At the end of the course, student will be 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", 3nd 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", 1996Applied Technology Council, California, ATC 40.

23CSO101

BUSINESS ANALYTICS

Open Elective – VI

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 prescriptive analytics.
3. Prepare the students to model business data using various data mining, decision making methods.

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

Upon 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 find solutions to business problems that achieve statedobjectives.
3. Interpret various metrics, measures used in business analytics
4. Illustrate various descriptive, predictive and prescriptive methods and techniques.
5. Model the business data using various business analytical methods and techniques.
6. Create viable solutions to decision making problems.

CO-PO Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PEO1	PEO2	PEO3
CO1	3	2	2	1	1	-	-
CO2	3	3	2	1	-	3	3
CO3	3	3	3	1	-	-	-
CO4	3	3	3	1	-	-	-
CO5	3	3	3	1	-	-	-
CO6	3	3	3	1	-	-	-

UNIT - I

Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DDdecision 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 and method and random forest. Clustering: Distance and similarity measures used in clustering, Clustering algorithms, K-Means and Hierarchical algorithms, Prescriptive Analytics- Linear Programming (LP) and LP model building,

UNIT-V

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

TEXTBOOKS:

1. U Dinesh Kumar, “Business Analytics”, Wiley Publications, 1st Edition, 2017
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”,5th Edition, Cengage, 2015.

23ME O101

INDUSTRIAL SAFETY

(OPEN ELECTIVE – Common to All Branches)

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

COURSE OBJECTIVES: This course aims to

1. Causes for industrial accidents and preventive steps to be taken.
2. Fundamental concepts of Maintenance Engineering.
3. About wear and corrosion along with preventive steps to betaken
4. The basic concepts and importance of fault tracing.
5. The steps involved in carrying out periodic and preventive maintenance of various equipment's used in industry

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

1. Identify the causes for industrial accidents and suggest preventive measures.
2. Identify the basic tools and requirements of different maintenance procedures.
3. Apply different techniques to reduce and prevent Wear and corrosion in Industry.
4. Identify different types of faults present in various equipment's like machine tools, IC Engines, boilers etc.
5. Apply periodic and preventive maintenance techniques as required for industrial equipment's like motors, pumps and air compressors and machine tools etc.

CO-PO Articulation Matrix

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

UNIT – I:

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

UNIT – II

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

UNIT – III:

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

UNIT–IV:

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

UNIT – V:

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

References:

1. H. P. Garg, "*Maintenance Engineering*", S. Chand and Company
2. Audels, "*Pump-hydraulic Compressors*", McGraw Hill Publication

SUGGESTED READING:

1. Higgins & Morrow, "*Maintenance Engineering Handbook*", Disinformation Services.
2. Winterport, Hans, "*Foundation Engineering Handbook*", Chapman& Hall London

23ME O102

INTRODUCTION TO OPTIMIZATION TECHNIQUES
(OPEN ELECTIVE – Common to All Branches)

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

COURSE OBJECTIVES: This course aims to

1. Come to know the formulation of LPP models
2. Understand the Transportation and Assignment techniques
3. Come to know 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

Outcomes:
At the end of the course, student 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

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

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, Degeneracy in 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 Latest 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

References:

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

SUGGESTED READING:

1. Hitler Libermann, "*Operations Research*", McGraw Hill Pub.2009
2. Pannerselvam, "*Operations Research*", Prentice Hall of India2010
3. Harvey M Wagner, "*Principles of Operations Research*", Prentice Hall of India 2010

23CE O101

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

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

COURSE OBJECTIVES: This course aims to

1. To enable the students to understand the concepts of Project management.
2. To provide knowledge on concepts of Project Planning and scheduling.
3. To create an awareness on Project Monitoring and Cost Analysis
4. To provide adequate knowledge to the students on Recourse Management Costing-Variance Analysis
5. 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
At the end of course, students will able to

1. Acquire in-depth knowledge about the concepts of project management and understand the principles of project management.
2. Determine the critical path of a typical project using CPM and PERT techniques.
3. Prepare a work break down plan and perform linear scheduling using various methods.
4. Solve problems of resource scheduling and levelling using network diagrams.
5. 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:

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.

References:

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 McGraw-Hill Education. (2004).
2. Kumar Neeraj Jha "*Construction Project Management Theory and Practice*", Pearson Education India; 2 edition (2015).

23ME O103

COMPOSITE MATERIALS

(OPEN ELECTIVE – Common to All Branches)

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

COURSE OBJECTIVES: This course aims to

1. Composite materials and their constituents.
2. Classification of the reinforcements and evaluate the behavior of composites.
3. Fabrication methods of metal matrix composites.
4. Manufacturing of Polymer matrix composites.
5. Failure mechanisms in composite materials.

Outcomes:

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

1. Classify and characterize the composite materials.
2. Describe types of reinforcements and their properties.
3. Understand different fabrication methods of metal matrix composites.
4. Understand different fabrication methods of polymer matrix composites.
5. Decide the failure of composite materials.

CO-PO Articulation Matrix

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

UNIT – I

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

UNIT – II

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

UNIT – III

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

UNIT–IV

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

UNIT – V

Strength: Lamina Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygro thermal failure. Laminate first play failure-insight strength;

REFERENCES:

1. R.W. Cahn – VCH*, "Material Science and Technology*", (Vol 13) Composites, West Germany.
2. WD Callister, Jr., Adapted by R. Balasubramaniam*, "Materials Science and Engineering, An introduction"*. John Wiley &Sons, NY, Indian edition, 2007.
3. Ed-Lubin, "*Hand Book of Composite Materials*"

SUGGESTED READING:

1. K.K. Chawla, "*Composite Materials*".
2. Deborah D.L. Chung, "*Composite Materials Science and Applications"*
3. Daniel Gay, Suong V. Hoa, and Stephen W. Tsai*, "Composite Materials Design and Applications*"

23EE O101

WASTE TO ENERGY
(OPEN ELECTIVE – Common to All Branches)

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

COURSE OBJECTIVES: This course aims to

1. To know the various forms of waste
2. To understand the processes of Biomass Pyrolysis.
3. To learn the technique of Biomass Combustion.

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

After completion of this course, students will be able to

1. Understand the concept of conservation of waste
2. Identify the different forms of wastage
3. Chose the best way for conservation to produce energy from waste
4. Explore the ways and means of combustion of biomass
5. Develop a healthy environment for the mankind

CO-PO Articulation Matrix

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

References:

1. Desai, Ashok V.," *Non-Conventional Energy",* Wiley Eastern Ltd., 1990.
2. Khandelwal, K.C. and Mahdi, S.S., Bio *gas Technology-A Practical Hand Book",* Vol. I&II, Tata McGraw Hill Publishing Co. Ltd., 1983.

SUGGESTED READING:

1. Challal, D. S, "*Food, Feed and Fuel from Biomass",* IBH Publishing Co.Pvt. Ltd., 1991.
2. C. Y. Were Ko-Brobby and E. B. Hagan," *Biomass Conversion and Technology*", John Wiley & Sons, 1996.

23CE C111

DISSERTATION PHASE-I

Instruction	20P Hours per week
Duration	Presentation and Viva
SEE	0 Marks
CIE	100 Marks
Credits	10

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

COURSE OBJECTIVES: This course aims to

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

1. Carry out the dissertation/ Research work independently.
2. Survey the literature such as books, national/ international refereed Journals and contact resource persons for the selected topic of research.
3. Write technical reports.
4. Develop oral and written communication skills to present.
5. Defend their work in front of technically qualified audience.

CO-PO Articulation Matrix

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

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.

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)

(With effect from the academic year 2023-24)

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	23CE C112	Dissertation Phase-II	0	0	32	-	100	100	16
TOTAL			0	0	32	-	100	100	16

L: Lecture T: Tutorial P: Practical

CIE - Continuous Internal Evaluation SEE - Semester End Examination

23CE C112

DISSERTATION PHASE-II

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

COURSE OBJECTIVES: This course aims to

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

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

1. Use different experimental techniques and will be able to use different software/computational/analytical tools.
2. Design and develop an experimental set up/ equipment/test rig.
3. Conduct tests on existing setups/equipment and draw logical conclusions from the results after analyzing them.
4. Work in a research environment or in an industrial environment.
5. 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	3
CO2	2	2	3	2
CO3	2	2	3	2
CO4	2	2	2	3
CO5	2	3	2	2

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

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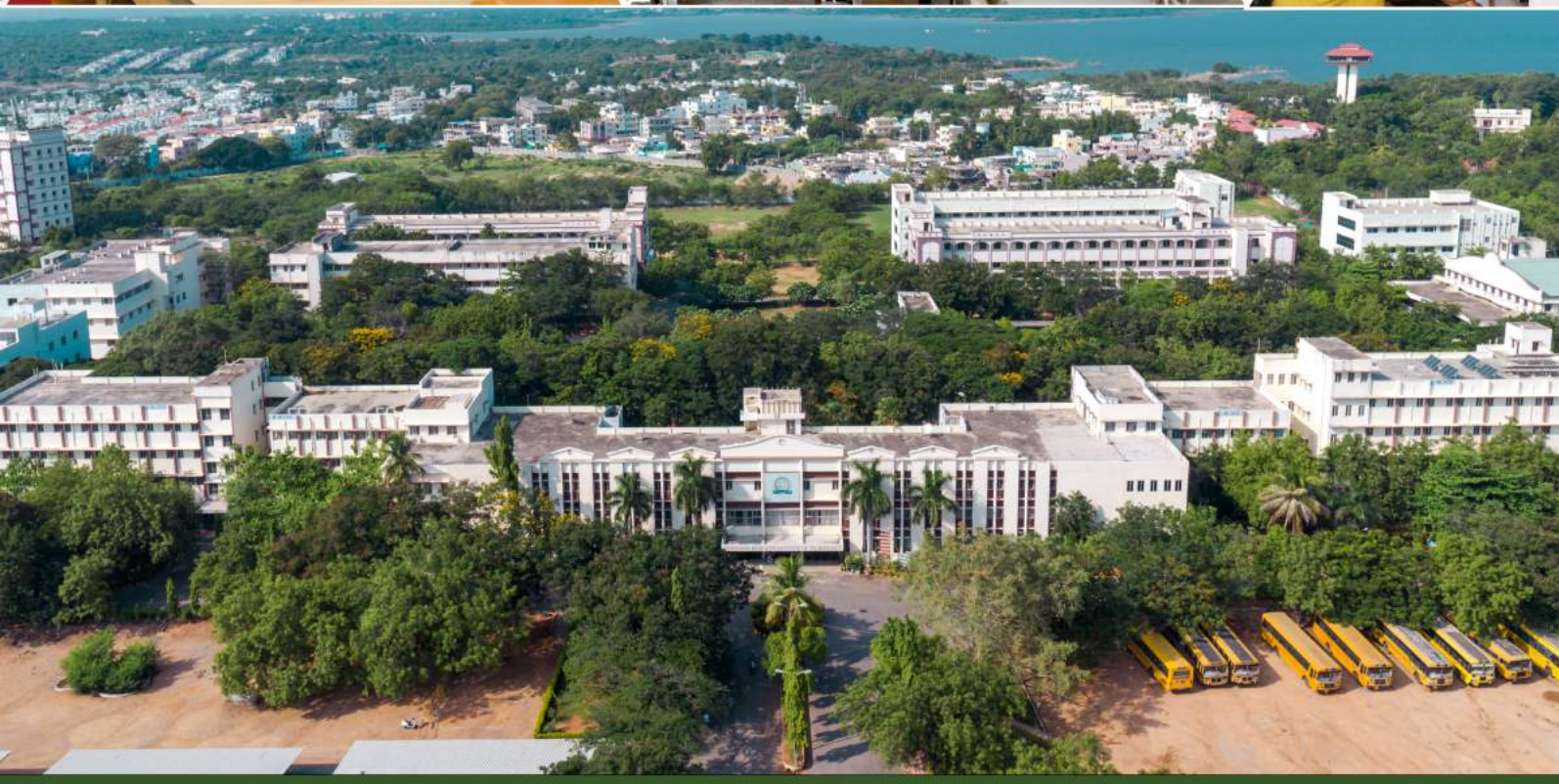

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

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