Scheme of Instruction, Evaluation

and

Syllabi of

M.E. (CIVIL)

with specialization in

STRUCTURAL ENGINEERING

Regular & CEEP

With effect from Academic Year 2026-27

Estd. 1917

DEPARTMENT OF CIVIL ENGINEERING

UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

Osmania University

Hyderabad – 500 007, TS, INDIA

Estd. 1929

INSTITUTION

The University College of Engineering is established in the prestigious Osmania University, Hyderabad in the year 1929 having the distinction of being the 6th oldest Engineering College in the then British India. The college become autonomous in the year 1994. Over the decades, the UCE(A), OU has produced several illustrious alumni who brought laurels to the nation at world forums. The college is offering BE in eight branches viz., AI&ML, BME, CE, CSE, EEE, ECE, ME and Mining Engineering; ME in 22 specialisations with majority of them receiving NBA Accreditation. The college offers Ph.D. in all ME specialisations. The college has well established laboratories and research facilities and is well placed in NIRF Rankings. The faculty members are well qualified and several of them received Best Teacher Award from Government of Telangana state. They are serving as expert members on several professional bodies, state and national level committees. The faculty members authored several research publications, text/reference books and extend consultancy services.

Vision

The Vision of the institute is to generate and disseminate knowledge through harmonious blending of science, engineering and technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

Mission

- To achieve excellence in Teaching and Research
- To generate , disseminate and preserve knowledge
- To enable empowerment through knowledge and information
- Advancement of knowledge in Engineering, Science and Technology
- Promote learning in free thinking and innovative environment
- Cultivate skills, attitudes to promote knowledge creation
- Rendering socially relevant technical services to the community
- To impart new skills of technology development
- To inculcate entrepreneurial talents and technology appreciation programmes
- Technology transfer and incubation

DEPARTMENT

The Department of Civil Engineering was established in the year 1929 and was the first Department to commence the undergraduate programme at University college of Engineering, Osmania University. Over the years, the Department grew from strength to strength in terms of its academic achievements and infrastructure development. The Department has produced many All India GATE 1st Rankers / Toppers in Indian Civil Services / IES / State Public Service Commission Tests and those who got admitted in to IITs/IISc./Top Universities in the world for higher studies. The renowned alumni of this Department include several successful Engineers in Government Departments / Consultants / Contractors / Academicians who made positive contribution to the development of State and Nation.

Currently, the Department offers BE in Civil Engineering; ME in Structural Engineering, Geotechnical Engineering, Water Resources Engineering and Transportation Engineering specializations and Ph.D. programs. The Department also has the distinction of enrolling large number of foreign students both at UG and PG level. The Department provides research and consultancy services to various organizations. Several faculty members have received prestigious awards including the Best Teacher awards of the State Government and the Best Publication awards reflecting high standards in teaching and research. Many of the faculty members are listed in several national and international biographical directories. Many of them are serving in Panel of Experts in the State and National level committees. The faculty members have published over 1500 papers in various international and national journals and conferences besides text books and professional books.

Vision

To be as a leading academic department on pace with global standards and contribute to the development of economic, technically viable and useful to societal problems and challenges of civil engineering profession and also contribute to the regional and country's developmental activities.

Mission

- To produce highly competent and capable professionals to face the challenges and provide viable solutions to Civil Engineering problems

- Integration of their knowledge and skills to excel in the profession through continuous learning and contribute to the well being of the society.
- To enhance the technical knowledge, research aptitude to serve the society in highly competent manner.

Program Educational Objectives (PEO):

The graduating students of the structural engineering program will be able to:

PEO1	Apply basic principles of structural mechanics to comprehensively analyse the structure and apply design philosophies for design of structural elements.
PEO2	Understand characterization of material and its application together with construction technologies.
PEO3	Motivate themselves to carryout innovative research in core and multidisciplinary areas and disseminate the same through publications.
PEO4	Use computational techniques and tools and engage them in lifelong learning to solve real world engineering problems.
PEO5	Communicate effectively with their team mates, manage projects efficiently and practice their profession with regard to societal needs, with ethical responsibilities for sustainable development.

Program Outcomes (PO):

PO1	Applying the core knowledge in Structural Engineering to address and solve the Civil engineering problems.
PO2	Identify appropriate materials and construction technologies so as to arrive at feasible solutions maintaining ecological balance.
PO3	Recognizing the need for continuous updating of his skills and knowledge to meet the challenges in the field of structural engineering.
PO4	Utilizing modern equipments and tools together with software packages necessary to solve structural engineering problems.
PO5	.Preparing the technical report and presenting the seminar in domain area to disseminate knowledge among professional peers
PO6	Communicate effectively, demonstrate leadership skills, work in inter-disciplinary engineering teams with social responsibility and ethical values

MAPPING OF PEO'S WITH PO'S

PROGRAMME EDUCATIONAL OBJECTIVES	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
PEO-1	3	2	--	1	1	-
PEO-2	-	3	2	--	--	--
PEO-3	-	--	3	2	3	2
PEO-4	1	--	1	3	-	--
PEO-5	1	-	2	--	2	3

DEPARTMENT OF CIVIL ENGINEERING, U.C.E., O.U
M. E. CIVIL (STRUCTURAL ENGINEERING) AICTE Model

Type of course	Course Code	Course Name	Contact hours per week		Scheme of Examination		Credits
			L	P	CIE	SEE	
SEMESTER-I							
Core-I	CE101	Advanced Structural Analysis	3		40	60	3
Core-II	CE102	Theory of Elasticity	3		40	60	3
Core-III	CE103	Structural Design	3		40	60	3
Program Elective-I	CE111	Fracture Mechanics in Concrete Structures	3		40	60	3
	CE112	Advanced Reinforced Concrete Design					
	CE113	Theory of Structural Stability					
Program Elective-II	CE114	Composite Construction	3		40	60	3
	CE115	Structural Health Monitoring					
	CE116	Advanced Steel Design					
Program Elective-III	CE117	Design of Pre-stressed Concrete Structures	3		40	60	3
	CE118	Structural Optimization					
	CE119	Retrofitting and Rehabilitation of Structures					
Lab-I	CE151	Structural Design Lab		2	50	-	1
Seminar	CE161	Seminar		2	50	-	1
TOTAL			**18**	**4**	**340**	**360**	**20**
SEMESTER-II							
Core-IV	CE104	Finite Element Method	3		40	60	3
Core – V	CE105	Structural Dynamics	3		40	60	3
Core - VI	CE106	Theory of Plates	3		40	60	3
Program Elective-IV	CE120	Advanced Concrete Technology	3		40	60	3
	CE121	Tall Buildings					
	CE122	Structural Fire Engineering					
Program Elective-V	CE123	Earthquake Resistant Design of Buildings	3		40	60	3
	CE124	Bridge Engineering					
	CE125	Theory of Shells and Folded Plates					
Open Elective	OE 941 CE	Green Building Technology	3		40	60	3
	OE 942 CE	Cost Management of Engineering Projects					
	OE 941 ME	Operational Research					
	OE 942 ME	Composite Materials					
	OE 943 ME	Industrial Safety					
	OE 941 CS	Business Analytics					
	OE 941 EE	Waste to Energy					
	OE 942 EE	Power Plant Control & Instrumentation					
	OE 941 EC	Elements of Embedded Systems					
	OE 941 BM	Medical Assistive Devices					
	OE 942 BM	Medical Imaging Techniques					
	OE 941 LA	Intellectual Property Rights					
Lab-II	CE152	Structural Dynamics Lab		2	50	-	1
Lab-III	CE153	Advanced Concrete Technology Lab		2	50	-	1
MC	CE171	Mini Project		4	50		2
TOTAL			**18**	**8**	**390**	**360**	**22**

SEMESTER-III							
Audit - I	AC 030	Engineering Research Methodology	2		40	60	0
Audit-II	AC 031	English for Research Paper Writing	2		40	60	0
	AC 032	Disaster Mitigation & Management					
	AC 033	Sanskrit for Technical Education					
	AC 034	Value Education					
	AC 035	Stress Management by Yoga					
	AC 036	Personality Development					
	AC 037	Constitution of India					
	AC 038	Pedagogy Studies					
Mandatory	CE181	Dissertation-I		20*	100		10
TOTAL			**4**	**20**	**180**	**20**	**10**
SEMESTER-IV							
Mandatory	CE182	Dissertation-II		32	100	100	16
GRAND TOTAL			**40**	**64**	**910**	**940**	**68**

Note:

i. Dissertation-II has two parts, CIE - I and CIE - II, at the end of 8th week and 16th week respectively for evaluation of 50 marks each.

ii. Audit Course will be offered in ONLINE/OFFLINE/HYBRID mode and SEE will be conducted in Computer Based Test Mode.

iii. Research Methodology and IPR will be offered as an Audit Course for all PG Programs.

iv. Engineering Research Methodology workshop will be conducted for one week to the Ph.D scholars.

***The student has to work a minimum of 20 hours/week and 32 hours/week at Dissertation - I and II.**

TABLE-II

M.E./M.Tech. Six Semester (CEEP) Program Scheme of Instruction and Evaluation

S.No.	Course Name	Contact hours per week		Scheme of Examination		Credits
		L	P	CIE	SEE	
	SEMESTER-I					
CE101	Advanced Structural Analysis	3	---	40	60	3
CE102	Theory of Elasticity	3	---	40	60	3
CE 112	Advanced Reinforced Concrete Design	3	---	40	60	3
CE151	Structural Design Lab	---	2	50	---	1
	TOTAL	**9**	**2**	**170**	**180**	**10**
	SEMESTER-II					
CE104	Finite Element Method	3	---	40	60	3
CE105	Structural Dynamics	3	---	40	60	3
CE120/ CE122	Advanced Concrete Technology Fire Resistant Design of Structures	3	---	40	**60**	3
CE153	Advanced Concrete Technology Lab	---	2	50	---	1
	TOTAL	**9**	**2**	**170**	**180**	**10**
	SEMESTER-III					
CE103	Structural Design	3	---	40	60	3
CE116	Advanced Steel Design	3	---	40	60	3
CE117	Design of Pre-stressed Concrete Structures	3	---	40	60	3
CE161	Seminar	---	2	50	---	1
	TOTAL	**9**	**2**	**170**	**180**	**10**
	SEMESTER-IV					
CE106	Theory of Plates	3	---	40	60	3

CE124	Bridge Engineering	3	---	40	60	3
	Open Elective	3	---	40	**60**	3
OE 941 CE	Green Building Technology					
OE 942 CE	Cost Management of Engineering Projects					
OE 941 ME	Operational Research					
OE 942 ME	Composite Materials					
OE 943 ME	Industrial Safety					
OE 941 CS	Business Analytics					
OE 941 EE	Waste to Energy					
OE 942 EE	Power Plant Control & Instrumentation					
OE 941 EC	Elements of Embedded Systems					
OE 941 BM	Medical Assistive Devices					
OE 942 BM	Medical Imaging Techniques					
OE 941 LA	Intellectual Property Rights					
CE152	Structural Dynamics Lab	---	2	50	-	1
CE171	Mini Project	---	4	50		2
	TOTAL	**9**	**6**	**220**	**180**	**12**
	SEMESTER-V					
	Audit Course-I	2	---	40	60	0
AC 030	Engineering Research Methodology					
.	Audit Course-II	2	---	40	60	0
AC 030	Engineering Research Methodology					
AC 031	English for Research Paper Writing					
AC 032	Disaster Mitigation & Management					
AC 033	Sanskrit for Technical Education					
AC 034	Value Education					
AC 035	Stress Management by Yoga					
AC 036	Personality Development					
AC 037	Constitution of India					
AC 038	AC 038					
1.	Dissertation-I	---	20*	100	---	10
	TOTAL	**6**	**20**	**180**	**120**	**10**
	SEMESTER-VI					
1.	Dissertation-II	0	32*	100	100	**16**
	GRAND TOTAL	**42**	**64**	**1010**	**940**	**68**

Note:

i. Dissertation-II has two parts, CIE - I and CIE - II, at the end of 8th week and 16th week respectively for evaluation of 50 marks each.

ii. Audit Course will be offered in ONLINE mode and SEE will be conducted in Computer Based Test Mode.

iii. Research Methodology and IPR will be offered as an Audit Course for all PG Progrms.

iv. Engineering Research Methodology workshop will be conducted for one week to the Ph.D scholars.

***The student has to work a minimum of 20 hours/week and 32 hours/week at Dissertation – I and II.**

SEMESTER-I

CE 101	**ADVANCED STRUCTURAL ANALYSIS**					
(CORE - I)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand the concepts of matrix methods of analysis and equip them with the knowledge to independently handle the problems of structural analysis
2	Enhance the competency level in analysis of continuous beam, portal frames, pin jointed structures by flexibility and stiffness matrix methods
3	Understand the formation of global stiffness matrix from local stiffness matrix and equation solving techniques using direct stiffness method
4	Gain an insight into the nonlinear analysis of structures
5	Learn the concepts of beams on elastic foundation

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Equipped with knowledge of different matrix method of analysis
CO-2	Analyze different structural elements using the matrix methods
CO-3	Formulate the element and global stiffness matrices by direct stiffness method and learn equation solution techniques
CO-4	Understand and differentiate between the linear and nonlinear analyses
CO-5	Solve the problems pertaining to beams on elastic foundation.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	1	1	1	2	2
CO-2	3	1	1	1	2	2
CO-3	3	2	2	2	2	2
CO-4	3	2	2	2	1	-
CO-5	3	2	2	2	1	-

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit – I
Introduction to Matrix Methods of Analysis: Static indeterminacy and kinematic indeterminacy, Coordinate systems, displacement and force transformation matrices, element and structure stiffness matrices, equivalent joint loads and fixed end forces
Stiffness Method: Stiffness of prismatic member, Analysis of bar element, plane truss, continuous beams, plane frames and grid frames, also dealing with effect of settlements, internal hinges and guided fixed end supports.

Unit – II
Flexibility Method: Flexibility of prismatic member, Analysis of bar element, plane truss, continuous beams, plane frames and grid frames, also dealing with effect of settlements, internal hinges and guided fixed end supports.

Unit – III
.**Direct Stiffness Method:** Assemblage of global stiffness matrix, Analysis of plane truss, continuous beams, plane frame and grid frames, also dealing with effect of settlements, internal hinges and guided fixed end supports - bank matrix-semi bandwidth-computer algorithm for assembly by direct stiffness matrix method Exposure to software‟s

Unit – IV
Introduction to Nonlinear Analysis: Geometric and material nonlinearity
P- effect, Effects of axial force on flexural stiffness – buckling of ideal columns, buckling behavior of real columns
Flexural behaviour of beam columns, flexural stiffness measures for braced prismatic beam columns, effect of axial tension, flexural stiffness measures for unbraced prismatic beam columns

Unit –V
Beams on Elastic Foundations: Introduction-Modulus of foundation & Basic equation. Beams of infinite length under concentrated & uniformly distributed loads, Analysis of semi-infinite beams making use of functions for infinite beams
Topics to be taught by Industry Subject Expert :
Case Study on beams on Elastic Foundation and Analyzing different structural elements using software

Suggested Reading:

1	Devdas Menon(2009), Advanced Structural Analysis by. Narosa Publishing House.
2	Amin Ghali, Adam M Neville and Tom G Brown (2007), “Structural Analysis: A Unified Classical and Matrix Approach", Sixth Edition, Chapman & Hall
3	Asslam Kassimali,(1999), “Matrix Analysis of Structures", Brooks/Cole Publishing Co., USA,.
4	William Weaver, Jr & James M. Gere, Matrix(1990), “ Analysis of Framed Structures”, 3rdedition Van Nostrand Reinhold New York
5	Thandava moorthy (2011), “Structural Analysis” 1st edition published by Oxford University

CE 102	**THEORY OF ELASTICITY**					
(CORE –II)						
Pre-requisites	Strength of Materials		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand the concepts of elasticity and equip them with the knowledge to independently handle the problems of elasticity.
2	Enhance the competency level and develop the self-confidence through quality assignments in theory of elasticity.
3	Inculcate the habit of researching and practicing in the field of elasticity.

Course Outcomes :	
On completion of this course, the student will be able to do :	
CO-1	Solve the problems of 3-D elasticity with confidence.
CO-2	Acquire the knowledge of principle stresses and principle strains
CO-3	Work independently with the problems of 2-D elasticity in Cartesian coordinates
CO-4	Familiarize with the use of Airy‟s stress function in 2-D problems of elasticity in polar coordinates.
CO-5	Equip with the knowledge of various theories of torsion of prismatic bars of various cross sections and can solve the problems of torsion.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3		1	1		
CO-2	3		1	1		
CO-3	3		1	1		
CO-4	3		1	1		
CO-5	3		1	1		

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit - I
Introduction: Definition and notation for forces and stresses, components of stress and strain, Generalized Hooke‟s law, Stress-strain relations in three directions, Plane stress and plane strain, Equations of equilibrium and compatibility in two and three dimensions, Stress components on an oblique plane, Transformation of stress components under change of co-ordinate system.

Unit - II
Principal stresses and principal planes: Stress invariants, Mean and Deviator stress, Strain energy per unit volume, Distortion strain energy per unit volume, Octahedral shear stress, Strain of a line element. Principal strains, Strain invariants, Volume strain, Principle of superposition, reciprocal theorem.

Unit - III
Two dimensional problems in Cartesian co-ordinates: Solution by polynomials, St. Venant‟s Principle, Uniqueness of solution, Stress components in terms of Airy‟s stress function. Applications to Cantilever, simply supported and fixed beams with simple loading.

Unit - IV
Two dimensional problems in Polar co-ordinates: Stress-strain components, Equilibrium equations, Compatibility equations, Applications using Airy‟s strain functions in polar co-ordinates for stress distributions symmetric about an axis, Effect of hole on stress distribution in a plate in tension, Stress due to load at a point on a semi-infinite straight boundary, Stresses in a circular disc under diametrical loading.

Unit - V
Torsion: Torsion of various shapes of bars, Stress function method of solution applied to circular and elliptical bars, Torsion of rectangular bars, Solution of Torsional problems by energy method, use of soap films in solving torsion problems, Prandtl‟s membrane analogy. Solution of torsion of bars by Finite difference method.

Suggested Reading:

1	Timoshenko.S, Goodier.N (2017), Theory of Elasticity, Mc Graw Hill.
2	Sadhu Singh (2012), Theory of Elasticity, Khanna Publishers.
3	Ukad Gaonkar (2015), Theory of Elasticity and Fracture Mechanics, ,PHI Learning Private Limited
4	Chandramouli , P.N.(2017), Theory of Elasticity ,Yesdee Publishing Pvt.Ltd.
5	Landau, L D, Pitaevskii, L. P., Kosevich, A. M.(1984) , Lifshitz,E.M., Theory of Elasticity, Butterworth-Heinemann
6	Jane Helena,H(2017), Theory of Elasticity and Plasticity , PHI Learning

CE 103	**STRUCTURAL DESIGN**					
(CORE-III)						
Pre-requisites	Structural Analysis		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	Understand the design concepts of various Structural elements viz. fixed beams, continuous beams, flat slabs, circular slabs, ribbed slabs using relevant codal provisions.
2	Learn to analyze and design RCC portal frame and multistoried frame for vertical and horizontal loads
3	Understand the basic concepts of plastic design of steel structures and composite structures.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Analyse and design fixed and continuous beams using relevant codes.
CO-2	Understand the concepts of design of different types of flat slabs, circular slabs and ribbed slab
CO-3	Attain confidence in designing and detailing of RCC portal frame and RCC multistoried frame
CO-4	Analysis and design indeterminate beams and frames using the concepts of plastic analysis.
CO-5	Analyse and design composite constructions system using relevant codes.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	1	2	3	1	1
CO-2	3	1	2	3	1	1
CO-3	3	1	2	3	1	1
CO-4	3	1	2	3	1	1
CO-5	3	1	2	3	1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit - I
Analysis and Design of RC Beams: Introduction, Redistribution of moments in fixed beam, Positions of points of contraflexure, Conditions for moment redistribution, Final shape of redistributed bending moment diagram, Moment redistribution for a two-span continuous beam, Advantages and disadvantages of moment redistribution, Design of Fixed and Continuous beams.

Unit - II
Flat slabs: Introduction – Components - IS code recommendations, Design methods, Design for Flexure and Shear – Openings in Flats Slabs – Moments in Columns. **Circular slabs**: Introduction - IS code recommendations - Types of Circular slabs - Analysis and Design of Circular Slabs. **Design of Ribbed Slabs.**

Unit - III
Reinforced Concrete Portal Frames: Introduction - Analysis and Design of Rectangular Portal Frames for vertical loading – Design of hinge.
Approximate methods of Analysis: Analysis and Design of Multi Storied Frame due to vertical loads by Substitute Frame Method - Analysis and Design of Multi Storied Frame due to horizontal loads by Portal method, Cantilever method and Factor method.

Unit - IV
Plastic Design of Steel Structures: Introduction, Plasticity in ductile materials, stress-strain for mild steel, Elasto-Plastic behavior of beam in flexure, shape factor for different cross sections, yield zones, concept of plastic hinge, Plastic Analysis and Design of Indeterminate Beams and Portal frames of Single bay two storied and two bay single storied – Minimum weight design.

Unit - V
Composite construction: Introduction - Design principles - Shear connectors and their types - IS Codal provisions – Design of Slab-Beam type composite construction systems.

Suggested Reading:

1	V.L. Shah and Dr. S.R. Karve 2022, "Limit State Theory and Design of Reinforced Concrete", Standard Publishers Distributors
2	Punmia, B.C. (2015). R.C.C. Design, 4th Ed., Laxmi Publications, New Delhi.
3	Varghese, P. C. (2010). Advanced reinforced concrete design, PHI Learning,NewDelhi.
4	Shah,H.J. (2000). Reinforced Concrete, Vol.II., Charotar Publications, New Delhi.
5	Park, R. and Paulay, T.(1995)., Reinforced Concrete Structures, John Wiley & Sons, Inc., New York.
6	Popov, E.P.(2015), Mechanics of Materials, Second edition, Prentice-Hall, Englewood Cliffs, New Jersey.
7	Shah,H.J. (2000). Reinforced Concrete, Vol.II., Charotar Publications, New Delhi.
8	Ramamrutham, S. (2016). Steel Structures, 6th Ed., Dhanpat Rai Publications, New Delhi.
Codes books	
1	IS 456, (2000), Indian Standard Code of Practice for Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi
2	SP 22 (S&T), (1982), Explanatory Handbook on Codes for Earthquakes Engineering - IS 1893:1975 and IS 4326:1976, Bureau of Indian Standards, New Delhi
3	IS 875(1987)(Reaffirmed 2008), Code of practice for design loads (other than earthquake) for buildings and structures(Parts 1-5), Bureau of Indian Standards, New Delhi.
4	IS 11384: Code of Practice for Composite Construction in Structural Steel and Concrete Bureau of Indian Standards, New Delhi
5	IS 3935: 1966 (Reaffirmed Year: 2017) Code of practice for composite construction, Technical Committee : CED 38

CE 111	FRACTURE MECHANICS IN CONCRETE STRUCTURES					
	(PROGRAM ELECTIVE – I)					
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Learn the causes and the effects of cracks in concrete structures based on fracture mechanics.
2	Understand the type of failures in concrete structures.
3	Study the methods for calculating stress intensity factors.
4	Understand the concepts of Fracture Models for Concrete Materials.
5	Develop an understanding of fracture energy determination.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identify and classify cracking of concrete structures based on fracture mechanics.
CO-2	Know the various fracture mechanics aspects and failure aspects of systems in a structure.
CO-3	Understand stress intensity factor and implement to notched members.
CO-4	Understand the concepts of LEFM and compute fracture parameters for various sections.
CO-5	Apply fracture mechanics models to high strength concrete and FRC structures.

Course outcome	Program Outcome					
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	3	3	2	1	3
CO-2	3	3	3	2	2	3
CO-3	3	3	3	2	2	3
CO-4	3	3	3	2	1	3
CO-5	3	3	3	2	2	3

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit – I
Introduction**:** Basic fracture mechanics, crack in a structure, characteristics of cracks, fracture, modes of deformation of a cracked body, crack growth mechanisms, mechanisms of fracture and crack growth

Unit – II
Cleavage fracture, ductile fracture, fatigue cracking, fatigue strength of concrete, Fatigue of Reinforcement steel, Fatigue of Reinforced concrete members, fatigue crack growth model, environment assisted cracking, service failure analysis

Unit – III
Linear elastic fracture mechanics, Stress Concentration Effect of Flaws, Griffith‟s Criteria, The Energy Release Rate, Stress intensity factors, Stress at crack tip, Concept of R curve, Review of concrete behavior in tension and compression- Fracture Process Zone-Basic frameworks for modeling of quasibrittle materials, Concept of CTOD and CMD.

Unit – IV
Fracture Models for Concrete Materials-Fictitious crack model- Crack band model-Two parameter fracture model-Size effect model. Concrete Fracture Properties- Direct method-indirect method-Flexural tests on notched beams- Fracture energy & Fracture parameters using three-point bend test.
Topics to be taught by Industry Subject Expert :
Finite element applications in Fracture mechanics and case study on the methodologies for advanced finite element analysis and crack width prediction in RC structures / components and practical aspects during its implementation.

Unit – V
Introduction to Damage Mechanics. Applications to High Strength Concrete, Fibre Reinforced Concrete, Crack Concepts and Numerical Modeling.
Topics to be taught by Industry Subject Expert :
Case study on the usage of the XFEM method to study the crack growth in a concrete beam under 3

Suggested Reading:

1	Fracture Mechanics Fracture Mechanics, Suri, C.T. and Jin, Z. H., 1st Edition, Elsevier Academic Press, 2012.
2	Elementary Engineering Fracture Mechanics, Broek David, 3rd Edition, Springer, 1982.
3	Fracture Mechanics of Concrete Structures – Theory and Applications, Elfgreen, L., RILEM Report, Chapman and Hall, 1989.
4	Fracture Mechanics – Applications to Concrete, Victor, Li C., Bazant Z. P., ACI SP118, ACI Detroit, 1989.
5	Fracture Mechanics And Structural Concrete,B.L. Karihaloo,Longman Scientific & Technical, 1995

CE 112	ADVANCED REINFORCED CONCRETE DESIGN					
(PROGRAM ELECTIVE – I)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Learn the analysis and design of beams curved in plan
2	Design and detail the deep beams.
3	Analyse and detail the water tanks.
4	Design and detail Bunkers and silos.
5	Analyse and design the raft, pile and machine foundations.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Design the beams curved in plan
CO-2	Propose and design the deep beams.
CO-3	Design domes and various type water tanks.
CO-4	Differentiate and design the bunkers and silos.
CO-5	Design the raft, pile and machine foundations.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	3	3	2	1	3
CO-2	3	3	3	2	2	3
CO-3	3	3	3	2	2	3
CO-4	3	3	3	2	1	3
CO-5	3	3	3	2	2	3

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit – I
Beams Curved in Plan: Introduction - design principles – Terminologies, structural design of beams curved in plan of circular and rectangular type.

Unit – II
Deep Beams: Introduction to deep beams, Flexural and Shear stresses in deep beams, IS Code provisions - design of deep beams.

Unit – III
Domes: Introduction - Stresses and forces in domes - design of spherical and conical domes. **Water Tanks**: Types, Codal specifications, Design of circular, rectangular and Intze type water tanks.

Unit – IV
Bunkers and Silos: Introduction - Design principles and theories Code provisions - design of square and circular bunkers - design of cylindrical silos. IS specifications.
Topics to be taught by Industry Subject Expert :
Advanced design of curved beams, deep beams, and elevated water tanks for industrial Structures, case studies and design and demonstrations on live industrial structures.

Unit – V
Raft and Pile Foundations: Introduction, need for the design, Design principles - Structural design of raft and pile foundations including the design of pile caps.
Machine Foundations: Introduction, Types, Design Principles, Case studies, detailed designs.
Topics to be taught by Industry Subject Expert :
Advanced design of silos, Bunkers, Raft foundations, pile foundations and machine foundations. Case studies, design techniques and live design of industrial structures.

Suggested Reading:

1	"Advanced Reinforced Concrete Design", by N. Krishna Raju, CBS Pub. 1986.
2	"Reinforced Concrete", by H.J. Shah, Charotar Pub. 2000. Vol. II.
3	"R.C.C. Designs" by B.C. Punmia, Laxmi Pub. 1998
4	Structural Engineering Design and drawing by N. Krishna Raju 2009
5	Reinforced concrete design by S Unnikrishna Pillai and Devdas Menon 2004

CE 113	THEORY OF STRUCTURAL STABILITY					
	(PROGRAM ELECTIVE – I)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Learn the buckling of columns, analysis using equilibrium, energy and approximate methods.
2	Know the stability analysis of beam-columns and frames with different loads
3	Analyse for torsional, flexural and lateral buckling of beams
4	Perform the buckling analysis of thin plates using different approaches
5	Study the inelastic buckling analysis of plates.

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the analysis of buckling of columns using appropriate method
CO-2	Analyse the practical problems of beam-columns and frames.
CO-3	Analyse the beams for torsional, flexural and lateral buckling
CO-4	Perform buckling analysis of thin plates.
CO-5	Analyse the plates for inelastic buckling and understand the post-buckling behaviour of plates.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	1	1	-	-	-
CO-2	3	1	1	-	-	-
CO-3	3	1	1	-	-	-
CO-4	3	1	1	-	-	-
CO-5	3	1	1	-	-	-

Unit – I

Buckling of columns: States of equilibrium - Classification of buckling problems - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis - Eigen value problem. Governing equation for columns - Analysis for various boundary conditions - using Equilibrium, Energy methods. Approximate methods - Rayleigh Ritz, Galerkin‟s approach - Numerical Techniques - Finite difference method - Effect of shear on buckling.

Unit – II

Buckling of beam-columns and frames: Theory of beam column - Stability analysis of beam column with single and several concentrated loads, distributed load and end couples Analysis

of rigid jointed frames with and without sway - Moment distribution - Slope deflection and stiffness method.

Unit – III
Torsional and lateral buckling: Torsional buckling - Torsional and flexural buckling - Local buckling. Buckling of Open Sections. Numerical solutions. Lateral buckling of beams, pure bending of simply supported beam and cantilever beam.

Unit – IV
Buckling of plates: Governing differential equation - Buckling of thin plates, various edge conditions - Analysis by equilibrium and energy approach - Approximate and Numerical techniques.

Unit – V
Inelastic buckling: Double modulus theory - Tangent modulus theory – Shanley‟s model – Eccentrically loaded inelastic column. Inelastic buckling of plates - Post buckling behavior of plates.

Suggested Reading:

1	Timoshenko, S., and Gere., ―Theory of Elastic Stability‖, McGraw Hill Book Company, 1963.
2	Chajes, A. ―Principles of Structures Stability Theory‖, Prentice Hall, 1974.
3	Ashwini Kumar, ―Stability Theory of Structures‖, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1995.
4	Iyenger.N.G.R., ―Structural stability of columns and plates‖, Affiliated East West Press,1986.
5	Gambhir, ―Stability Analysis and Design of Structures‖, springer, New York

CE 114	COMPOSITE CONSTRUCTIONS					
(PROGRAM ELECTIVE – V)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Study the concepts of composite construction.
2	Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes of practice.
3	Apply the concepts for design of multi-storey composite buildings.
4	Scope of analysis is restricted to skeletal structures subjected to prescribed dynamic loads

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the fundamentals of composite construction, and analysis and designs of composite beams.
CO-2	Analyse and design the composite floors and connection details.
CO-3	Analyse and design the composite columns and connection details
CO-4	Analyse and design the composite trusses and connection details
CO-5	Analyse and design the multi-storey composite buildings.

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	2	1	2	-	-
CO-2	3	2	1	2	-	-
CO-3	3	2	1	2	-	-
CO-4	3	2	1	2	-	-
CO-5	3	2	1	2	-	-

Unit – I
Introduction of composite constructions: Benefits of composite construction - Introduction to IS - BS and Euro codal provisions.
Composite beams: Elastic behaviour of composite beams - No and full interaction cases - Shear connectors - Ultimate load behaviour - Serviceability limits - Effective breadth of flange - Interaction between shear and moment - Basic design consideration and design of composite beams.

Unit – II
Composite floors: Structural elements - Profiled sheet decking - Bending resistance - Shear resistance - Serviceability criterion - Analysis for internal forces and moments - Design of composite floors.

Unit – III
Composite columns: Materials - Concrete filled circular tubular sections - Non-dimensional slenderness - Local buckling of steel sections - Effective elastic flexural stiffness - Resistance of members to axial compressions - Composite column design - Fire resistance.

Unit – IV
Composite trusses: Design of truss - Configuration - Truss members - Analysis and design of composite trusses and connection details.
Topics to be taught by Industry Subject Expert :
Case study on composite trusses.

Unit – V
Design of multi-storey composite buildings: Design basis - Load calculations - Design of composite slabs with profile decks - Composite beam design - Design for compression members - Vertical cross bracings - Design of foundation.
Topics to be taught by Industry Subject Expert :
Case study on multi-storey composite buildings.

Suggested Reading:

1	R.P. Johnson, "Composite Structures of Steel and Concrete - Beams, Slabs, Columns and Frames in Buildings", Blackwell Publishing, Malden, USA, 2004.
2	" INSDAG Teaching Resources for Structural Steel Design", Vol-2, Institute for Steel Development and Growth Publishers, Calcutta, India.
3	"INSDAG Handbook on Composite Construction – Multi-Storey Buildings", Institute for Steel Development and Growth Publishers, Calcutta, India.
4	"INSDAG Design of Composite Truss for Building", Institute for Steel Development and Growth Publishers, Calcutta, India
5	"INSDAG Handbook on Composite Construction – Bridges and Flyovers", Institute for Steel Development and Growth Publishers, Calcutta, India.
6	IS: 11384-1985, "Code of Practice for Composite Construction in Structural Steel and Concrete", Bureau of Indian Standards, New Delhi, 1985.

CE 115	STRUCTURAL HEALTH MONITORING					
	(PROGRAM ELECTIVE – II)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Learn the fundamentals of structural health monitoring.
2	Study the various vibration-based techniques for structural health monitoring.
3	Learn the structural health monitoring using fiber-optic and Piezoelectric sensors.
4	Study the structural health monitoring using electrical resistance and electromagnetic techniques

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	*Understand the fundamentals of maintenance and repair strategies.*
CO-2	*Diagnose for serviceability and durability aspects of concrete.*
CO-3	*Know the materials and techniques used for repair of structures.*
CO-4	*Decide the appropriate repair, strengthening, rehabilitation and retrofitting technique required for a case study building.*
CO-5	*Use an appropriate health monitoring technique and demolition technique.*

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	1	2	1	-	-
CO-2	3	1	2	1	-	-
CO-3	3	1	2	1	-	-
CO-4	3	1	2	1	-	-
CO-5	3	1	2	1	-	-

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit – I
Introduction to structural health monitoring: Definition of structural health monitoring (SHM) – Objectives- Need –Steps involved in SHM-Motivation for SHM - SHM as a way of making materials and structures smart - SHM and biomimetics - Process and pre usage monitoring as a part of SHM - SHM as a part of system management - The most remarkable characters of SHM Birth of the SHM community.

Unit - II
Vibration-based techniques for SHM: Basic vibration concepts for SHM -Local and global methods - Damage diagnosis as an inverse problem -Model-based damage assessment - General dynamic behavior-State- space description of mechanical systems - Neural network approach to SHM - The basic idea of neural networks - Detection of delamination in a CFRP plate with stiffeners.

Unit – III
Fiber-optic sensors: Classification of fiber-optic sensors - Intensity-based sensors - Phase-modulated optical fiber sensors - or interferometers -Wavelength based sensors - or Fiber Bragg Gratings (FBG) - The fiber Bragg grating as a strain and temperature sensor - Orientation of the optical fiber optic with respect to the reinforcement fibers - Fiber Bragg gratings as damage sensors for composites - Measurement of strain and stress variations

Unit – IV
SHM with piezoelectric sensors: The use of embedded sensors as Acoustic Emission (AE) detectors - Available industrial AE systems- New concepts in acoustic emission - State-the-art and main trends in piezoelectric transducer-based acousto-ultrasonic SHM research –The full implementation of SHM of localized damage with guided waves in composite materials - Available industrial acousto-ultrasonic systems with piezoelectric sensors
Topics to be taught by Industry Subject Expert :
Health monitoring of residential buildings a case study.

Unit – V
SHM using electrical resistance: Composite damage - Electrical resistance of unloaded composite - Percolation concept - Anisotropic conduction properties in continuous fiber reinforced polymer - Influence of temperature - Composite strain and damage monitoring by electrical resistance -Randomly distributed fiber reinforced polymers - Damage localization. Low frequency electromagnetic techniques: Theoretical considerations on electromagnetic
Topics to be taught by Industry Subject Expert :
Health monitoring of commercial and residential high rise buildings case studies.

Suggested Reading:

1	Daniel Balageas, Claus-Peter Fritzen and Alfredo Güemes "Structural Health Monitoring", John Wiley-ISTE, London, 2006.
2	Douglas E Adams, "Health Monitoring of Structural Materials and Components - Methods with Applications", John Wiley & Sons, New York, 2007.
3	J.P. Ou, H. Li and Z. D. Duan, "Structural Health Monitoring and Intelligent Infrastructure", Vol.-1, Taylor & Francis, London, 2006.
4	Victor Giurglutiu, "Structural Health Monitoring with Wafer Active Sensors", Academic Press Inc., 2007.
5	M.V. Gandhi and B.D. Thompson, "Smart Materials and Structures," Springer, 1992.
6	Fu Ko Chang, "Structural Health Monitoring: Current Status and Perspectives", Technomic, Lancaster, 1997.

CE 116	ADVANCED STEEL DESIGN					
(PROGRAM ELECTIVE – II)						
Pre-requisites	-		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand fundamentals of design of steel tanks.
2	Learn designs of grillage foundations and tubular structures.
3	Know concepts of bunkers and silos.
4	Learn designs of transmission line towers.
5	Enhance knowledge of light-gauge steel structures.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Design rectangular plated and pressed steel tanks.
CO-2	Perform design of grillage foundations and hollow tubular structures.
CO-3	Differentiate rectangular/square bunkers and silos and design using appropriate theory.
CO-4	Analyze and design transmission towers subjected to various loads.
CO-5	Demonstrate design of light-gauge steel compression and flexural members.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	1	2	1	3	2
CO-2	3	1	2	1	3	2
CO-3	3	1	2	1	3	2
CO-4	3	1	2	1	3	2
CO-5	3	1	2	1	3	2

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit - I
Steel Tanks: Introduction - Types - Loads - Permissible stresses - Detailed design of elevated rectangular and pressed steel tanks including columns.

Unit - II
Grillage Foundations: Introduction - Necessity of grillage foundation - Various types - Grillage foundations for single and double columns.
Tubular Structures: Introduction - Permissible stresses - Design considerations - Design of tension members - Compression members and flexural members - Design of tubular trusses including joints.

Unit - III
Bunkers and Silos: Introduction - General design principles - Design theories for bunkers and silos - Detailed design of bunkers and silos.

Unit - IV
Transmission Line Towers: Classification - Economical spacing - Design loads - IS codal provisions - Calculation of wind loads - Permissible stresses - Overall arrangement and design procedure - Detailed design including foundations.
Topics to be taught by Industry Subject Expert :
Case-study of transmission line towers.

Unit - V
Design of Light Gauge Steel Structures: Introduction - Forms of light-gauge sections - Behaviour of compression elements - Effective width for load and deflection calculation - Behaviour of unstiffened and stiffened elements - Design of compression members - Design of laterally supported beams and laterally unsupported beams – Connections.
Topics to be taught by Industry Subject Expert :
Case-study of light gauge steel structures.

Suggested Reading:

1	Duggal, S.K. (2009). *Design of Steel Structure*, Tata McGraw-Hill, 3rd Ed., New Delhi.
2	Gambhir, M.L. (2013). Fundamentals of Structural Steel Design, McGraw-Hill, New Delhi.
3	Punmia, B.C. (2001). *Design of Steel Structures*, Laxmi Publications, New Delhi.
4	Ram Chandra (1989). *Design of Steel Structures, Vol. I & II*, Standard Book House, New Delhi.
5	Vazirani, V.N., Ratwani, M.M., and Mehra, H. (2000). 17th Ed., *Design and Analysis of Steel Structures*, Khanna Publishers, New Delhi.
6	Syal I.C., and Singh, S. (2000). *Design of Steel Structures*, Standard Book House, New Delhi.
7	Dayaratnam, P. (1987). *Design of Steel Structures*, Orient Longman Publications, New Delhi.

IS Codes:

1	IS:800-1984 (1984). *Code of Practice for General Construction in Steel*, Bureau of Indian Standards, New Delhi.
2	IS:800-2007 (2007), *General Construction in Steel-Code of Practice*, Bureau of Indian Standards, New Delhi.
3	IS: 801-1976 (1976), *Code of Practice for Use of Cold-Formed Light Gauge Steel Structural Members in General Building Construction*, Bureau of Indian Standards, New Delhi.
4	IS:802 (Part 1/Sec 1)-2015 (2015), *Use of Structural Steel in Overhead Transmission Line Towers - Code of Practice*, Bureau of Indian Standards, New Delhi.
5	IS:802 (Part 1/Sec 2)-2016 (2016), *Use of Structural Steel in Overhead Transmission Line Towers - Code of Practice*, Bureau of Indian Standards, New Delhi.
6	IS:802 (Part 2)-1978 (1978), *Use of Structural Steel in Overhead Transmission Line Towers - Code of Practice*, Bureau of Indian Standards, New Delhi.
7	IS:804-1967 (1967), *Specification for Rectangular Pressed Steel Tanks*, Bureau of Indian

	Standards, New Delhi.
8	IS:805-1988 (1988), *Code of Practice for Use of Steel in Gravity Water Tanks*, Bureau of Indian Standards, New Delhi.
9	IS:806-1968 (1968), *Code of Practice for Use of Steel Tubes in General Building Construction*, Bureau of Indian Standards, New Delhi.
10	IS:811-1987 (1987), *Specification for Cold Formed Light Gauge Structural Steel Sections*, Bureau of Indian Standards, New Delhi.
11	IS:1161-2014 (2014), *Steel Tubes for Structural Purposes - Specification*, Bureau of Indian Standards, New Delhi.
12	IS:9178 (Part 1)-1979 (1979), *Criteria for Design of Steel Bins for Storage of Bulk Materials*, Bureau of Indian Standards, New Delhi.
13	IS:9178 (Part 2)-1979 (1979), *Criteria for Design of Steel Bins for Storage of Bulk Materials*, Bureau of Indian Standards, New Delhi.
14	SP:6(1)-1964 (1964), *Handbook for Structural Engineers*, Bureau of Indian Standards, New Delhi.
15	SP:6(5)-1980 (1980), *Handbook for Structural Engineers*, Bureau of Indian Standards, New Delhi.

CE 117	**DESIGN OF PRESTRESSED CONCRETE STRUCTURES**					
(PROGRAM ELECTIVE – III)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1.	Learn the concepts of pre-stressed concrete, systems of pre-stressing and losses of pre-stress
2.	Understand the analysis and design of sections for flexure and shear
3.	Study the analysis and design of sections for torsion and deflection
4.	Learn the analysis and design of end blocks and continuous pre-stressed concrete beams
5.	Study the design of pre-stressed concrete pipes and slabs

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Apply the fundamentals of pre-stressed concrete, systems of pre-stressing and losses of pre-stress
CO-2	Analyze and design the sections for flexure and shear
CO-3	Design of sections for torsion and deflection
CO-4	Apply the concepts of design for end anchorages and pre-stressed concrete continuous beams
CO-5	Analyze and design the pre-stressed concrete pipes and slabs

Course Outcomes	***PO1***	***PO2***	***PO3***	***PO4***	***PO5***	***PO6***
CO1	3	-	1	1	-	-
CO2	3	-	1	1	-	-
CO3	3	-	1	1	-	-
CO4	3	-	1	1	-	-
CO5	3	-	1	1	-	-

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

Unit – I
Introduction: Basic concepts, materials, permissible stresses**,** advantages, types of prestressing systems, devices of pre-tensioning and post-tensioning. **Loss of prestress:** Loss of prestress in pre-tensioned and post-tensioned members**.**

Unit - II
Flexure: Analysis of prestress and design of rectangular, I and T sections for flexure. **Shear:** Shear and principal stresses**,** shear resistance of PSC beam, design of shear reinforcement

Unit – III
Torsion: Design of PSC beam for torsion, shear and bending. **Deflections:** Importance of deflections, factors influencing deflections, codal provisions, short-term and long-term deflections. Deflections of PSC beams with uniformly distributed and point loads.

Unit – IV
End blocks Design of a transmission zone in pre-tensioned members and design of anchorage zone in post-tensioned members by IS method **Continuous beams:** Concordant cable profile, advantages of continuous members**,** codal provisions and design of two-span continuous beams
Unit – V
Tension members: Introduction to circular pre-stressing**,** design of PSC pipes. **Slabs:** Introduction to PSC slabs, codal provisions, design of PSC one-way and two-way slabs.

Suggested Reading:

1	Prestressed Concrete, N Krishna Raju, Tata Mc Graw Hill Publishers, 6th Edition, 2018.
2	Prestressed Concrete, N Rajagopalan, Narosa Publishers, 2nd Edition, 2010.
3	Prestressed Concrete, P Dayaratnam and P Sarah, Medtech Publishers, 7th Edition, 2017.
4	Prestressed Concrete, G S Pandit and S P Gupta, CBS Publishers, 2019.
5	Design of prestressed Concrete, S S Bavikatti, MEDTECH Scientific International Pvt. Ltd. Publishers, 2019.
6	Prestressed Concrete, K U Muthu et al., PHI Learning Pvt. Ltd. Publishers, 2016.

CE 118	STRUCTURAL OPTIMIZATION					
	(PROGRAM ELECTIVE – III)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand the basic principles and techniques for optimization
2	Learn to formulate Structural Optimization problems
3	Familiarized with the application of optimization techniques to structural elements.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the basic concepts of optimization and linear programming model.
CO-2	Ability to solve engineering problems using various optimization techniques.
CO-3	Able to formulate and solve nonlinear optimization models.
CO-4	Understand the concept and application of dynamic programming, simulation and decision theory for engineering problems
CO-5	Use the optimization techniques for simple structural elements

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	-	-	3	3	-	1
CO-2	3	-	3	3	-	1
CO-3	3	-	3	3	-	1
CO-4	3	-	3	3	-	1
CO-5	3	-	3	3	-	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit – I
Introduction to optimization: Introduction, basic theory and elements of Optimization, Terminology and definitions, Basic principles and procedure of optimization, Engineering applications of Optimization. **Classical Methods of Optimization**: Trial and error method, Monte-Carlo method,Lagrangian multiplier method, illustrative examples
Linear Programming: Introduction, terminology, formulation of LPP, graphical and algebraic methods of solving LPP, standard form and canonical form of linear programming, geometrical interpretation, illustrative examples..

Unit - II
Linear Programming: Simplex methods, Artificial variable techniques, solution of simultaneous equations, Dual formulations - illustrative examples.

Network analysis: Modifications and improvements on CPM/PERT **Transportation and Assignment problem**: Introduction, terminology, formulation and solution of mathematical models, illustrative examples

Unit – III
Non-Linear Programming: local and global optimum, problem formulation, Unconstrained and constrained methods of Optimization – Kuhn Tucker conditions. Lagrangian Multiplier methods, graphical method Univariable search method, Steepest Descent Methods, quadratic programming problem, Wolfs modified simplex method, illustrative examples

Unit – IV
Dynamic programming: Introduction, terminology, need and characteristics of dynamic programming, formulation, solution of LPP, applications, illustrative examples Decision theory: Introduction, types, decision trees. Simulation: Introduction, advantages, limitations, types, applications.
Topics to be taught by Industry Subject Expert :
Case study on Optimization using Linear Programming, Non Linear Programming, Dynamic Programming, Cost Optimization of Civil Engineering Structure.

Unit – V
Structural Optimization: Optimum structural design of rectangular timber beam, reinforced concrete rectangular, T and L beams, concrete mix proportioning, reinforced concrete deep beams, planner trusses, Procedure of optimization for structural grid and slab.
Topics to be taught by Industry Subject Expert :
Case study on Optimization of structural members using Linear Programming, Non Linear Programming, Dynamic Programming, Cost Optimization of Civil Engineering Structure.

Suggested Reading:

1	Rao, S.S. (1999). Engineering Optimization, New Age Internationals, New Delhi.
2	Paul, J.O. (1988).Systems Analysis for Civil Engineers, john Wiley & Sons.
3	Bhavikatti, S.S. (2001).Fundamentals of Optimum Design in Engineering, New Age International Publications, New Delhi.
4	Kalavathy, S. (1998). Operation Research, Vikas Publishing house Pvt Ltd., New Delhi.
5	Morris,A. J.(1982).Foundations of Structural Optimization, Wiley, New York.
6	Arora,J. (2004). Introduction to Optimum Design, 2nd ed., Academic Press, San Diego.
7	Wilde,D. J.(1978).Globally Optimal Design, Wiley, New York.

CE 119	RETROFITTING AND REHABILITATION OF STRUCTURES					
(PROGRAM SPECIFIC ELECTIVE – III)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Learn the fundamentals of maintenance and repair strategies.
2	Design and detail the deep beams. Study the quality assurance, serviceability and durability of concrete.
3	Know the various materials and techniques used for repair of structures
4	Educate the different repair, strengthening, rehabilitation and retrofitting techniques.
5	Instruct the various health monitoring and demolition techniques.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the fundamentals of maintenance and repair strategies.
CO-2	Diagnose for serviceability and durability aspects of concrete.
CO-3	Know the materials and techniques used for repair of structures
CO-4	Decide the appropriate repair, strengthening, rehabilitation and retrofitting technique required for a case study building.
CO-5	Use an appropriate health monitoring and demolition techniques

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	3	2	2	2	3
CO-2	3	3	2	2	2	3
CO-3	3	3	2	1	2	3
CO-4	3	3	2	2	1	3
CO-5	3	3	2	2	2	3

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

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 Shotcrete, 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 inUnder Water Structures – Guniting – Shot Create – Underpinning. Strengthening of Structures – Strengthening Methods – Retrofitting – Jacketing.
Topics to be taught by Industry Subject Expert :
Retrofitting methods, Techniques, Procedures and their implementation strategies according to the present day needs of the industry. Case studies on repair and rehabilitation of buildings, bridges, post tensioned slabs etc.,

Unit – V
Health Monitoring and Demolition Techniques: Long term health monitoring techniques, engineered demolition techniques for dilapidated structures, Use of Sensors – Building Instrumentation.
Machine Foundations: Introduction, Types, Design Principles, Case studies, detailed designs.
Topics to be taught by Industry Subject Expert :
Identification of repairs on structural elements, diagnosis, techniques, and methodologies for industrial structures. Case studies on industrial buildings with temperatures" etc.

Suggested Reading:

1	Concrete Technology by A.R. Santakumar, Oxford University press
2	Defects and Deterioration in Buildingts, E F & N Spon, London
3	Non-Destructive Evaluation of Concrete Structures by Bungey - Surrey University
4	Maintenance and Repair of Civil Structures, B.L. Gupta and Amit Gupta, Standard Publications.
5	Concrete Repair and Maintenance Illustrated, RS Means Company Inc W. H. Ranso, (1981)
6	Building Failures: Diagnosis and Avoidance, EF & N Spon, London, B
7	Mehta, P.K and Montevic. P.J., Concrete- Microstructure, Properties and Materials, ICI, 1997. Jackson, N., Civil Engineering Materials, ELBS, 1983.

CE 151	**STRUCTURAL DESIGN LABORATORY**					
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**	25		

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand fundamentals of continuous and circular beams..
2	Enhance knowledge to analyze/design portal frames.
3	Know analysis/design of continuous beam and column of a building using substitute frame method.
4	Learn designs of a single-storey single-bay ground floor building.
5	Learn designs of three-storey multi-bay G+2 floor building.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Analyze/design continuous and circular beams.
CO-2	Perform design of portal frames.
CO-3	Design continuous beam and column of a building using substitute frame method..
CO-4	Demonstrate design of a single-storey single-bay ground floor building.
CO-5	Analyze and design three-storey multi-bay G+2 floor building.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	1	3	3	3	3
CO-2	3	1	3	3	3	3
CO-3	3	1	3	3	3	3
CO-4	3	1	3	3	3	3
CO-5	3	1	3	3	3	3

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Design by manual calculation/excel sheets, model using latest design software like STAAD.Pro/ETABS, etc., check the results for different loads including wind/earthquake as per latest relevant IS codes and prepare detailed drawings using drafting software like AUTOCAD, etc.

Experiment - I
Analysis and design of continuous and circular RCC/steel beam.

Experiment - II
Analysis and design of RCC/steel hinged/fixed portal frame.

Experiment - III
Analysis and design of continuous beam and column of RCC/steel building using substitute frame method.

Experiment - IV
Analysis and design of slabs, beams, columns and foundations of a single-storey single-bay ground floor RCC/steel building.
Topics to be taught by Industry Subject Expert :
Case-study of single-storey RCC/steel building design.

Experiment - V
Complete analysis and design of slabs, beams, columns and foundations of a three-storey multi-bay G+2 floor RCC/steel building.
Topics to be taught by Industry Subject Expert :
Case-study of high-rise building design.

Suggested Reading :

1	Karve, S.R., and Shah, V.L. (1995). *Illustrated Design of Reinforced Concrete Buildings*, Structures Publications, Pune.
2	Shah, H.J., and Sudhir K. Jain, *Design Example of a Six Storey Building*, IITK-GSDMA Project on Building Codes, Document No. IITK-GSDMA-EQ26-V3.0.
3	Munir Hamad (2012). *Using STAAD.Pro 2007*, Shroff Publishers, Mumbai.
4	Sham Tickoo (2018), *Exploring Bentley STAAD.Pro CONNECT Edition*, CADCIM Technologies, Schererville, USA.
5	Makar Nageh (2007). *How to model and design high rise building using ETABS program*, Scientific Book House, Cairo, Egypt.
6	Bently STAAD.Pro Documentation.
7	Integrated Building Design Software (ETABS) Documentation.

CE 161	**SEMINAR**					
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	3	1.5
Evaluation	**SEE**	-	**CIE**	25 Marks		

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Identify appropriate topic of relevance.
2	Update literature on technical articles of selected topic and develop comprehension.
3	Prepare a technical report.
4	Deliver presentation on specified technical topic.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Review literature on technical articles and develop comprehension.
CO-2	Recognize appropriate topic of relevance
CO-3	Prepare review repot of literature studied
CO-4	Write a technical report.
CO-5	Give presentation on specified technical topic

Course outcome	**Program outcome**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	0.4	-	0.3	0.2	0.1	-
CO2	0.5	0.1	0.1	0,1	0.1	0.1
CO3	0.5	0.1	0.1	0,1	0.1	0.1
CO4	0.5	0.1	0.1	0,1	0.1	0.1
CO5	0.5	0.1	0.1	0,1	0.1	0.1

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SEMESTER-II

CE 104	**FINITE ELEMENT METHOD**					
(CORE- IV)						
Pre-requisites	Advanced Structural Analysis		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand concept of finite element method and potential-energy approach.
2	Learn 1-D analysis using basic and higher order axial bar elements.
3	Know 2-D analysis using basic and higher order triangular as well as quadrilateral elements.
4	Learn 3-D problems using axisymmetric and basic 3-D elements.
5	Enhance knowledge of 2-D plane trusses, beams and 2-D plane frames.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Describe fundamentals of finite element method and potential-energy approach.
CO-2	Demonstrate 1-D problems using 2-node and 3-node axial bar elements.
CO-3	Analyze 2-D problems using 3-node/6-node triangular elements and 4-node/8-node/9-node quadrilateral elements.
CO-4	Demonstrate 3-D problems using 3-node triangular ring element, 4-node Tetrahedron element and 8-node hexahedron element.
CO-5	Analyze Civil Engineering problems such as 2-D plane trusses, beams and 2-D plane frames.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	1	2	1	3	2
CO-2	3	1	2	1	3	2
CO-3	3	1	2	1	3	2
CO-4	3	1	2	1	3	2
CO-5	3	1	2	1	3	2

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit - I
Introduction to FEM: Types of problems – Types of materials – Elastic / inelastic situations – Types of forces - Body forces / Surface Traction / Point loads – Types of deformations – Homogeneous / Non homogeneous problems – Equations of equilibrium for elastic 2-D / 3-D continua - Equilibrium equations for 2-D / 3-D boundary elements – Boundary conditions – Strain-displacement relation - Stress-strain relation for 2-D / 3-D problems – Plane stress / Plane strain problems – Initial strain - Displacement model - Criterion for convergence - Conforming and non-conforming elements – Subparametric / Superparametric / Isoparametric formulations.

***Potential-Energy / Variational Approach*:** Rayliegh-Ritz Method – Galerkin„s Method – Application to discrete connected system and 1-D axial bar.

Unit - II
1-D Bar Elements: 1-D 2-node axial bar element - Finite element modeling – Natural coordinates - Shape functions – Strain-displacement relation matrix - Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector – Assembly of global stiffness matrix and load vector – Finite element equations – Treatment of boundary conditions – Elimination approach – Penalty approach – Multipoint constraints – Temperature effects – Application problems.
2nd Order Bar Elements: Shape functions, Strain-displacement matrix - Expression for stiffness matrix - Load matrices due to body forces and surface traction – Application problems.

Unit - III
2-D Triangular Elements: 2-D 3-node triangular element - CST - Shape functions – Area coordinates -Isoparametric formulations - Strain-displacement matrix – Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector - Temperature effects – Application problems.
2-D Isoparametric Quadrilateral Elements: 2-D 4-node quadrilateral - Shape functions – Jacobian matrix - Strain-displacement matrix - Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector – Numerical integration - Gaussian quadrature – 1-D and 2-D integrals - Application problems.
2nd Order Triangular Elements: 2-D 6-node triangular element - Shape functions – Degradation technique.
2nd Order Quadrilateral Elements: 2-D 8-node quadrilateral - 2-D 9-node quadrilateral - Shape functions.

Unit - IV
3-D Axisymmetric Problems: Axisymmetric formulation - Finite element modeling - 3-node triangular ring element - Strain-displacement matrix - Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector - Temperature effects – Application problems (industry).
***3-D Tetrahedron / Hexahedron Elements*:** Finite element formulation – 3-D 4-node Tetrahedron element - 3-D 8-node hexahedron / brick element - Shape functions – Volume coordinates - Jacobian matrix - Strain-displacement matrix - Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector – Application problems.
Topics to be taught by Industry Subject Expert :
Case-study using 3-D tetrahedron / hexahedron elements.

Unit - V
Civil Engineering Problems: ***2-D Trusses*:** 2-D Plane Truss – Local and global coordinate systems – Transformation matrix – Potential-Energy approach - Stiffness matrix – Strain-displacement matrix - Stress – Temperature effects – Application problems (industry).
Beams: Finite element formulation - Hermite shape functions – Potential-energy approach -

Stiffness matrix – Load vector – Shear force – Bending moment – Reaction – Application problems.
2-D Plane Frames: 2-D plane frame element – Local-global transformation matrix – Potential-energy approach - Stiffness matrix – Load vector – Application problems.
Topics to be taught by Industry Subject Expert :
Case-study using beam and 2-D plane frame elements.

Suggested Reading:

1	Zienkiewicz, O.C., and Taylor, R.L. (1993). *The Finite Element Method, Volume 1: The Basi*s, McGraw-Hill, London.
2	Reddy, J.N. (1993). *An Introduction to the Finite Element Method*, McGraw-Hill, New York.
3	Bathe, K.J. (2006). *Finite Element Procedures*, Prentice Hall of India, New Delhi.
4	Cook, R.D., Malkus, D.S., Plesha M.E., and Witt, R.J. (2003). *Concepts and Application of Finite Element Analysis*, 4th Ed., John Wiley, Singapore.
5	David V. Hutton (2005). *Fundamentals of Finite Element Analysis*, 1st Ed., Tata McGraw-Hill, New Delhi.
6	Chandrupatla, T.R. and Belegundu, A.D. (2003). *Introduction to Finite Elements in Engineering*, 3rd Ed., Prentice Hall of India, New Delhi.
7	Desai, C.S., and Abel, J.F. (2004). *Introduction to Finite Element Method*, 1st Ed., CBS Publishers, New Delhi.

CE 105	**STRUCTURAL DYNAMICS**					
(CORE-V)						
Pre-requisites	Advanced Structural Analysis		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Study the various types as well as characteristics of loading and formulate the equations of motion.
2	Learn the response of un-damped and damped SDOF and MDOF systems under various loadings
3	Learn the response of un-damped and damped SDOF and MDOF systems under various loadings
4	Use the seismic codes in analysis and design of civil engineering structures.
5	Understand the dynamic response by numerical methods.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	formulate dynamic equation of motions for given conditions and analysis methods for dynamic systems.
CO-2	Understand the modelling approach of dynamic response in civil engineering applications
CO-3	Create the simple computer models for engineering structures using knowledge of structural dynamics
CO-4	Interpret the dynamic analysis results for design, analysis and research purposes.
CO-5	Apply the structural dynamics theory to earthquake analysis, response, and design of structures

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	-	2	1	-	-
CO-2	3	1	1	1	-	-
CO-3	2	1	1	2	-	-
CO-4	2	1	1	1	1	-
CO-5	2	2	1	2	-	-

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit – I
Introduction to Structural Dynamics: Objectives of dynamic analysis–Types of prescribed dynamicloading – Characteristics of a dynamic problem – Methods of discretization: Lumped mass Procedure / Consistent mass procedure/generalised displacements
Single Degree Freedom Systems – Formulation of Equation of Motion: D"Alemberts"s Principle / Method of Virtual Work / Hamilton,,s Principle – Influence of Gravity Forces and Ground Motion on equation of motion – Generalised SDOF systems: Rigid Body Assemblage

Unit – II
Single Degree of Freedom Systems: Response of Un-damped/Damped free vibrations of SDOFsystems – Un-damped/Damped vibrations of SDOF systems subjected to Harmonic loading:
Resonant Response / Vibration Isolation – Un-damped / Damped vibrations of SDOF systems subjected Periodic loading Response of SDOF systems subjected Impulse loads: Half-sine pulse/Rectangular pulse/Triangular Pulse/ Shock spectra / Approximate method of impulse load analysis
Un-damped / Damped vibrations of SDOF systems subjected General dynamic loading / Duhamel Integral - Un-damped / Damped vibrations of SDOF systems subjected arbitrary dynamic loading.

Unit – III
Multi Degree Freedom Systems: Formulation of Equations of Motion / Evaluation of Lumped Mass Matrix and consistent mass matrix/ Evaluation of Stiffness Matrix. Un-damped Free Vibrations: Analysis of Frequency matrix and mode shape matrices using detrimental equation
Orthogonality Conditions/ Normalizing Mode shapes/Analysis of Dynamic Response/Normal Coordinates/ Uncoupled Equations of Motion for un-damped systems/Conditions for damping orthogonality – Mode super position procedure for damped forced vibration
Time History Analysis – Direct Integration Methods due to New Mark(average acceleration, linear acceleration), Wilson theta correction.

Unit – IV
Practical Vibration Analysis: Stodola Method, Holtzer Method–Fundamental mode only, Reductionof degrees of freedom, basic concepts in matrix iteration.
Variational Formulation of Equations of Motion: Generalized coordinates, Lagrange‟s Equations of Motion, Application to simple un-damped and damped problems of 2-DOF systems.

Unit –V
Distributed Parameter Systems: Partial Differential Equation of Motion–Beam Flexure (Elementarycase) – Undamped free vibrations (Elementary case) – Analysis of dynamic response – normal coordinates
Topics to be taught by Industry Subject Expert :
Earthquake Resistant Design: Brief exposure to relevant IS Codes of Practice, Response Spectra method.

Suggested Reading

1	Clough, Ray. W, and Penzien, Joseph. "Dynamics of Structures", 3rd addition 1993 Tata McGraw Hill Company Limited, New Delhi.
2	Anil K Chopra "Dynamics of Structures: Theory and Applications to Earthquake Engineering", 5th edition 2019 Prentice-hall International Series I Civil Engineering and Engineering Mechanics
3	Mario Paz (Author), Young Hoon Kim (Author)"Structural Dynamics: Theory and Computation", 6th edition 2018 Springers publication
4	Patrick Paultre "Dynamics of Structures", 1st edition 2011 Wiley publication
5	Online Resources: https://nptel.ac.in/courses/105/106/105106151/ https://nptel.ac.in/courses/105/104/105104189/

CE 106	**THEORY OF PLATES**					
(CORE-VI)						
Pre-requisites	-		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Learn the analysis of rectangular and circular plates subjected to various loading conditions with different boundary conditions
2	Understand fundamentals of buckling of plates
3	Know the concepts of small deflection theory of laterally loaded plates
4	Study the approximate methods of analysis of rectangular plates
5	Derive the governing differential equations for orthotropic plates and apply them to practical problems

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Analyse the rectangular and circular plates subjected to various loading conditions
CO-2	Determine critical buckling load for plates with different edge conditions
CO-3	Apply the concepts of small deflection theory for laterally loaded plates with different loading conditions
CO-4	Understand the various approximate methods of analysis for bending of plates
CO-5	Apply the concepts of orthotropic plates to simply supported laminates, slabs & grids

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	-	1	1	-	-
CO-2	3	-	1	1	-	-
CO-3	3	-	1	1	-	-
CO-4	3	-	1	1	-	-
CO-5	3	-	1	1	-	-

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit – I
Bending of rectangular plates: Pure and cylindrical bending, differential equation, cylindrical bending of uniformly loaded rectangular plates with simply supported and built-in edges, relation between slope and curvature of slightly bent plates, moment-curvature relations in pure bending, strain energy in pure bending.
Bending of circular plates: Symmetrical bending, differential equation of equilibrium, uniformly loaded plates at center, Circular plates with circular holes at the center.

Unit – II
Buckling of plates: Differential equation for bending of plate under the combined action of in-plane loading and lateral loading, calculation of critical loads, buckling of simply supported rectangular plates uniformly compressed in one and two directions with different edge conditions.

Unit – III
Small deflections of laterally loaded plates: Differential equation of equilibrium, boundary conditions, solution of simply supported rectangular plates under various loading conditions viz. uniformly distributed load (full or partial), concentrated load by Navier,,s approach, Levy type solution for rectangular plates under UDL with all four edges simply supported or two opposite edges simply supported and other two fixed.

Unit – IV
Approximate methods for rectangular plates: Finite difference method for simply supported or fixed rectangular plates carrying UDL (full or partial) or central point load, strain energy approaches, Rayleigh-Ritz method.

Unit –V
Bending of Orthotropic Plates: Differential equation of the bent plate. Application of the theory to simply supported rectangular (i) laminates; (ii) RC slabs (iii) grids.

Suggested Reading:

1	Timoshenko S P and Krieger S W. (2017). *Theory of Plates and Shells,* 2nd Edition, TATA McGraw-Hill, Chennai.
2	Chandrashekhara K. (2000). *Theory of Plates,* Universities Press, Hyderabad.
3	Ansel C Ugural. (2017). *Plates and Shells: Theory and Analysis,* 4th Edition, CRC Press, Boca Raton, Florida, USA.
4	Rudolph Szilard. (2004). *Theories and Applications of Plate Analysis,* Wiley, New Jersey, USA.
5	Bhaskar K and Varadan T K. (2021). *Plates: Theories and Applications,* Wiley, New Delhi.
6	Reddy J N. (2006). *Theory and Analysis of Elastic Plates and Shells,* 2nd Edition, CRC Press, Boca Raton, Florida, USA.

CE 120	ADVANCED CONCRETE TECHNOLOGY					
(PROGRAM ELECTIVE – IV)						
Pre-requisites	Concrete Technology		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Learn the microstructure and material science aspect of concrete.
2	Comprehend the long term and durability properties of concrete.
3	Design high strength and high performance concrete mix by standard guidelines.
4	Study the role of admixtures in concrete.
5	Identify the mix proportion and properties of special concrete

Course Outcomes :	
On completion of this course, the student will be able to do :	
CO-1	Assessment of the hydrated structure and microstructure of concrete.
CO-2	Acquire the knowledge of dimensional stability and durability properties of concrete.
CO-3	Design concrete mixes by various methods of mix design
CO-4	Familiarize with the types of admixtures added to concrete.
CO-5	Carryout the mix design and properties of special concretes.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	3	1	1		
CO-2	3	3	1	1		
CO-3	3	3	1			1
CO-4	3	3	1	1		
CO-5	3	3	1			1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit - I
Concrete as a composite material; advantages-limitations; Materials science aspects of the properties and behavior of Cement Concrete: physical and chemical aspects of cement hydration, type and morphology of hydrates; Structure of concrete-Transition zone-Micro structural engineering. Modern trends in concrete manufacture and placement techniques-methods of transportation-placing and curing-extreme whether concreting-special concreting methods-vaccum dewatering of concrete-under water concreting.

Unit - II
Strength of Hardened concrete-NDT; Stress-strain relations; Dimensional stability-shrinkage and creep; Durability of concrete -Durability concept- pore structure and transport processes- reinforcement corrosion-chloride attack-carbonation- fire resistance- frost damage- sulphate attack- alkali aggregate reaction- delayed ettringite formation- methods of providing durable concrete- short-term tests to assess long-term behavior.

Unit - III
Mix design of concrete –Quality control – Principles of concrete mix design-Various methods of mix design - IS code method - British and ACI methods-Mix design of special concrete- Design of high strength and high performance concrete-Design of pumpable concrete

Unit - IV
Mineral Admixtures – Hydration of Admixtures - Slags – Pozzolanas and Fillers – Dispersing admixtures-Retarding admixtures-Accelerating admixtures-Air entraining admixtures-Water resisting admixtures-Corrosion inhibiting admixtures-Shrinkage reducing admixtures-Under water admixtures-Sprayed concrete admixtures- Compatibility issues with Chemical Admixtures.
Topics to be taught by Industry Subject Expert :
Special materials used in the preparation of concrete-Challenges faced to achieve workability in the field-Field problems related to compaction of concrete-Current techniques of concrete placement in inaccessible locations

Unit - V
Special concrete- Fly ash concrete -Silica fume concrete -Fiber reinforced concrete- Sprayed concrete -Geopolymer concrete-Self compacting concrete- Roller compacted concrete- Ferro cement-Recycled aggregate concrete-Slurry Infiltrated Concrete-Mix design-properties and their applications; Engineered cementitious composites
Topics to be taught by Industry Subject Expert :
Application of admixture in the field-challenges faced-Remedial measures-Case studies related to Special concrete-challenges faced in the field-Remedial measures

Suggested Reading:

1	Neville. A.M.(1988), “Properties of Concrete”, English Language Book Society-Longman Publications.
2	Neville A.M. & Brooks J.J.(2010), “Concrete Technology”, Pearson Education Limited.
3	Mehta P.K. and Paulo J.M.M.(1997), “Concrete – Microstructure – Properties and Material”, McGraw-Hill, New York .
4	Zongji Li(2011) “Advanced Concrete Technology”, John Wiley & sons, inc.
5	John Newman, Ban Seng Choo(2003), “Advanced Concrete Technology”, Elsevier publisher.
6	Thomas Dyer(2014), “ Concrete Durability”, CRC Press, Taylor & Francis group.
7	Krishna Raju,N (1985), “Design of Concrete Mix”, CBS Publications, New Delhi
8	IS 10262-2019- Guidelines for Concrete Mix Design Proportioning

CE 121	TALL BUILDINGS					
(PROGRAM ELECTIVE – IV)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand the impact of wind and earthquake load on tall buildings
2	Learn the analysis of tall buildings for wind and earthquake loads
3	Study the base isolation techniques for tall buildings
4	Learn the analysis of slab column frames

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the effect of wind and earthquake load on the response of tall buildings
CO-2	Calculate the wind load and design the tall buildings for wind loads.
CO-3	Design the tall buildings for earthquake loads using quasi-static and dynamic analysis
CO-4	Suggest base isolation techniques for tall buildings
CO-5	Design and detail the slab column frames

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	1	1	3	-	-
CO-2	3	1	1	3	-	-
CO-3	3	1	1	3	-	-
CO-4	3	1	1	3	-	-
CO-5	3	1	1	3	-	-

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit – I
Introduction: Brief review of matrix methods, loads due to wind and earthquake, structure, structural elements. Tall buildings, codes, methods, of analysis, structural dynamics. Statistical methods.

Unit – II
Wind: Introduction to wind, characteristic of wind, effect of wind, impact on structures, wind pressure, internal and external wind, aerodynamic forces, natural frequencies, vibration and its types. National standards, maximum design loads for buildings and other structures. Calculation of wind loads, special winds, gust, wind speed data and importance. Wind resistant design. Formulation of equation.

Unit – III
Earthquake: Introduction to earthquake, characteristic, impact of earthquake on ground, foundations and structural elements, ground motion, quasi-static approach, dynamic analysis, structural systems, performance criteria, structural resisting units, frames, shear walls, coupled shear walls, isolation techniques for earthquakes resistance, foundation design criteria.

Unit – IV
Tall buildings: Definition, Structural systems, influence of design criteria, response of buildings to lateral forces, analysis of tall buildings, frames, shear walls, interaction of shear walls and frames.
Topics to be taught by Industry Subject Expert :
Case studies on tall building.

Unit – V
Analysis of slab column frames; effect of slab width for flat plate - column frames. Stiffness of slab column structures. Moment transfer and its impact on punching shear - Creep and shrinkage in columns, tube, tube in tube and bundled tube. Designing and detailing, construction methods, choice of materials, foundation design and consideration, resistance to overturning, design techniques, codes and standard charts.
Topics to be taught by Industry Subject Expert :
Case studies on tall building foundations.

Suggested Reading:

1	Wind Effects on Structures": An Introduction to Wind Engineering, E. Simlu, Wile and Sons, 1978.
2	"Hand Book of Concrete Engineering", M. Fintel, Von Nostrand 1974.
3	"Design of Earthquake Resistant Structures", Emilio Rosenblueth, Pentech Press Ltd., 1990.

CE 122	STRUCTURAL FIRE ENGINEERING					
(PROGRAM ELECTIVE – II)						
Pre-requisites	-		L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	Understand the impact of fire hazard and the need for fire safety measures
2	Learn the growth of a fire and its severity in a compartment
3	Study the fire resistance evaluation of structural and non-structural members through testing
4	Learn the analysis and design of steel structural members for fire resistance using prescriptive and rational approaches
5	Study the analysis and design of reinforced concrete structural members for fire resistance using prescriptive and rational approaches

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Suggest strategies to mitigate fire hazard and measures for fire safety in buildings
CO-2	Assess the growth of a fire and estimate its severity
CO-3	Determine the fire resistance of structural and non-structural members using test methods
CO-4	Design of steel structural members for fire resistance using prescriptive and rational approaches
CO-5	Design of reinforced concrete members for fire resistance using prescriptive and rational approaches

Course outcome	Program Outcome					
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	2	1	1	-	-
CO-2	3	2	1	1	-	-
CO-3	3	2	1	1	-	-
CO-4	3	2	1	1	-	-
CO-5	3	2	1	1	-	-

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

Unit - I
Fire hazard in built infrastructure: Overview of fire hazard, fire statistics, recent fire incidents, strategies to overcome fire hazard**.**
Fire safety in buildings: Fire scenarios in buildings, need for fire safety measures, active and passive fire protection systems, codes and standards, limitations of codes and standards.

Unit - II
Fire growth and fire severity: Heat transfer mechanisms, fire development in a compartment, fire calculations: pre-flashover, flashover and post-flashover; time-temperature relations, need for fire severity and estimation of equivalent fire severity.
Material properties at elevated temperature: Thermal and mechanical properties of concrete, steel and insulation.

Unit - III
Fire resistance evaluation: Test methods: overview of fire tests, standard fire resistance test and its limitations, resistance evaluation under non-standard fire conditions, fire resistance of non-structural members, Calculation methods: Prescriptive and rational engineering approaches.

Unit - IV
Steel structures: Behaviour of steel structures under fire exposure, strategies for achieving required fire resistance, prescriptive and rational approaches for evaluation fire resistance of beams, columns and slabs.

Unit - V
Reinforced Concrete structures: Behaviour of reinforced concrete structures under fire exposure, strategies for achieving required fire resistance, prescriptive and rational approaches for evaluation fire resistance of beams, columns and slabs.

Suggested Reading:

1	Venkatesh Kodur and Mohannad Naser. (2020). *Structural Fire Engineering,* 1st Edition, McGraw-Hill, New York, USA.
2	Andrew H Buchanan and Anthony K Abu. (2017). *Structural Design for Fire Safety,* 2nd Edition, Wiley, Chichester, England.
3	John A Purkiss and Long-yuan Li. (2017). *Fire Safety Engineering Design of Structures,* 3rd Edition, CRC Press, Boca Raton, Florida, USA.
4	Jean-Marc Franssen et al. (2009). *Designing Steel Structures for Fire Safety,* 1st Edition, CRC Press, Boca Raton, Florida, USA.
5	Jain V K. (2020). *Fire Safety in Buildings,* New Age International, New Delhi.
6	Yong Wang et al. (2013). *Performance-Based Fire Engineering of Structures,* 1st Edition, CRC Press, Boca Raton, Florida, USA.

CE 123	**EARTHQUAKE RESISTANT DESIGN OF BUILDINGS**					
Pre-requisites	Structural Analysis, Structural Dynamics		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objective of enabling the student to	
1	Learn the causes of earthquake and the effects of ground motion / structural irregularities on a RC Building.
2	Understand the various structural systems to resist the lateral loads of a RC building
3	Understand the concepts of ductile detailing of reinforced concrete building as per IS 4326 and IS 13920.
4	Learn the seismic analysis of masonry buildings.

Course Outcomes : (5)	
On completion of this course, the student will be able to :	
CO-1	Understand the causes of earthquake and effects of ground motion / structural irregularities on RC building.
CO-2	Know the design aspects of various lateral load resisting systems in a RC Building .
CO-3	Analyse the RC building to resist earthquake forces by different methods.
CO-4	Design the various structural elements resisting earthquake forces as per IS Codes.
CO-5	Analyse and design of masonry buildings as per codal provisions.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	2	2	3	1	1
CO-2	3	2	2	3	1	1
CO-3	3	2	2	3	1	1
CO-4	3	2	2	3	1	1
CO-5	3	2	2	3	1	1

Unit - I
Earthquake Ground Motion: Engineering seismology, Seismic zoning map of India, Strong motion characteristics, Strong motion studies in India.
Concepts of Earthquake Resistant Design of RCC building, Identification of seismicdamages in RCC buildings, Effect of structural irregularities on performance of RCC buildings during earthquakes.

Unit - II
Structural System of Seismic Design – Requirements of efficient Earthquake Resistance Structural Systems. Infill walls, Shearwall – Analysis and design based on IS 13920, Base Isolators, and Dampers. Bracing, Outtrigger and Tube in Tube

Unit - III
Seismic Analysis of RCC Building: Code based procedure for determination of design lateral loads, Seismic analysis procedure as per IS 1893 code, Equivalent static force method, Response spectrum method, Time history analysis, Effect of Soil Structure Interaction.

Unit - IV
Earthquake Resistant Design of RCC Building : Introduction, General principles, factors, specification of materials, Load combinations, Ductility considerations as per IS 13920, Earthquake resistant design of multi-storey RCC buildings, Capacity based design.
Topics to be taught by Industry Subject Expert :
Case study on the seismic analysis and ductile detailing of RCC multistoried **Building** with various lateral load resisting system and practical aspects during its construction.

Unit - V
Earthquake Resistant Design of Masonry Building: Identification of damages and non-damages in masonry buildings, Elastic properties of structural masonry, Lateral load analysis of masonry buildings, Seismic analysis and design of one-storey masonry buildings.
Topics to be taught by Industry Subject Expert :
Case study on the seismic analysis and design of masonry building and practical aspects during its construction

Suggested Reading:

1	Duggal, S.K. (2013). Earthquake Resistant Design of Structures, 2nd Ed, Oxford University Press, New Delhi.
2	Brebbia,C.A. (2011). Earthquake Resistant Engineering Structures, WIT Press, New York.
3	Mohiuddin Ali Khan, (2012). Earthquake Resistant Structures: Design, Build and Retrofit, Elsevier Science & Technology.
4	Pankaj Agarwal and Manish Shrikhande, (2009). Earthquake Resistant Design of Structures, Prentice Hall of India, New Delhi.
5	Chopra, A.K.(2007), Dynamics of Structures: Theory and Applications to Earthquake Engineering. 3rd ed, Pearson Education publishing.
6	Dowrick, D.J. (2004)., Earthquake Resistant Design, John Wiley & Sons, Chichester, U.K.
7	Clough, R.W. and Penzien, J. (2003), Dynamics of Structures, Second edition, McGraw-Hill International edition.

Code format	
1	IS 1893-2016, Indian Standard Criteria for Earthquake Resistant Design of Structures (5th Revision),Bureau of Indian Standards, New Delhi, 2002.
2	IS 13920, 1993, Indian Standard Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces, Bureau of Indian Standards, New Delhi
3	IS 4326, 1993, Indian Standard Code of Practice for Earthquake Resistant Design and Construction of Buildings (2nd Revision)

4	IS-456 2000, Plain and Reinforced Concrete-Code of Practice, Bureau of Indian Standards, New Delhi.
5	IS 1905 (1987): Code of Practice for Structural use of Unreinforced Masonry [CED 13: Building Construction Practices including Painting, Varnishing and Allied Finishing]
6	IS 13828-1993, Indian Standard Guidelines for Improving Earthquake Resistance of Low Strength Masonry Buildings, Bureau of Indian Standards, New Delhi.

CE 124	BRIDGE ENGINEERING					
(PROGRAM ELECTIVE – V)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Learn the high strength materials, IRC loads, planning and lay out of bridges,hydraulic, geological and geo-technical aspects in bridge design.
2	Analyse, design and detail the bridge deck slabs and box girder systems,
3	Learn steel and composite bridges.
4	Analyse and design the sub-structures and super structures, bearings, joints and retaining walls.
5	Learn the various long span bridges.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the fundamentals, materials and IRC codes of practice of bridge design.
CO-2	Design the bridge deck slabs and box girder systems using appropriate method.
CO-3	Design the steel and composite steel-concrete bridges
CO-4	Propose the sub-structure components such as pier, abutments, retaining walls etc. joints and bridge bearings
CO-5	Design the various types of long span bridges, curved and skew bridges

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	3	2	2	1	3
CO-2	3	3	2	2	2	3
CO-3	3	3	2	2	2	3
CO-4	3	3	2	2	1	3
CO-5	3	3	2	2	2	3

Unit – I
Types of bridges, materials of construction, codes of practice (Railway and Highway Bridges), aesthetics, loading standards (IRC, RDSO, AASHTO), recent developments box girder bridges historical bridges (in India and overseas).
Planning and layout of bridges, hydraulic design, geological and geo-technical considerations; Design aids, computer software, expert systems.

Unit – II
Concrete Bridges: Bridge deck and approach slabs, Slab design methods, design of bridge

deck systems, slab-beam systems (Guyon-Massonet and Hendry Jaeger Methods), box girder systems, analysis and design. Detailing of box girder systems.

Unit – III
Steel and Composite Bridges: Introduction to composite bridges, Advantages and disadvantages, Orthotropic decks, box girders, composite steel-concrete bridges, analysis and design, truss bridges.

Unit – IV
Sub-Structure: Piers, columns and towers, analysis and design, shallow and deep foundations, caissons,abutments and retaining walls.
Bridge appurtenances: Expansion joints, design of joints, types and functions of bearings, design of elastomeric bearings, railings, drainage system, lighting.
Topics to be taught by Industry Subject Expert :
Current design practices in Bridge foundations, piers, bridge decks, abutments. Case studies on Industrial area bridges.

Unit – V
Long span bridges: Design principles of continuous box girders, curved and skew bridges, cable stayed and suspension bridges, seismic resistant design, seismic isolation and damping devices. Construction techniques (cast in-situ, prefabricated, incremental launching, free cantilever construction), inspection, maintenance and rehabilitation, current design and construction practices.
Topics to be taught by Industry Subject Expert :
Heavy loading with bridge bearings, joints, corbels, pile caps. Case studies on live constructions, pre cast- post tensioned slab girders. Design techniques for box girder systems. Case studies on cable stayed and suspension bridges.

Suggested Reading:

1	"Bridge Engineering Handbook", Wai-Fah Chen Lian Duan, CRC Press, USA, 2000.
2	"Design of Highway Bridges", Barker, P.M. and Puckett, J.A., John Wiley & Sons, New York, 1997.
3	"Theory and Design of Bridges", Xanthakos, P.P., John Wiley & Sons, New York, 1994.
4	Essentials of Bridge Engineering by D. John Victor 2006.
5	Design of Bridge Structures by T.R.Jagadeesh and M.A.Jayaram 2004 .

CE 125	THEORY OF SHELLS AND FOLDED PLATES					
	(PROGRAM ELECTIVE – IV)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Learn the analysis and design of cylindrical shells, short and long shells.
2	Study the concepts of bending theory using D.K.J. equations and Schorer theory.
3	Understand the beam theory and beam arch analysis.
4	Gain knowledge of the analysis and design of different shells of double curvature and axi-symmetrical shells by membrane theory.
5	Analyse different types of folded plates using Simpson‟s and Whitney‟s methods.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Analyse the cylindrical shells using membrane theory.
CO-2	Analyse the shells using bending theory.
CO-3	Evaluate and design the different shells using beam theory.
CO-4	Analyse the shells of double curvature using membrane theory
CO-5	Analyse the folded plates using Simpson and Whitney methods

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	1	1	1	1	1
CO-2	3	1	1	1	1	1
CO-3	3	-	1	1	-	-
CO-4	3	1	1	1	1	1
CO-5	3	1	1	1	1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit – I
Introduction: Definition and classification of shells.
Cylindrical shells: Membrane theory – Equilibrium equations for differential shell elements – Calculation of stresses and displacement due to dead loads and snow loads for circular cylindrical shell.

Unit - II

Bending theory: Necessicity of bending theory - (i) D.K.J theory - Assumption – Equilibrium equations for a differential element – Stress strain relations – Moment-curvature relations – Derivation of D.K.J. differential and characteristics equations – Roots of the characteristic equation – Expression for deflection - (ii) Schorer theory – Assumptions – Equilibrium equations for a differential shell element – Stress-strain relations – Moment-curvature relations – Derivation of Schorer differential and characteristic equation – Roots of the characteristic equation – Expression of deflection.

Unit – III
Beam theory: Assumptions and range of their validity – Outline of the beam arch analysis – Advantages of beams theory over other theories.

Unit – IV
Shells of doubles curvature: Membrane theory of shells of revolution - Equilibrium equations for a differential shell element – Calculation of stresses in a spherical dome due to uniform load over the surface and due to concentrated load around a skylight opening - Shells of translation - Equilibrium equations for a differential shell element – Pucher‟s stress function - Derivation of a differential equation from equations of equilibrium using Pucher„s stress function - Calculation of stresses in hyperbolic paraboloids with straight edges under uniform load over the surface.

Unit – V
Folded plates: Assumptions – Structural behavior – Resolutions of ridge loads – Edge shears – Stress distribution – Plate deflections and rotations. Effect of joint moments – Analysis of V shaped folded plates using (i) Simpson and (ii) Whitney methods.

1	S. Timoshenko and W. Krienger, “Theory of Plates and Shells”, McGraw-Hill, London, 1959
2	G.S. Ramaswamy, “Design and Construction of Concrete Shell Roofs”, CBS Publications, New Delhi, 1986.
3	J. Ramchandran, “Thin Shells Theory and Problems”, Universities Press, Hyderabad, 1993.

Open Elective

OE 941 CE	**GREEN BUILDING TECHNOLOGY**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Exposure to the green building technologies and their significance.
2	Understand the judicial use of energy and its management.
3	Educate about the Sun-earth relationship and its effect on climate.
4	Enhance awareness of end-use energy requirements in the society.
5	Develop suitable technologies for energy management

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the fundamentals of energy use and energy processes in building.
CO-2	Identify the energy requirement and its management.
CO-3	Know the Sun-earth relationship vis-a-vis its effect on climate.
CO-4	Be acquainted with the end-use energy requirements.
CO-5	Be familiar with the audit procedures of energy

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	1	1	1	1		
CO-2		1	1	1		
CO-3	2	1	1	1		
CO-4	1	1	1			
CO-5		1				

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit – I
Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

Unit – II
Indoor environmental requirement and management - Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement.

Unit – III
Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

Unit – IV
End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non-steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer.

Unit – V
Energy management options - Energy audit and energy targeting - Technological options for energy management.

Suggested Reading:

1	Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.
2	Carter, W. Nick, (1991): Disaster Management, Asian Development Bank, Manila.
3	Sahni, Pardeep et.al. (eds.) (2002), Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.
4	Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.

OE 942 CE	COST MANAGEMENT OF ENGINEERING PROJECTS					
(OPEN ELECTIVE)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduce the concepts of cost management
2	Fundamentals of cost overruns
3	Introduce the concepts of Quantitative techniques for cost management Linear Programming, PERT/CPM.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understanding of strategic cost management process, control of cost and decision making based on the cost of the project.
CO-2	Ability to appreciative detailed engineering activities of the project and execution of projects
CO-3	Preparation of project report and network diagram
CO-4	Able to plan Cost Behavior , Profit Planning , Enterprise Resource Planning, Total Quality Management.
CO-5	Applications of various quantitative techniques for cost management

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	-	-		1		
CO-2	1	1	1	1	-	
CO-3	-	-	1	1	3	1
CO-4	1	1	1	1	-	
CO-5	1	1	1			

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

Unit – II
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning- Project execution as conglomeration of technical and non-technical activities- Detailed Engineering activities.

Unit – III
Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

Unit – IV
Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems- Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector- Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints- Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets- Performance budgets- Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Unit – V
Quantitative techniques for cost management, Linear Programming, PERT/CPM,- Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Suggested Reading:

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

OE 941 ME	OPERATION RESEARCH					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduce the concepts of optimization techniques
2	Formulation of LPP models
3	Basic concepts of Non-linear programming, Dynamic programming, Game theory are introduced.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
CO-2	Students should able to apply the concept of non-linear programming
CO-3	Students should able to carry out sensitivity analysis
CO-4	Student should able to model the real world problem and simulate it.
CO-5	Student should able to apply graph theory, competitive models, and game theory simulations.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	2	2	2	2		
CO-2	2	2	2	1		
CO-3	2	2	2	1		
CO-4	2	2	2	1		
CO-5	2	2	2	1		

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

Unit – II
Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming.

Unit – III
Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.

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

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

Suggested Reading:

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

OE 942 ME	COMPOSITE MATERIALS					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Study the concepts of composite construction.
2	Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes of practice.
3	Apply the concepts for design of multi-storey composite buildings.
4	Scope of analysis is restricted to skeletal structures subjected to prescribed dynamic loads.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the fundamentals of composite construction, and analysis and designs of composite beams.
CO-2	Analyse and design the composite floors
CO-3	Select suitable materials for composite columns,
CO-4	Analyse composite trusses and understand connection details.
CO-5	Analyse and design the multi-storey composite buildings

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	-	-	-	-	-	
CO-2	-	-	-	-	-	1
CO-3	-	1	-	-	-	
CO-4	-	-	-	-	-	
CO-5	-		-	-	-	

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit – I
Introduction of composite constructions: Benefits of composite construction - Introduction to IS - BS and Euro codal provisions. Composite beams: Elastic behaviour of composite beams - No and full interaction cases - Shear connectors - Ultimate load behaviour - Serviceability limits - Effective breadth of flange - Interaction between shear and moment - Basic design consideration and design of composite beams.

Unit – II
Composite floors: Structural elements - Profiled sheet decking - Bending resistance - Shear resistance - Serviceability criterion - Analysis for internal forces and moments - Design of composite floors.

Unit – III
Composite columns: Materials - Concrete filled circular tubular sections - Non-dimensional slenderness - Local buckling of steel sections - Effective elastic flexural stiffness - Resistance of members to axial compressions - Composite column design - Fire resistance.

Unit – IV
Composite trusses: Design of truss - Configuration - Truss members - Analysis and design of composite trusses and connection details.

Unit – V
Design of multi-storey composite buildings: Design basis - Load calculations - Design of composite slabs with profile decks - Composite beam design - Design for compression members - Vertical cross bracings - Design of foundation.

Suggested Reading:

1	P. Johnson, "Composite Structures of Steel and Concrete - Beams, Slabs, Columns and Frames in Buildings", Blackwell Publishing, Malden, USA, 2004.
2	NSDAG Teaching Resources for Structural Steel Design", Vol-2, Institute for Steel Development and Growth Publishers, Calcutta, India.
3	NSDAG Handbook on Composite Construction – Multi-Storey Buildings", Institute for Steel Development and Growth Publishers, Calcutta, India.
4	NSDAG Design of Composite Truss for Building", Institute for Steel Development and Growth Publishers, Calcutta, India.
5	NSDAG Handbook on Composite Construction – Bridges and Flyovers", Institute for Steel Development and Growth Publishers, Calcutta, India.
6	11384-1985, "Code of Practice for Composite Construction in Structural Steel and Concrete", Bureau of Indian Standards, New Delhi, 1985.

OE 943 ME	INDUSTRIAL SAFETY					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student 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 be taken
4	The basic concepts and importance of fault tracing.
5	The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identify the causes for industrial accidents and suggest preventive measures.
CO-2	Identify the basic tools and requirements of different maintenance procedures.
CO-3	Apply different techniques to reduce and prevent Wear and corrosion in Industry.
CO-4	Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.
CO-5	Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	1	-	1			
CO-2	-	1	1	1		
CO-3	1	1	-	1		
CO-4		1	1	1		
CO-5	1	1	1	1		

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

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

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

Unit – III

Wear and Corrosion and their Prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications 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.

Suggested Reading:

1	H. P. Garg, "Maintenance Engineering", S. Chand and Company
2	dels, "Pump-hydraulic Compressors", Mcgraw Hill Publication
3	Higgins & Morrow, "Maintenance Engineering Handbook", Da Information Services.
4	Winterkorn, Hans, "Foundation Engineering Handbook", Chapman & Hall London

OE 941 CS	BUSINESS ANALYTICS					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student 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 :	
On completion of this course, the student will be able to :	
CO-1	To understand the basic concepts of business analytics
CO-2	Identify the application of business analytics and use tools to analyze business data
CO-3	Become familiar with various metrics, measures used in business analytics
CO-4	Illustrate various descriptive, predictive and prescriptive methods and techniques
CO-5	Model the business data using various business analytical methods and techniques

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	1	1	1	1		
CO-2	-	1	1	1		
CO-3	1	1	1	1		
CO-4	1	1	1			
CO-5		1	1			

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

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 DD decision making and future.

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

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

Unit – IV
Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble 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.

Suggested Reading:

1	U Dinesh Kumar, "Data 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
3	S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 5th Edition, Cengage, 2015

Web Resources:

1	https://onlinecourses.nptel.ac.in/noc18-mg11/preview
2	https://nptel.ac.in/courses/110105089/

OE 941 EE	WASTE TO ENERGY					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student 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 :	
On completion of this course, the student will be able to :	
CO-1	Understand the concept of conservation of waste
CO-2	Identify the different forms of wastage.
CO-3	Chose the best way for conservation to produce energy from waste.
CO-4	Explore the ways and means of combustion of biomass.
CO-5	Develop a healthy environment for the mankind.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	1	1	1	1	-	
CO-2	1	1	1		-	
CO-3	1	1	1	2		
CO-4	-	-				
CO-5	-	2	1	-		

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

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 - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Reading:

1	on Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2	ogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3	od, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4	omass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

OE 941LA	INTELLECTUAL PROPERTY RIGHTS					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Acquaint the students with basics of intellectual property rights with special reference to Indian Laws and its practices.
2	Compare and contrast the different forms of intellectual property protection in terms of their key differences and similarities.
3	Provide an overview of the statutory, procedural, and case law underlining these processes and their interplay with litigation.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the concept of intellectual property rights.
CO-2	Develop proficiency in trademarks and acquisition of trade mark rights.
CO-3	Understand the skill of acquiring the copy rights, ownership rights and transfer.
CO-4	Able to protect trade secrets, liability for misappropriations of trade secrets.
CO-5	Apply the patents and demonstration of case studies.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	-	-	-	-	-	-
CO-2		1		1	1	
CO-3		1		1	1	
CO-4					1	2
CO-5					1	

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit – I
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit – II
Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

Unit – III
Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer**.**

Unit – IV
Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation. Unfair competition: Misappropriation right of publicity, false advertising.

Unit – V
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Suggested Reading:

1	lbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
2	Iayall, “Industrial Design”, McGraw Hill,1992
3	iebel, “Product Design”, McGraw Hill,1974.
4	simov, “Introduction to Design”, Prentice Hall,1962.
5	obert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”,2016.
6	Ramappa, “Intellectual Property Rights Under WTO”, S. Chand,2008

CE 152	**STRUCTURAL DYNAMICS LABORATORY**					
Pre-requisites	Advanced Structural Analysis		**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**		25 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To study behavior of SDOF system under different vibration modes
2	To study dynamic behavior of beams
3	To understand Mechanical vibration

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	To visualize mode shapes for different types of vibrations
CO-2	Visualize damage patterns in structures due to dynamic load
CO-3	to able to measure the amplitude and frequency of SHM
CO-4	draw response spectrum curve for given condition
CO-5	to determine absorbing capacity of dampers

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	2	-	1	2	1	-
CO-2	2	-	1	2	1	-
CO-3	2	-	1	2	1	-
CO-4	2	-	1	2	1	-
CO-5	2	-	1	2	1	-

LIST OF EXPERIMENTS

Experiment 1.1 Modal of Simply Supported Beam

Experiment 1.2 Natural Frequency & Modal of Cantilever

BeamExperiment 1.3 Natural Frequency and Modalo Disc

Experiment 2.1 Material‟s Elastic Modulus

Experiment 2.2 Determination of damping ratio (half-power band width method)

Experiment 2.3 Determination of damping ratio(Attenuation method)

Experiment 2.4 Strain Measurement (Need Strain Gauge)

Experiment 3.1 Signal Processing and Spectrum Analysis(Software Only)

Experiment 3.2 Superimposition Of Signals(Software Only)

Experiment 4.1 Understanding of mechanical vibration

Experiment 4.2 Measurement of Amplitude and Frequency of Simple Harmonic Motion

Experiment 4.4 Measurement of the Natural Frequency of Simply Supported Beam (Method of Sweep Sine Wave)

Experiment 4.5 Measurement of Natural Frequency of Cantilever Beam (Method ofSweep Sine Wave)

Experiment 4.6 Active Vibration Isolation

Experiment 4.7 Passive Vibration Isolation

Experiment 4.8 Vibration with Single Absorber

Experiment 4.9 Vibration with Double Absorber

Experiment 4.10 Vibration with Oil Damper Resources

Experiment 4.11Write a MATLAB script for plotting (a) the non-dimensional response magnitude for a system with harmonically moving base
(b) the response phase angle for system with harmonically moving base.

Experiment 4.12 Plot the response of the system using MATLAB for ωn = 5rad/s, ζ = 0.05, 0.1, 0.2 subjected to the initial conditions x(0) = 0, x(0) = v0 = 60 cm/s.

Software/online resources: 1. Software for simulation of Photoelastic effects: https://home.iitm.ac.in/kramesh/p_scope.html

2. Virtual labs: Vibrations (SDOF): http://sd-iith.vlabs.ac.in/List%20of%20experiments.html

http://mdmv-nitk.vlabs.ac.in/#

Suggested Reading:

1	Beijing Wavespectrum Science and Technology Co., Ltd
2	www.sensor.in

CE 153	**ADVANCED CONCRETE TECHNOLOGY LABORATORY**					
Pre-requisites	Concrete Technology Lab		**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**		25 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To study the concrete mix design of High strength concrete and investigate various mix proportions.
2	Learn to determine various properties of HYSD bars.
3	Carry out Strength tests and Nondestructive tests on concrete.
4	Understand structural behaviour of RC beams.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Design the mix proportion for High strength concrete.
CO-2	Evaluate the mechanical properties of High strength concrete and correlate its various properties.
CO-3	Evaluate the properties of HYSD bars and understand the effect of cyclic loading on steel.
CO-4	Perform Nondestructive tests on concrete structures
CO-5	Accesses the behaviour of beams under flexural and shear.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	3	3	3	2	1
CO-2	3	3	3	3	2	1
CO-3	3	3	3	3	2	1
CO-4	3	3	3	3	2	1
CO-5	3	3	3	3	2	1

LIST OF EXPERIMENTS

1. To investigate the basic properties of ingredients used in proportioning of concrete.
2. To design the mix and determine fresh properties for High Strength Concrete.
3. Study of stress-strain curve of high strength concrete, correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture.
4. To carry out tests on HYSD bars and study the effect of cyclic loading on steel.
5. Non Destructive tests on existing concrete structures.
6. To investigate the structural behaviour of RC beams and measure strains.

CE 171	**MINI PROJECT**					
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	4	2
Evaluation	**SEE**	-	**CIE**	50 Marks		

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	*To review available literature and formulate structural engineering problems*
2	*To learn the technique of writing reports and prepare presentation*

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	*Identify structural engineering problems reviewing available literature*
CO-2	*Study different techniques used to analyse complex structural systems.*
CO-3	*Able to work on the solutions given problem*
CO-4	*Present solution by using his/her technique applying engineering principles.*
CO-5	*Prepare technical report and presentation*

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	1	1	1	2		-
CO-2	1	1	2	2	2	-
CO-3	1	2	-	2	1	-
CO-4	-	1	-	-	3	2
CO-5	2	1	-	2	1	2

Syllabus Contents:

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

End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals‟ contribution. Continuous assessment of Mini Project at Mid Sem and End Sem will be monitored by the departmental committee

SEMESTER-III

AUDIT I

AC030	**ENGINEERING RESEARCH METHODOLOGY**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduce the conceptual and philosophical foundation of research methodology for Scientific and Engineering Research
2	Provide an understanding of the importance of literature review and formulating of a good research problem.
3	Offer procedural instruction on how to plan, design & conduct research projects and interpret the data
Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Demonstrate the knowledge of research processes (reading, evaluating, and developing) and formulate a research problem
CO-2	Perform literature reviews, present research ideas, plan research projects, and to explain the rationale for research ethics
CO-3	Understand the importance of innovation & patenting and will be aware of rules and regulations about Intellectual Property Rights
CO-4	Select appropriate sampling methods for qualitative and quantitative data collection and processing
CO-5	Applications of various statistical methods for proper characterization, stigmatization, presentation and interpretation of the result of research, to test the Hypothesis by using SPSS software and other similar softwares

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	-	-		-	1	1
CO-2	-	-	1	-	1	
CO-3	-	-	1	-	1	1
CO-4	-	-	2	-	2	2
CO-5	-	-	1	-	2	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

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

UNIT - II
Effective literature studies approaches, analysis Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee. Preparation of thesis

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

UNIT - IV
Data collection and measurement Methods in Civil Engineering: Primary data through:- communication, Designing Questionnaire, Qualitative Research sampling and sampling designs Attitude measurement and scales Data presentation and analysis: Data processing, Univariate and Bivariate analysis, Correlational analysis
Topics to be taught by Industry Subject Expert :

UNIT - V
Measure of central tendency, Measure of central dispersion, Measure of skewness, Measure of kurtosis, parametric and statistic sampling and non-sampling errors, standard error and central limit theorem, sampling distribution, degree of freedom, hypothesis of testing, test statistics and critical region, procedure for hypothesis testing for mean and variance. Introduction to linear regression model and multi-linear regression models, mathematical basis and introduction to SPSS.
Topics to be taught by Industry Subject Expert :

Suggested Reading:

1	Stuart Melville and Wayne Goddard, "*Research methodology: an introduction for science & Engineering students*", 2008
2	Ranjit Kumar, 2nd Edition, "*Research Methodology: A Step by Step Guide for beginners" 2009.*
3	Halbert, "*Resisting Intellectual Property*", Taylor & Francis Ltd , 2007.
4	Mayall, "*Industrial Design",* McGraw Hill, 1992.
5	T. Ramappa, "*Intellectual Property Rights Under WTO*", S. Chand, 2008
6	R. Kothari. *"Research Methodology - Methods and Techniques",* 2nd Edition, New

AUDIT-II

AC 032	**DISASTER MITIGATION AND MANAGEMENT**					
	(AUDIT COURSE - I)					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction of various types of disasters and its effect on structures.
2	Learning of quality assurance and damage assessment of structures
3	Educate different types of repair, strengthening, rehabilitation and retrofitting techniques.
4	Awareness about flood characteristics and flood forecasting systems
5	Description of Flood mitigation, adjustment, and regulation

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the fundamentals of disaster and seismic performance of buildings
CO-2	Able to assess various damages in structures and give assurance of quality of concrete
CO-3	Decide the appropriate repair, strengthening, rehabilitation and technique required for a case study of building.
CO-4	Applications of flood routing, flood forecasting and space time characteristics of rainfall.
CO-5	Advanced understanding of flood plain adjustments and employment of appropriate technologies for flood mitigation.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	2	1	1	1	1	1
CO-2	2	2	2	2	1	1
CO-3	2	2	1	1	1	1
CO-4	2	2	1	1	1	0
CO-5	2	2	1	1	1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit – I
Disaster: Classifications - Causes - Impacts including social, economical, political, environmental, health, psychosocial, etc.
Seismic performance of buildings: case studies of major earthquakes in the country, damage to buildings, damage patterns, performance of non-engineered buildings-Introduction to repair and rehabilitation of structures.

Unit – II
Quality assurance for concrete – Strength, Durability and Thermal properties of concrete. Damage Assessment**:** - Condition assessment and distress, Purpose of assessment, Rapid assessment - diagnostic techniques, Investigation of damage, ,

Evaluation of surface and structural cracks, Damage assessment procedure, destructive, non-destructive and semi destructive testing systems, Procedure for evaluating damaged of structure.

Unit – III
Repair, Rehabilitation And Retrofitting Techniques : Repair materials, Common types of repairs – Repair in concrete structures – Repairs in under water structures – Guniting – Shot create –Underpinning, Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, Leakage, earthquake, Retrofitting techniques

Unit – IV
Introduction to Disasters: Hazard, Vulnerability, Resilience, Risks.-Disaster- Different types of cold wave-heat wave- droughts- floods-Effect of climate change on Processes.
Flood characteristics and forecasting: Measureable features of a flood (Elevation, discharge, volume, and duration), flood forecasting (unit hydrograph method, meteorological and snow data, and snow field air temperatures), operation of flood forecasting systems.
Space-time characteristics of rainfall: Policy criteria for design flood of a major and minor reservoir, spillways, diversion dams and barrages, design flood criteria for dams and other hydraulic structures (CWC recommendations).

Unit – V
Flood Routing: Mathematics of flood routing, various methods of flood routing, Hydrologic and Hydraulic routing.
Flood mitigation: flood ways, channel improvement, evacuation and flood proofing, land management, flood plain management, estimating benefits of flood mitigation.
Flood plain adjustments and regulations: Results of controlling floods, alternatives to controlling floods, range of possible adjustments, practical range of choice, critical characteristics of flood hazards.

Suggested Reading:

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	“Pankaj Agarwal and Manish Shrihkande (2006). “Earthquake Resistance Design of Structures.” Prentice Hall of India.
5	“Ravishankar.K., Krishnamoorthy.T.S, "Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures", Allied Publishers, 2004. New Technological Age”,2016.
6	CPWD and Indian Buildings Congress, Hand book on Seismic Retrofit of Buildings, Narosa Publishers, 2008.
7	Chow, Ven Te ‘Hand Book of Applied Hydrology’, McGraw-Hill Publishers, New York. (1964),
8	Linsley, R. K. and Franzini A. W. ‘Water Resource Engineering’, McGraw-Hill Publishers, New York. 1992
9	Varshney, R. S. , ‘Engineering Hydrology’, Nem Chand Publishers, Roorkee.1979
10	Jaya Rami Reddy, P. , ‘A. Text Book of Hydrology’, Lakshmi Publishers, New Delhi.1987
11	Daniel H. Hoggan ‘Computer Assisted Flood Plain Hydrology and Hydraulics’, McGraw-Hill Publishers, New York.1989

AC 031	ENGLISH FOR RESEARCH PAPER WRITING					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand that how to improve your writing skills and level of readability
2	Learn about what to write in each section
3	Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission
4	

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Able to plan and prepare paragraphs
CO-2	Writing of abstracts
CO-3	Providing of critical and thorough review of literature
CO-4	Able to exhibit key skills for writing titles
CO-5	Able to show key and necessary skills for paper writing

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	-	-	-	-		1
CO-2	-	-	1	-		
CO-3	-	-	1	-	1	1
CO-4	-	-	2	-	3	2
CO-5	-	-	2	-	2	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit - I
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

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

Unit - III

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

Unit - IV
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature
Topics to be taught by Industry Subject Expert :

Unit - V
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions -Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission
Topics to be taught by Industry Subject Expert :

Suggested Reading :

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

AC033	SANSKRIT FOR TECHNICAL KNOWLEDGE					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2	Learning of Sanskrit to improve brain functioning
3	Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4	The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understanding basic Sanskrit language
CO-2	Ancient Sanskrit literature about science & technology can be understood
CO-3	Being a logical language will help to develop logic in students
CO-4	
CO-5	

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	-	-	1	-	-	-
CO-2	-	1	-	-	-	2
CO-3	-	1	1	-	-	1
CO-4	-	-	-	-	-	-
CO-5	-	-	-	-	-	-

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit - I
Alphabets in Sanskrit,Past/Present/Future Tense, Simple Sentences

Unit - II
Order Introduction of roots Technical information about Sanskrit Literature

Unit - III
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Unit - IV

Topics to be taught by Industry Subject Expert :

Unit - V
Topics to be taught by Industry Subject Expert :

Suggested Reading:

1	"Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2	Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3	"India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

AC034	VALUE EDUCATION					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand value of education and self- development
2	Imbibe good values in students
3	Let the should know about the importance of character
4	

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Knowledge of self-development
CO-2	Learn the importance of Human values
CO-3	Developing the overall personality

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	1	1	-	-	1	1
CO-2	1		-	-	-	1
CO-3	-	-	-	-	-	-
CO-4	1	-	-	-	-	-
CO-5	1	-	-	-	-	2

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Unit - I
Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism-Moral and non- moral valuation. Standards and principles-Value judgements

Unit - II
Importance of cultivation of values-Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness-Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature ,Discipline.

Unit - III
Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. • Punctuality, Love and Kindness. • Avoid fault Thinking-Free from anger, Dignity

of labour-Universal brotherhood and religious tolerance-True friendship. • Happiness Vs suffering, love for truth-Aware of self-destructive habits-Association and Cooperation-• Doing best for saving nature

Unit - IV
Character and Competence –Holy books vs Blind faith.-Self-management and Good health-Science of reincarnation-Equality, Non-violence, Humility, Role of Women-All religions and same message-Mind your Mind, Self-control-• Honesty, Studying effectively

Unit - V

Suggested Reading :

1	Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi
2	

AC 035	STRESS MANAGEMENT BY YOGA					
	(AUDIT COURSE - II)					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Creating awareness about different types of stress and the role of yoga in the management of stress.
2	Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
3	Prevention of stress related health problems by yoga practice.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	To understand yoga and its benefits.
CO-2	Enhance Physical strength and flexibility.
CO-3	Learn to relax and focus.
CO-4	Relieve physical and mental tension through Asanas
CO-5	Improve work performance and efficiency.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	-	-	-	-	-	
CO-2	-	-	-	-	-	1
CO-3	-	-	-	1	-	1
CO-4	-	-	-	-	1	1
CO-5	-	-	-	-	1	1

Unit – I
Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

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

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

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

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

Suggested Reading:

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

Web resource:

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

AC 036	PERSONALITY DEVELOPMENT THROUGH LIFE ENHANCEMENT SKILLS					
(AUDIT COURSE - II)						
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Learn to achieve the highest goal happily
2	Become a person with stable mind, pleasing personality and determination
3	Awaken wisdom in students

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Develop their personality and achieve their highest goal of life.
CO-2	Lead the nation and mankind to peace and prosperity.
CO-3	To practice emotional self regulation.
CO-4	Develop a positive approach to work and duties.
CO-5	Develop a versatile personality.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	-	-	-	-	-	1
CO-2	-	-	-	-	-	1
CO-3	-	-	-	-	-	1
CO-4	-	-	-	-	1	1
CO-5	-	-	-	-	1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

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) - Verses 52, 53, 59 (dont's) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

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

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

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

Suggested Reading:

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

Web resource:

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

AC 037	CONSTITUTION OF INDIA					
	(AUDIT COURSE - II)					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student 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 :	
On completion of this course, the student will be able to :	
CO-1	Understand the making of the Indian Constitution and its features.
CO-2	Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.
CO-3	Have an insight into various Organs of Governance - composition and functions
CO-4	Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
CO-5	Understand Electoral Process, special provisions.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	-	-	-	-	-	1
CO-2	-	-	-	-	-	1
CO-3	-	-	-	-	-	1
CO-4	-	-	-	-	-	-
CO-5	-	-	--	-	-	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

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, ayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla 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**.**

Suggested Reading:

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

Web resource:

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

AC038	PEDAGOGY STUDIES					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2	Identify critical evidence gaps to guide the development.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	What pedagogical practices are being used by teachers in formal and informal classrooms in Developing countries?
CO-2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
CO-3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	1		1		1	
CO-2					1	
CO-3	1	1	1		1	

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

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 are being used 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 materials 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 followup support • Peer 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

Suggested Reading :

1	Ackers J, Hardman F (2001) *Classroom interaction in Kenyan primary schools*, Compare, 31 (2): 245-261.
2	Agrawal M (2004) *Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies*, 36 (3): 361-379.
3	Akyeampong K (2003) *Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1*. London: DFID.
4	Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) *Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count?* International Journal Educational Development, 33 (3): 272–282.
5	Alexander RJ (2001) Culture and pedagogy: *International comparisons in primary education*. Oxford and Boston: Blackwell.
6	Chavan M (2003) *Read India: A mass scale, rapid, 'learning to read' campaign*.
7	www.pratham.org/images/resource%20working%20paper%202.pdf.

CE181	DISSERTATION PHASE-I					
Pre-requisites			**L**	**T**	**P**	**C**
			6	-	-	10
Evaluation	**SEE**	-	**CIE**		100 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Identification of the research problem
2	Discussion of literature survey.
3	Discussion of methodology for the research work

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identification of the objectives for the particular research problem. (10 marks)
CO-2	Ability to update the latest **literature** in chosen area of research & establishment of scope of work (20 m)
CO-3	Development of the methodology and perform analytical and /or experimental studies. (20 marks)
CO-4	Preparation of technical report (40 marks)
CO-5	Ability to justify the methodology of the chosen research problem (20 marks)

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	1	1	1	2		-
CO-2	1	1	2	2	2	-
CO-3	1	2	-	2	1	-
CO-4	-	1	-	-	3	2
CO-5	2	1	-	2	1	2

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Each student will be attached to a faculty member/supervisor for project. The student will carry out the project which may be development of Software / Hardware / Simulation studies / Design analysis / Experimental related to his/her specialization. The work will be monitored regularly by the supervisor. At the end of the semester student will submit the report on the work done and submit to the supervisor. Student shall present his/her work before the committee constituted by HoD and BOS. The committee consists of Supervisor and two examiners. The sessional marks will be awarded jointly by these examiners based on the report, presentation and viva voice

SEMESTER-IV

CE182	DISSERTATION PHASE-II					
Pre-requisites			**L**	**T**	**P**	**C**
			32	-	-	16
Evaluation	**SEE**	-	**CIE**		200 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Identification of the research problem
2	Discussion and critical appraisal of literature review.
3	Implementation of Methodology for the research problem

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identification of methods and/or materials to carry out the analytical/experimental/simulation analysis for the selected research problem (20 marks)
CO-2	Analysis of data, development of models, and offer solutions to the research problem (20 marks)
CO-3	Analyse and interpret the results to draw valid conclusions (20 marks)
CO-4	Preparation of dissertation report (20 marks)
CO-5	Ability to defend the work and possible publication (20 marks)

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	3	1	2	2	1	1
CO-2	1	3	-	3	-	1
CO-3	--	2	1	2	-	1
CO-4	--	--	--	1	3	2
CO-5	--	--	--	3	2	2

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Each student will be attached to a faculty member/supervisor for project. The student will carry out the project which may be development of Software / Hardware / Simulation studies / Design analysis / Experimental related to his/her specialization. The work will be monitored regularly by the supervisor. At the end of the semester student will write the report on the work done and submit to the supervisor. Student shall present his/her work before the committee constituted by HoD and BOS. The committee consists of Supervisor and two examiners. The dissertation evaluation is carried out in two stages each of which is 50 marks. The internal evaluation score will be awarded jointly by these examiners including supervisor based on the report, presentation and viva voice. Further, final presentation is evaluated for 100 marks which is evaluated by external examiner for 100 marks. Students are directed to submit plagiarism report containing less than 30% similarity index.