P.E.S. COLLEGE OF ENGINEERING, MANDYA

(An Autonomous Institution affiliated to VTU, Belagavi)

MASTER OF TECHNOLOGY

SCHEME OF TEACHING AND EXAMINATION

2020 - 21

I – Semester

Sl. No.	Course Code	Course Title	Teaching Hours/Week			Examination Marks			Credits
			Theory	Tutorial	Practical / Field work / Assignment	CIE	SEE	Total	
1.	P20MCAD11	Computational Structural Mechanics & FEM	03	02	--	50	50	100	4
2.	P20 MCAD 12	Structural Dynamics- Theory and Computation	03	02	--	50	50	100	4
3.	P20 MCAD 13	Continuum Mechanics-Classical and FE Approach	03	02	--	50	50	100	4
4.	P20 MCAD 141	Professional Elective – I	03	02	--	50	50	100	4
5.	P20 MCAD 152	Professional Elective – II	03	02	--	50	50	100	4
6	P20 MCAD L16	Structural Engineering Laboratory	-	--	04	50	50	100	2
Total			**15**	**10**	**04**	**300**	**300**	**600**	**22**

Professional Elective 1			Professional Elective 1I		
Sl. No	**Course Code**	**Course Title**	**Sl. No**	**Course Code**	**Course Title**
1.	P20MCAD141	Rehabilitation of Structures	1.	P20MCAD151	Reliability Analysis and Design of Structural Elements
2.	P20MCAD142	Design of Concrete Bridges	2.	P20MCAD152	Advances in artificial intelligence

II – Semester

Sl. No.	Course Code	Course Title	Teaching Hours/Week			Examination Marks			Credits
			Theory	Tutorial	Practical / Field work / Assignment	CIE	SEE	Total	
1.	P20MCAD21	Seismic Resistant Design of Structures	03	02	--	50	50	100	4
2.	P20MCAD22	Structural Stability Analysis Classical and FE Approach	03	02	--	50	50	100	4
3.	P20MCAD23	Structural Design –RCC Structures	03	02	--	50	50	100	4
4.	P20MCAD241	Professional Elective – III	03	02	--	50	50	100	4
5.	P20MCAD251	Professional Elective – IV	03	02	--	50	50	100	4
6	P20MCAD26	Project Phase – I	-	--	--	100	--	100	2
7	P20MCADL27	Structural Software Laboratory	-	--	04	50	50	100	2
Total			**15**	**10**	**04**	**400**	**300**	**700**	**24**

Professional Elective 1II			Professional Elective 1V		
Sl. No	**Course Code**	**Course Title**	**Sl. No**	**Course Code**	**Course Title**
1.	P20MCAD241	Advanced Design of Steel Structures	1.	P20MCAD251	Composite and Smart Materials
2.	P20MCAD242	Design of Tall Structures	2.	P20MCAD252	Analysis of Plates

III – Semester									
Sl. No.	Course Code	Course Title	Teaching Hours/Week			Examination Marks			Credits
			Theory	Tutorial	Practical / Field work / Assignment	CIE	SEE	Total	
1.	P20MCAD31	Research Methodology and IPR	04	--	--	50	50	100	4
2.	P20MCAD32	Special Concrete	--	--	--	50	50	100	3
3.	P20MCAD33	Formwork Techniques and Design	--	--	--	50	50	100	3
4.	P20 MCAD 34	Technical Seminar	--	--	--	100	--	100	2
5.	P20 MCAD 35	Project Phase – II	-	--	--	100	--	100	6
6.	P20 MCAD L36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters)			50	50	100	4
Total			**04**	**--**	**--**	**400**	**200**	**600**	**22**

IV – Semester									
Sl. No.	Course Code	Course Title	Teaching Hours/Week			Examination Marks			Credits
			Theory	Tutorial	Practical / Field work / Assignment	CIE	SEE	Total	
1.	P20MCAD41	Project Phase – III	--	--	--	100	--	100	6
2.	P20 MCAD 42	Project Phase – IV [Thesis Evaluation]	--	--	--	100	--	100	6
3.	P20 MCAD 43	Project Phase – IV [Viva - Voce]	--	--	--	--	100	100	6
4	P20 MCAD 44	Term Paper	--	--	--	100	--	100	2
Total			**--**	**--**	**--**	**300**	**100**	**400**	**20**

Category of Courses:

1. Core Courses: The Core courses constitute the core of the programme of study. Core courses are to be compulsorily studied by a student and are mandatory to complete them to fulfill the requirements of a programme.

2. Professional Electives: Elective courses offer a choice of advanced or specialized courses related to the programme of study. They enable students to specialize in a domain of interest or tune their learning to suit career needs and current trends.

3. Laboratories: The Laboratories are evaluated for 100 marks which includes CIE: 50 marks & SEE: 50 marks. The assessment of CIE is done with execution of lab programs & report submission. The final SEE assessment is done with the conduction of exam and Viva-Voce.

4. Self-Study Course: The Self-Study Course syllabus should consist of five units and the course should refer to NPTEL online courses of 8 weeks duration. The Self-Study Course will be assessed has normal Core Course / Professional Elective.

5. Internship: All the students have to undergo mandatory internship of 8 weeks during the vacation of I and II semesters and / or II and III semesters. An examination shall be conducted during III semester and the prescribed credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/ Complete the internship shall be declared as failed and have to complete during the subsequent examination after satisfying the internship requirements.

6. Technical Seminar: CIE marks shall be awarded by a committee comprising of HOD as Chairman, Guide/co-guide, in any and a senior faculty of the department. Participation in seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory. The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

7. Project Work: The Project Work carries 26 credits and spreads over THREE semesters, i.e. during II, III and IV semesters. Project work Phase-1, 2 & 3 to be awarded by the Department committee constituted for the purpose.

- The **Project Phase-I** evaluation shall be of 100 marks CIE. It is based on the submission report consisting of Title, Introduction, Literature Survey, Objectives and Methodology (50 Marks) and Presentation (50 marks).
- The **Project Phase-II** evaluation shall be of 100 marks CIE. It is based on submission report consisting of theoretical analysis and design approach of the work (50 Marks) and Presentation for 50 marks.
- The **Project Phase-III** evaluation shall be of 100 marks CIE. It is based on the overall completion & demonstration / execution of the project (50 Marks) and presentation for 50 marks.
- The **Project Phase-IV** [**Thesis]** evaluation shall be of 100 marks CIE. It is based on the evaluation done separately by internal and external examiners and average marks of the two examiner shall be consider as final marks.
- The **Project Phase-V [Viva Voce]** evaluation shall be of 100 marks SEE. It is based on Thesis presentation and project viva voce has to be conducted jointly by internal and external examiner for a total of 100 marks SEE.

8. Term Paper: The term paper is purely based on the project work he/she chooses.

- The Term paper shall be for 100 marks CIE only. It has to be evaluated by the committee formed by HOD consisting of PG coordinator, guide and subject expert internal/ external for each candidate.
- The term paper evaluation is based on the publication of an article in peer reviewed conference/ journal (national/ international) and quality of the journal. If the term paper is not published by the candidate or the same is communicated for publication at the end of his/ her tenure, then the committee formed by HOD consisting of PG coordinator, guide and subject expert internal/ external for each candidate will assess for the award of credit.

Course Title : COMPUTATIONAL STRUCTURAL MECHANICS AND FEM			
Course Code : P20MCAD11	**Semester : I**	**L-T-P : H : 3-2-0-5**	**Credits :4**
Contact Period : 52 Hrs	**Exam Hours : 3Hrs**	**Weight age : CIE : 50% , SEE : 50%**	
Prerequisites : Structural Analysis and Theory of Elasticity			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Learn concepts of matrix methods such as flexibility and stiffness matrix methods, particularly direct stiffness method, and learn the analysis of indeterminate structures, such as plane trusses.
2	Learn the analysis of indeterminate structures, such as continuous beams and 2D frames, using direct stiffness method.
3	Introduce the concept of finite element method, displacement model and weighted residual methods in the analysis of structures.
4	Importance of shape functions and its development using different approaches for various types of elements
5	Development of element stress, strain and stiffness matrices, isoparametric elements and solving simple beams using finite element analysis.

Course content	
UNIT -I	
Direct Stiffness Method: Degrees of static and kinematic indeterminacies, concepts of stiffness and flexibility, local and global coordinate systems, analysis of indeterminate trusses, with and without initial strains for different types of boundary conditions such as fixed, hinged, elastic (spring) supports.	
Self Study Component: Analysis of trusses for support settlement.	**12 Hrs**
UNIT -II	
Direct Stiffness Method: Analysis of continuous beams for different types of boundary conditions such as fixed, hinged, roller, support settlement. Analysis of simple 2d frames with and without sway.	
Self Study Component: Stiffness matrix for 3D frames.	**10 Hrs**
UNIT -III	
Basic Concept of Finite Element Method: Concept of FEM, formulation using principle of virtual work, principles minimum potential energy, method of weighted residuals(Galerkin's), choice of displacement function, degree of continuity, Generalized and natural coordinates.	
Self Study Component: Concept of stress, strain, displacement relations from TOE.	**10 Hrs**
UNIT -IV	
FE Analysis using Bar Elements and plane stress / plane strain problems: Derivation of shape functions for linear and higher order elements using inverse and Lagrange interpolation formula, element strains and stresses-element stiffness matrices. Nodal load vector- constant and varying cross sectional area subjected to concentrated loads, distributed body force and surface traction and initial strains due to temperature.	
Self Study Component: Higher order elements.	**10 Hrs**
UNIT -V	

FE Analysis of 2D Beam problems: Derivation of shape function for two noded beam element, Hermitian interpolation, element strains and stresses- element stiffness matrix, consistent nodal load vector. Isoparametric elements-Numerical integration. Analysis of cantilever and simply supported beams.	
Self Study Component: Run a FEM package for the analysis of trusses, beams and 2D frames.	**10 Hrs**

Text Books :	
1	Rajasekaran.S, "Computational Structural Mechanics", PHI, New Delhi 2001.
2	Reddy.C.S, "Basic Structural Analysis," TMH, New Delhi 2001.
3	Krishnamoorthy C.S, "Finite Element Analysis", Tata-McGraw-Hill Publishing Company.

Reference Books :	
1	Weaver.W and Gere.J.H., "Matrix Analysis of Framed Structures", Van Nastran, 1980.
2	Desai. C. S and Abel .J. F, "Introduction of Finite Element method", CBS Publishers and Distributors.
3	Chandrupatla and Belegundu "Introduction to Finite Elements in Engineering", Prentice Hall, India, 3rd edition, 2002.
4	Bathe.K.J, "Finite element procedures in Engineering Analysis". PHI. New Delhi

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to

1. Comprehend the matrix methods and method of direct stiffness method of analysis of trusses with different support and loading conditions.
2. Apply the direct stiffness method to analyze the continuous beams and 2D frames with different support and loading conditions.
3. Understanding the concept of fem, formulate the displacement models for bar and beam elements and different weighted residual methods.
4. Learn the concept of shape functions/ interpolation functions for bar element and beam element and apply the FEM to analyze cantilever and simply supported beams.

Course Articulation Matrix (CAM)

Sl. no	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Comprehend the matrix methods and method of direct stiffness method of analysis of trusses with different support and loading conditions.	**3**	**1**	**3**	**3**	**2**
2	Apply the direct stiffness method to analyze the continuous beams and 2D frames with different support and loading conditions.	**3**	**1**	**3**	**3**	**2**
3	Understanding the concept of fem, formulate the displacement models for bar and beam elements and different weighted residual methods.	**3**	**1**	**3**	**2**	**3**
4	Learn the concept of shape functions/ interpolation functions for bar element and beam element and apply the FEM to analyze cantilever and simply supported beams.	**2**	**2**	**3**	**2**	**3**

Course Title : STRUCTURAL DYNAMICS - THEORY & COMPUTATION			
Course Code : P20MCAD12	**Semester : I**	**L-T-P : H : 3-2-0-5**	**Credits :4**
Contact Period : 52Hrs	**Exam Hours : 3 Hrs**	**Weight age : CIE50 : , SEE 50:**	
Prerequisites : Basic Science, Basic Strength of Materials			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Learn basic principles of Structural Dynamics
2	Understand the response of SDOF systems to different types of dynamic loads
3	solve problems of force transmissibility and displacement transmissibility of structural systems
4	Evaluate the dynamic characteristics of shear buildings and continuous systems
5	Use finite element methods for the Dynamic Analysis of Beams

Course content	
UNIT –I	
Single Degree of Freedom System: concept of degrees of freedom, undammed system, springs in parallel or in series, free body diagram, D'Alembert's principle, solution of the differential equation of motion, frequency and period, amplitude of motion. Mathematical models of Single-degree-of-freedom systems system. Free vibration response of damped and undamped systems.	
Self Study Component: Methods of evaluation of damping.	**12 Hrs**
UNIT –II	
Response to General Dynamic Loading: Response of Single-degree-of-freedom systems to harmonic loading (rotation unbalance) including support motion, vibration isolation, transmissibility, Numerical methods applied to Single-degree-of-freedom systems –Duhamel's integral.	
Self Study Component: Response of SDOF system to Reciprocating unbalance, principle of vibration measuring instruments –seismometer and accelerometer.	**10Hrs**
UNIT –III	
Dynamics of Multi-degree freedom systems: Multistory Shear Building. Free vibration – natural frequencies and normal modes. Forced motion – modal superposition method. Damped motion of shear building – equations of motions – uncoupled damped equation.	
Self Study Component : Conditions for uncoupling	**10 Hrs**
UNIT –IV	
Discretization of Continuous Systems: Longitudinal Vibration of a uniform rod. Free transverse vibration of uniform beams– The effect of axial loading.	
Self Study Component: Orthogonality of normal modes. Undamped forced vibration of beams by mode superposition.	**10 Hrs**
UNIT –V	
Dynamic Analysis of Beams: Stiffness matrix, mass matrix (lumped and consistent); equations of motion for the discretised beam in matrix form.	
Self Study Component: Run a programme to get mass matrix and element matrix of two noded beam elements.	**10 Hrs**

Text Books :	
1	Mario Paz, "Structural Dynamics, Theory and Computation", 2nd Edition, CBS Publisher andDistributors, New Delhi.
2	Madhujit Mukhopadyay, Vibrations, Dynamics and Structural Systems, Oxford Publishers, New Delhi
3	S.R. Damodaraswamy, S. Kavitha,"Basics of Structural Dynamics and Aseismic Design"PHI

Reference Books :	
1	Leonard Meirovitch, Elements of Vibration Analysis, Tata Mcgraw Hill, New Delhi
2	Roy Craig, Structural Dynamics, John Wiley Publications, New York
3	Anil K Chopra, Dynamics of Structures, Pearson Publications, New Delhi
4	Rao S.S, Mechanical Vibrations, Pearson Publications, New Delhi

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to

1. Understand the basic principles of dynamics.
2. Analyze lumped mass systems for their dynamic behavior.
3. Evaluate the structural characteristics of continuous vibratory system.
4. Carry out dynamic analysis of beams using FEM.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Understand the basic principles of dynamics.	**2**		**2**	**1**	**1**
2	Analyze lumped mass systems for their dynamic behavior.	**3**		**2**	**2**	**1**
3	Evaluate the structural characteristics of continuous vibratory system.	**2**		**2**	**2**	**1**
4	Carry out dynamic analysis of beams using FEM.	**3**		**3**	**2**	**2**

Course Title : CONTINUUM MECHANICS – CLASSICAL AND FE APPROACH			
Course Code : P20MCAD13	**Semester : I**	**L-T-P- H : 3-2-0-5**	**Credits :4**
Contact Period : 52Hrs	**Exam Hours : 3 Hrs**	**Weight age : CIE :50% , SEE : 50%**	
Prerequisites : Knowledge on basic strength of materials			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Understand the basic principles of mechanics of deformable bodies
2	Introduction to stresses and strains in 2D and 3D Cartesian and polar co-ordinates
3	Understand the relationships between stress and strains
4	Understanding the application of principles of theory of elasticity in the field of civil engineering
5	Understanding of application of FE analysis in solid continuum mechanics

Course content	
UNIT -I	
Analysis of Stress: Introduction, Definition of stress at a point, Rectangular and Polar coordinates in 2D and 3D, Components of stresses, Equilibrium equations, Principal stresses and stress invariants, Maximum shear stresses, Stress transformation, Octahedral Stresses, Stress boundary Conditions. (All Topics to be discussed in both rectangular and polar co-ordinate systems in 2D and 3D treatments).	
Self-Study Component : Mohr's Circle for stresses	**12Hrs**
UNIT -II	
Analysis of Strain: Definition of a Strain at a point and Strain components in rectangular and polar coordinates (2D and 3D), Strain displacement relationships, strain compatibility, Principal strain, Maximum shear strain & octahedral strains.(All Topics to be discussed in both rectangular and polar co-ordinate systems in 2D and 3D treatments).	
Self-Study Component: Strain Rossette	**10Hrs**
UNIT -III	
Stress-Strain Relationship: Hook's law, General Constitutive Relationship, Definition of Plane stress and Plane strain idealizations, Constitutive relation for plane stress and plane strain cases, Compatibility equations. **Airy's Stress Function**: Airy's stress function approach to2D problems of elasticity. Solution by Polynomials –End Effects, Saint –Venant's Principle.	
Self-Study Component: Stress –strain relationship in polar co-ordinates.	**10Hrs**
UNIT -IV	
Applications: Solution of some simple beam problems, including working out of displacement components. Applications in polar coordinates: Axi- symmetric stress distribution, Analysis of Thick cylinders, Hallow and solid Rotating discs. The effect of a small circular hole on stress distribution in large plates subjected to uni-axial tension and pure shear.	
Self-Study Component: Application of theory of elasticity to obtain solutions for problems - Pure bending of curved bars, Bending of a curved bar by a force at the end.	**10Hrs**

UNIT -V	
FE APPROACH: 2D and 3D Elements - CST, LST, Rectangular family: Shape functions, element stiffness matrix, equivalent loads, isoparametric formulation of triangular and general quadrilateral elements.	
Self-Study Component: Axisymmetric elements & Gauss quadrature.	**10Hrs**

Text Books :	
1	Timoshenko and Goodier, "Theory of elasticity", McGraw Hill Book Company, III Edition, 1983.
2	Valliappan. S, "Continuum Mechanics fundamentals", Oxford and IBH.
3	Tirupathi R.Chandruptla and Ashok D.Belegundu, "Introduction to Finite Element in Engineering", Pearson publications.

Reference Books :	
1	Srinath. L.S., Advanced Mechanics of Solids", Tata McGraw-Hill Publishing Co ltd., New Delhi .
2	T.G.Sitharam and L.Govindaraju, "Elasticity for Engineers", IK International publishing house Pvt, Ltd.
3	Bathe. K.J, "Finite element procedures in Engineering Analysis".PHI. New Delhi.
4	Krishnamoorthy C.S, "Finite Element Analysis", Tata-McGraw-Hill Publishing Company.

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to

1. Understand the concept of stresses and analyse the various mathematical operations involved in analyzing stresses in 2D and 3D problems in Cartesian and polar co-ordinates.

2. Apply the concept of stain at a point and to get acquaint with the various mathematical operations involved in analysis strains in 2D and 3D problems in Cartesian and polar co-ordinates.

3. Develop general stress strain relations and to understand its application in various cases.

4. Apply the basic principles of theory of elasticity to obtain classical solutions to some of the problems in structural engineering. And apply the principles of FEA to solve problems in continuum mechanics.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Understand the concept of stresses and analyse the various mathematical operations involved in analyzing stresses in 2D and 3D problems in Cartesian and polar co-ordinates.	**2**	**1**	**2**	**1**	
2	Apply the concept of stain at a point and to get acquaint with the various mathematical operations involved in analysis strains in 2D and 3D problems in Cartesian and polar co-ordinates.	**1**	**1**	**2**	**1**	
3	Develop general stress strain relations and to understand its application in various cases.	**2**	**1**	**2**	**1**	**1**
4	Apply the basic principles of theory of elasticity to obtain classical solutions to some of the problems in structural engineering. And apply the principles of FEA to solve problems in continuum mechanics.	**1**	**1**	**2**	**2**	**2**

Course Title : REHABILITATION OF STRUCTURES			
Course Code:P20MCAD141	**Semester: I**	**L–T–P–H : 4–0–0 : 4**	**Credits:4**
Contact Period : 52 Hrs	**Exam Hours : 3 Hrs**	**Weight age : CIE : 50% , SEE : 50%**	
Prerequisites : - NIL			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Understand the concept of maintenance and rehabilitation of structures.
2	Able to understand and demonstrate the procedural knowledge to maintain and rehabilitate structures
3	Study and understand the culture of professional and ethical responsibilities by following codal provisions in the rehabilitation of structures.
4	Provide factual knowledge on analysis and design of rehabilitation of structures and train students to participate and succeed in competitive examinations
5	Explain and Evaluate the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures, maintenance and rehabilitation of structures.

Course content
UNIT -I
Durability and Deterioration: Physical causes: Durability of concrete causes of distress in concrete, sulphate attack, shrinkage, freeze and thawing, weathering, abrasion, temperature, fire, formwork movement, settlement, foundation settlement, construction errors, overloads, accidental loadings and design errors. Chemical causes: Chemical attack on concrete, sulphate attack, acid attack, alkali reaction, aggregate reaction, silica reaction, crystallization of salts in pores, sea water attack, biological attack, other chemical attacks. Corrosion: Principle of corrosion, mechanism, process, damage due to corrosion, codal provisions, symptoms of distress due to corrosion. Corrosion protection techniques.
10 Hrs
Self Study Component: Corrosion protection techniques.
UNIT -II
Structural Damage Assessment: Inspection, Structural Appraisal, Economic appraisal, components of quality assurance, conceptual basis for quality assurance schemes. Destructive testing systems - direct load tests, load test on structural elements, semi destructive testing systems - penetration techniques Pull out test, core sampling, and permeability test, and non destructive testing systems – NDT methods, ultrasonic pulse velocity test, pulse echo method, electromagnetic methods.
10 Hrs
Self Study Component: Acoustic emissions, radiographic methods.
UNIT -III
Functional Materials for Repair and Rehabilitation: Criteria for selecting repair materials, classification of materials, physical and chemical strength tests, adhesive strengths and test for surface quality. Patching materials, cementations' materials, polymer mortar and concrete, quick setting compounds, bituminous materials, protective coatings, sealing materials, water stops,

water proofing materials, coatings, membranes, bonding materials. Special repair materials, chemicals and mineral admixtures, SP, accelerators, fly ash, GGBS, CSF.
12 Hrs
Self Study Component: Polymeric materials and coatings, SFRC.
UNIT -IV
Rehabilitation and Strengthening Techniques: Repair of cracks, methods of repair, and stages of repair, resin injection, routing and sealing, stitching, external stressing, bonding, blanketing, overlays, flexible sealings, drilling, plugging, surface coatings, grinding, sand blasting, acid etching. Rust eliminators and polymers coating for re-bars, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Examples of repairs to structures, Repairs to overcome low member strength, deflection, cracking, chemical disruption, weathering, wear, fire, leakage, marine exposure. Structure concrete strengthening, jacketing, external bonding, section enlargement, externally bonded steel plates, external reinforcement.
10 Hrs
Self Study Component: NSM technique.
UNIT -V
Maintenance and Demolition : Definition, necessity of maintenance, classification of maintenance, environmental agencies, normal wear and tear , failure of structures, inspection of structures, inspection periods, preventive maintenance, predictive maintenance, reliability centered maintenance, reactive maintenance, organization for maintenance, computerized maintenance management system. Condition of flooring, roof leakage, Condition of service fittings, drainage from terrace roof, growth of vegetation, management tools for effective maintenance. **Safety in Maintenance :** Causes and Remedies to avoid accidents, Accident prevention, construction audits, safety programs for construction, safety in building maintenance, precautions prior and during dismantling, dismantling sequences, dismantling walls, floor, concrete demolition, methods of demolition
10 Hrs
Self Study Component: steps to reduce repairs and replacement, normal breakup, demolition tools and materials, general information regarding demolition

Text Books :	
1	"Rehabilitation of Concrete Structures", Dr. B. Vadivelli, Standard Publishers and Distributors, Delhi.
2	Concrete Structures Repair, Rehabilitation and Retrofitting by J.Bhattacharjee.
3	Alexander Newman "Structural Renovation of Buildings" –, McGraw Hill, 2009.

Reference Books :	
1	Repair and Rehabilitation of Concrete Structures by Poonam I. Modi & ChiragN.Patel
2	RT. Allen and S.C. Edwards, "Repair of concrete Structures", Blakie and sons, UK, 1987.
3	"Training course notes on damage assessment and Repair in low cost housing Santhakumar", S.R. RHDC-NBO Anna University, Madras, July,1992
4	"CPWD hand book for Rehabilitation of structures"

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to

1 Reproduce the basic knowledge of mathematics, science and engineering in the maintenance and rehabilitation of structures.
2 Demonstrate the procedural knowledge to maintain and rehabilitate structures.
3 Practice the culture of professional and ethical responsibilities by following codal provisions in the rehabilitation of structures.
4 Provide factual knowledge on analysis and design of rehabilitation of structures and train students to participate and succeed in competitive examinations.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Reproduce the basic knowledge of mathematics, science and engineering in the maintenance and rehabilitation of structures.	**3**	**1**		**2**	**1**
2	Demonstrate the procedural knowledge to maintain and rehabilitate structures.	**2**	**1**	**2**	**1**	**2**
3	Practice the culture of professional and ethical responsibilities by following codal provisions in the rehabilitation of structures.		**3**	**1**	**3**	**3**
4	Provide factual knowledge on analysis and design of rehabilitation of structures and train students to participate and succeed in competitive examinations.	**2**	**1**	**3**	**1**	**2**

Course Title : DESIGN OF CONCRETE BRIDGES			
Course Code : P20MCAD142	**Semester : I**	**L-T-P : H : 3 – 2 – 0 : 5**	**Credits :04**
Contact Period : 52 Hrs	**Exam Hours : 03 Hrs**	**Weight age : CIE:50% SEE:50%**	
Prerequisites : Design of Reinforced Concrete Structures			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	To provide a detailed study of fundamental concepts for the design of bridge elements, and to present different methods for the design of bridge systems.
2	Explain the underlying theory for the provisions in IRC standards.
3	To understand the load flow mechanism and identify loads on bridges.
4	To carry out designs for different types of bridges.
5	To apply the concepts in proportioning and design of bridges in terms of aesthetics, geographical location and functionality.

Course content	
UNIT -I	
Introduction & Design of Slab Culvert: Historical Developments, Selection for Bridges, Classification of Bridges, Forces on Bridges, Dead load BM & SF, BM & SF For IRC Class AA Tracked Vehicle, BM & SF For IRC Class AA Wheeled Vehicle, BM & SF For IRC Class A Loading, Structural Design of Slab Culvert, Reinforcement Detail.	
Self Study Component : student shall visit the nearby bridge site & understand the component parts of bridge	**10 Hrs**
UNIT -II	
Box Culvert: Loading Cases, IRC Class AA Tracked Vehicle, IRC Class AA Wheeled Vehicle, IRC Class A Loading, Moment Distribution, Structural Design of Box Culvert, Reinforcement Detail.	
Self Study Component : Structural design of pipe culvert	**10 Hrs**
UNIT -III	
T Beam Bridge: Slab Design: Proportioning of Components, Analysis of Slab using IRC Class AA Tracked Vehicle, Analysis of Slab Using IRC Class AA Wheeled Vehicle, Analysis of Slab using IRC Class A Loading, Structural Design of Slab. **Cross Girder:** Analysis of Cross Girder for Dead Load & IRC Class AA Tracked Vehicle, Analysis of Cross Girder for IRC Class AA Wheeled Vehicle & Class A Loads, Structural Design of Cross Girder. **Main Girder:** Analysis of Main Girder Using COURBON"S Method for IRC Class AA Tracked vehicle for B M, Analysis of Main Girder Using COURBON"S Method for IRC Class AA Wheeled vehicle for B M, Calculation of Live load SF, Calculation of Dead load BM and SF, Structural Design of Main Girder, Reinforcement Details of Main Girder.	
Self Study Component : Distribution of L.L on longitudinal girders by Guyon masso	**10 Hrs**
UNIT -IV	
PSC Bridge: Introduction to Pre & Post Tensioning, Proportioning of Components, Analysis & Structural Design of Slab, Analysis of Main Girder Using COURBON"S Method for IRC Class AA Tracked vehicle, Calculations of Prestressing Force, Calculations of Stresses, Cable profile,	

Design of End Block, Detailing of Main Girder.	
Self Study Component: Design of prestressed concrete cellular Box Girder bridge deck.	**10 Hrs**
UNIT -V	
Balanced Cantilever Bridge: Introduction & Proportioning of Components, Design of Simply Supported Portion, Design of Simply Supported Portion, Design of Cantilever Portion, , Design of Articulation, Reinforcement Details of Main Girder.	
Self Study Component : Design of continuous bridges	**12 Hrs**

Text Books :	
1	Essentials of Bridge Engineering by Dr D Johnson Victor, Oxford & IBH Publishing Co. New Delhi.
2	Design of Bridges by Dr N Krishna Raju, Oxford & IBH Publishing Co. New Delhi.
3	Principles and Practice of Bridge Engineering by S P Bindra, Dhanpat Rai& Sons New Delhi.

Reference Books :	
1	IRC 6 -2014 Standard Specifications And Course Code Of Practice For Road Bridges Section II Loads and Stresses, The Indian Road Congress New Delhi
2	IRC 21 – 2000 Standard Specifications And Course Code Of Practice For Road Bridges Section III Cement Concrete (Plain and reinforced) The Indian Road Congress New Delhi
3	IS 456 - 2000 Indian Standard Plain and Reinforced Concrete Course Code of Practice (Fourth Revision) BIS New Delhi.
4	IS 1343 - Indian Standard Prestressed Concrete Course Code of Practice BIS New Delhi.

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to

1. Analyze and solve engineering problems in design of slab culvert subjected to flexure, shear and torsion.
2. Analyze and solve engineering problems in design of box culvert subjected to flexure, shear and torsion.
3. Demonstrate the procedural knowledge to design a system component as per needs and specifications of T- beam bridges subjected to various load combinations.
4. Analyze and Design of Pre-tensioned as well as Post-tensioned slabs, girders subjected to various load combinations.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Analyze and solve engineering problems in design of slab culvert subjected to flexure, shear and torsion.	**2**		**2**	**2**	**2**
2	Analyze and solve engineering problems in design of box culvert subjected to flexure, shear and torsion.	**2**		**2**	**2**	**2**
3	Demonstrate the procedural knowledge to design a system component as per needs and specifications of T- beam bridges subjected to various load combinations.	**2**		**3**	**2**	**2**
4	Analyze and Design of Pre-tensioned as well as Post-tensioned slabs, girders subjected to various load combinations.	**2**		**1**	**2**	**2**

Course Title : RELIABILITY ANALYSIS AND DESIGN OF STRUCTURAL ELEMENTS			
Course Code :P20MCAD151	**Semester : I**	**L-T-P : H : 3 – 2 – 0 - 5**	**Credits : 04**
Contact Period : 52 Hrs	**Exam Hours : 3 Hrs**	**Weightage : CIE : 50% , SEE : 50%**	
Prerequisites: Engineering Mathematics, Design of RC Structural Elements.			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Adopt statistical methods to work out the reliability of structures.
2	Apply statistical methods for analysis of random processes.
3	Apply statistical methods for Quality control in Civil Engineering.
4	Analyze a structure and compute its inherent safety level.
5	Determine the factors of safety by simulation methods.

Course content	
UNIT -I	
Concept of variability: Applications of Statistical principles to deal with randomness in basic variables, statistical parameters and their significance, Description of various probability distributions – Binomial, Poisson, Normal, Log-Normal, Beta, Gama, distributions. Testing of goodness– of – fit of distributions to the actual data using chi-square method.	
Self Study Component : Fit of distributions to the actual data using K.S Method	**10Hrs**
UNIT -II	
Statistical regression and correlation: Least – square and chi – square methods, Operation on one Random variable, expectation, multiple random variables, reliability distributions – basic formulation, the hazard function.	
Self Study Component: Weibull distribution.	**10Hrs**
UNIT -III	
Statistical Quality control in Civil Engineering: Characteristic strength and characteristic load, probability modeling of strength, geometrical dimensions, material properties and loading. Application problems Mean value method and its applications in structural designs, statistical inference, Comparison of various acceptance and rejection testing.	
Self Study Component: Probability mass function.	**10Hrs**
UNIT -IV	
Safety assessment of structures: Reliability analysis using mean value theorem – I, II and III order Reliability formats.	
Self Study Component: Importance sampling techniques.	**10Hrs**
UNIT -V	
Simulation techniques, reliability index - reliability formulation in various limit states, reliability based design, application to design of RC, PSC and steel structural elements.	
Self Study Component: Concepts of system reliability.	**12Hrs**

Text Books :	
1	R.Ranganthan, "Reliability Analysis and Design of Structures", Tata McGraw Hill

	publishing Co. Ltd., New Delhi.
2	L S Srinath, "Reliability Engineering", East West Books (Madras) Pvt. Ltd., 2005.
3	Agarwal, K.K., Reliability Engineering, Apress Springer (India) Pvt. Ltd., 2007.

Reference Books :	
1	John B.Kennedy and Adam M.Neville, "Basic Statistical Methods for Engineers and Scientists", Harper and Row Publishers, New York.
2	Ang A.H.S and W.H.Tang, "Probability concepts in Engineering planning and Design", John Wiley and sons, New York, Vol.I and II.
3	Andrzej, S. N and Kevin, R. C., Reliability of Structures, McGraw Hill Company, KOGA, 2012.
4	Devaraj, V., and Ravindra, R., "Reliability Based Analysis and Design for Civil Engineers", IK International Publishing House Pvt. Ltd., 2017.

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to:

1. Apply statistical principles for analyzing randomness in variables.
2. Test goodness of fit of distribution in the data.
3. Adopt different acceptance and rejection tests for strength and other parameters of measurement.
4. Carry out reliability analysis and compute reliability index, for the given design details.

Course Articulation Matrix (CAM)

Sl. No	**Course Outcomes (CO's)**	**Program outcomes (PO's)**				
		1	2	3	4	5
1	Apply statistical principles for analyzing randomness in variables.	**3**	**2**			
2	Test goodness of fit of distribution in the data.	**3**	**2**			
3	Adopt different acceptance and rejection tests for strength and other parameters of measurement.	**2**	**2**			
4		**2**	**2**			

Course Title : ADVANCES IN ARTIFICIAL INTELLIGENCE			
Course Code : P20MCAD152	**Semester : I**	**L-T-P : H : 3-2-0-5**	**Credits :4**
Contact Period : 52 Hrs	**Exam Hours : 03 Hrs**	**Weight age : CIE :50% , SEE : 50%**	
Prerequisites : Nil			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Study basics of machine learning and natural language processing.
2	Adopt different knowledge representation techniques.
3	Carry out state and space representation and adopt different search techniques.
4	Modules Teaching Hours RBT Levels.
5	Recognize Speech and speech synthesis.

Course content	
UNIT -I	
Artificial Intelligence: Introduction , Foundations of AI, History of AI, Agents and environments, The nature of the Environment, Problem solving Agents, Problem Formulation, Search Strategies	
Self Study Component: Matching control knowledge.	**12 Hrs**
UNIT -II	
Knowledge and Reasoning: Knowledge-based Agents, Representation, Reasoning and Logic, Prepositional logic, First-order logic, Using First-order logic, Inference in First- order logic, forward and Backward Chaining	
Self Study Component: Semantic networks.	**10 Hrs**
UNIT -III	
arning: Learning from observations, Forms of Learning, Inductive Learning, Learning decision trees, why learning works, Learning in Neural and Belief networks	
Self Study Component: Production systems.	**10 Hrs**
UNIT -IV	
Practical Natural Language Processing: Practical applications, Efficient parsing, Scaling up the lexicon, Scaling up the Grammar, Ambiguity, Perception, Image formation, Speech recognition and Speech Synthesis	
Self Study Component: Image processing operations for Early vision.	**10 Hrs**
UNIT -V	
botics: Introduction, Tasks, parts, effectors, Sensors, Configuration spaces, Navigation and motion planning, Introduction to AI based programming Tools	
Self Study Component: Architectures.	**10 Hrs**

Text Books :

1	Stuart Russell, Peter Norvig: "Artificial Intelligence: A Modern Approach", 2nd Edition, Pearson Education, 2007.
2	Yagna Narayana B., Artificial Neural Networks, PHI, 2004.
3	C.S. Krishnamoorthy, S. Rajeev., Artificial intelligence and expert systems for engineers, CRC Press, Year: 1996.

Reference Books :	
1	E. Rich and K. Knight., Artificial Intelligence, 2nd Edition, McGraw Hill, 1991.
2	Patterson, D. W., Introduction to Artificial Intelligence and Expert Systems –PHI, 2005.
3	Giarratano, J. C., G. D. Riley, Expert Systems: Principles and Programming- 4 Ed, Thomson. 2005.
4	PROLOG Programming for Artificial Intelligence. Ivan Bratka- Third Edition – Pearson Education.

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to

1. Explain the history of AI and formulate problems and search strategies.
2. Adopt different methods of reasoning and logic for problem identification.
3. Practice different forms of learning.
4. Carry out language processing and speech recognition and speech synthesis processes.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Explain the history of AI and formulate problems and search strategies.	**2**	**1**	**3**		**2**
2	Adopt different methods of reasoning and logic for problem identification.	**3**	**1**	**2**	**2**	**2**
3	Practice different forms of learning.	**2**	**1**	**2**	**2**	**2**
4	Carry out language processing and speech recognition and speech synthesis processes.	**3**	**2**	**3**	**2**	**2**

Course Title : STRUCTURAL ENGINEERING LABORATORY- II			
Course Code : P20MCADL16	**Semester: I**	**L-T-P : H : 0 – 0 – 4-4**	**Credits : 02**
Contact Period : 39 Hrs	**Exam Hours : 3 Hrs**	**Weight age : CIE:50% SEE:50%**	

Prerequisites : Structural Analysis 1, Concrete Technology

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Use industry standard software's in a proficient manner besides knowing the theoretical concepts of structural analysis.
2	To train the students to handle non-destructive testing instruments and to analyze the data obtained for quality assessment of concrete.
3	Hands on experience in testing and quality control of concrete making materials to design concrete mixes for different ranges of strength and workability.

	Course content
1	Structural Analysis of Continuous Beams for different types of loadings and support conditions, Analysis of steel trusses using STAAD-Pro.
2.	Static analysis of Building structure using software (ETABS / STAAD Pro.)
3.	NDT on structural elements using instruments like UPVT, Rebound hammer, Rebar locator, corrosion analyser.
4.	Mix proportion and fresh properties of normal strength concrete.

Text Books :	
1	Bhavikatti S.S., Structural Analysis Volume I", Vikas Publishinh house Pvt. Ltd.
2	Shetty M.S, 'Concrete Technology ', S. Chand & Co. Ltd, New Delhi.
3	Malhotra, V. M., and Nicholas J. Carino, "Handbook on nondestructive testing of concrete", CRC Press, 2004.

Reference Books :	
1	Harmer E. Davis, George Earl Troxell, and George F. W. Hauck, "The Testing of Engineering Materials", 4th Edition, McGraw-Hill Book Company, NewYork.
2	Bungey, J.H., Millard, S.G. and Grantham, M.G. (1982), Testing of Concrete in Structures, 4th Edition, Taylor and Francis, London.
3	IS: 10262-2009, Concrete Mix Proportioning, Guideline, BIS, New Delhi.
4	Relevant BIS codes.

Course Outcomes

After learning all the units of the course, the student is able to

1. Use industry standard software in a professional set up.
2. Assess the quality of existing structural elements using NDT methods.
3. Characterize and mix design of normal strength concrete.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)					Program Specific outcomes (PSO's)		
		1	2	3	4	5	1	2	3
1	Use industry standard software in a professional set up.	**3**	**3**	**2**	**2**	**3**			
2	Assess the quality of existing structural elements using NDT methods.	**2**	**1**	**2**	**3**	**3**			
3	Characterize and mix design of normal strength concrete.	**3**	**2**	**2**	**3**	**3**			

Course Title : SEISMIC RESISTANT DESIGN OF STRUCTURES			
Course Code : P20MCAD21	**Semester : II**	**L-T-P : H : 3-2-0 : 5**	**Credits : 04**
Contact Period : 52 Hrs	**Exam Hours : 03 Hrs**	**Weight age: CIE : 50% , SEE :50%**	
Prerequisites : Structural Dynamics			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Fundamentals of engineering seismology.
2	Evaluate seismic response of structures.
3	Irregularities in building which are detrimental to its earthquake performance
4	The concept of Earthquake Resistant Design of Earthen and Masonry structures.
5	Seismic evaluation, retrofitting strategies of RC and Masonry building

Course content	
UNIT -I	
Seismic Hazard Assessment: Engineering Seismology – Definitions, Introduction to seismic hazard, earthquake phenomenon –seismotectonics and seismic zoning of India — Characteristics of strong Earthquake motion - Estimation of earthquake parameters – Microzonation.	
Self Study Component: Lessons learnt from past earthquakes, Earthquake monitoring and seismic instrumentation.	**12Hrs**
UNIT -II	
Earthquake Effects on Structures: Response to ground acceleration – response analysis by mode superposition – torsional response of buildings -response spectrum analysis – selection of design earthquake – earthquake response of base isolated buildings – earthquake response of inelastic structures, allowable ductility demand response spectra / average response spectra Design response spectra - Evaluation of earthquake forces – (IS1893 – 2002). – Effect of earthquake on different types of structures.	
Self Study Component: Liquefaction of soils, Pushover Analysis.	**10Hrs**
UNIT -III	
Concepts of Earthquake Resistant Design: Structural systems / Types of buildings – causes of damage – planning consideration / architectural concept (IS 4326 – 1993) – philosophy and principle of earthquake resistant design – guidelines for earthquake resistant design.	
Self Study Component : Do's and Don'ts for protection of life and property	**10Hrs**
UNIT -IV	
Earthquake Resistant Earthen and Masonry Buildings: Earthquake resistant low strength masonry buildings, strength and structural properties of masonry –lateral load - design considerations.	
Self Study Component: Tips for the earthquake resistant masonry structures.	**10Hrs**

UNIT -V	
Earthquake Resistant Design of RCC Buildings – Material properties – lateral load analysis– design and detailing. Basic concepts of seismic base isolation and seismic isolation systems**.**	
Self Study Component: Worked examples.	**10Hrs**

Text Books :	
1	PankajAgarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall of India, 2006.
2	S K Duggal, "Earthquake Resistant Design of Structures", Oxford University Press, 2007.
3.	Vinod Hosur, Earthquake Resistant Design of Building Structures, , WILEY (india), 2012

Reference Books :	
1	Chopra, A.K. "Dynamics of structures", Prentice-Hall of India Pvt. Ltd. New Delhi.
2	Ghose, S.K. "Earthquake Resistance Design of Concrete Structures", SDCPL –R&D Center –New Mumbai 73.
3	Jaikrishna et al. "Elements of Earthquake Engineering", South Asia Publishers, New Delhi.
4	S.R. Damodaraswamy, S. Kavitha,"Basics of Structural Dynamics and Aseismic Design"PHI.

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to:

1. To provide the students with basic knowledge of earth quakes and it's relation to structural systems.
2. Use the response spectrum principle in the earthquake resistant design of structures.
3. Ability to apply the knowledge of engineering to conceptually design of structural systems against earthquakes.
4. Ability to analyze and design of reinforced concrete structural systems subjected to earthquake forces and Summarize the seismic evaluation and retrofitting of structures.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)					Program Specific outcomes (PSO's)		
		1	2	3	4	5	1	2	3
1	To provide the students with basic knowledge of earth quakes and it's relation to structural systems.	**2**	**3**						
2	Use the response spectrum principle in the earthquake resistant design of structures.	**3**	**2**						
3	Ability to apply the knowledge of engineering to conceptually design of structural systems against earthquakes.	**3**		**2**					
4	Ability to analyze and design of reinforced concrete structural systems subjected to earthquake forces and Summarize the seismic evaluation and retrofitting of structures.	**3**		**2**	**2**				

Course Title : STRUCTURAL STABILITY ANALYSIS – CLASSICAL AND FE APPROACH			
Course Code : P20MCAD22	**Semester : II**	**L-T-P : H : 3-2-0-5**	**Credits :4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weight age : CIE :50% , SEE : 50%**	
Prerequisites : Strength of Materials and Finite Element Analysis			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Understand beam column structural behavior, stability of column and compute Euler's critical load for different boundary conditions.
2	Understand energy method, bars on elastic foundation, successive approximation method for stability analysis.
3	Learn finite element method in stability analysis to simple plane truss and 2D beams and frames.
4	Grasp the concept of lateral buckling of beams and torsional buckling of beams.
5	Grasp the concept of lateral buckling of rectangular plate with different directional loading and boundary conditions.

Course content	
UNIT -I	
Beam column: Differential equation. Beam column subjected to (i) lateral concentrated load, (ii) several concentrated loads, (iii) continuous lateral load. Application of trigonometric series. Euler's formulation using fourth order differential equation for pinned-pinned, fixed- fixed, fixed-free and fixed-pinned columns.	
Self Study Component: Beam column subjected to partial udl**,** couples.	**10Hrs**
UNIT -II	
Buckling of frames and beams. Elastica, Energy method: Approximate calculation of critical loads for a cantilever, Exact critical load for hinged-hinged column using energy approach, Buckling of bar on elastic foundation. Buckling of cantilever column under distributed loads. Determination of critical loads by successive approximation. Bars with varying cross section. Effect of shear force on critical load.	
Self Study Component: Columns subjected to non-conservative follower and pulsating forces.	**12Hrs**
UNIT -III	
Stability analysis by finite element approach: Derivation of shape functions for a two noded Bernoulli-Euler beam element (lateral and translational dof) –element stiffness and Element geometric stiffness matrices – Assembled stiffness and geometric stiffness matrices for a discretised column with different boundary conditions – Evaluation of critical loads for a discretised (two elements) column (both ends built-in). Buckling of pin jointed frames (maximum of two active dof).Symmetrical single bay portal frame.	
Self Study Component : Write algorithm and program to generate elastic bending stiffness matrix and geometric stiffness matrix for beam element	**10Hrs**
UNIT -IV	
Lateral buckling of beams –Differential equation, pure bending, cantilever beam with tip	

load, simply supported beam of I section subjected to central concentrated load. **Torsional Buckling** – Pure torsion of thin- walled bars of open cross section. Non-uniform torsion of thin -walled bars of open cross section.	
Self Study Component: Lateral buckling of simply supported I beam subjected to udl.	**10Hrs**
UNIT -V	
Buckling of rectangular plate: Buckling of uniformly compressed simply supported rectangular plate –Uniaxial and biaxial loading, Buckling of uniformly compressed rectangular plate simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides.	
Self Study Component: Buckling of rectangular plates under the action of shearing stresses.	**10Hrs**

Text Books :	
1	Stephen P. Timoshenko, James M. Gere, "Theory of Elastic Stability", 2nd Edition, McGraw-Hill, New Delhi.
2	Zeiglar.H," Principles of Structural Stability", Blaisdall Publication.
3	Rajasekaran.S, "Computational Structural Mechanics", Prentice-Hall, India.

Reference Books :	
1	Robert D Cook et al, "Concepts and Applications of Finite Element Analysis", 3rd Edition, John Wiley and Sons, New York.
2	Ray W Clough and J Penzien, "Dynamics of Structures", 2nd Edition, McGraw-Hill, New Delhi.
3	Ashwini Kumar,"Stability of Structures", Allied Publishers Limited, 1998.
4	Timoshenko and kriger, "Theory of plates and shells", McGraw –Hill Internal Book Company.

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to

1. Idealize the concepts of beam column structural behavior, stability of column and compute Euler's critical load for different boundary conditions.
2. Comprehend the energy method, bars on elastic foundation, successive approximation method for stability analysis.
3. Comprehend finite element method in stability analysis to simple plane truss and 2D beams and frames.
4. Grasp the concept of lateral buckling of beams, torsional buckling of beams and buckling of rectangular plate type structures.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Idealize the concepts of beam column structural behavior, stability of column and compute Euler's critical load for different boundary conditions.	**3**	**1**	**3**	**2**	**2**
2	Comprehend the energy method, bars on elastic foundation, successive approximation method for stability analysis.	**3**	**1**	**3**	**2**	**2**
3	Comprehend finite element method in stability analysis to simple plane truss and 2D beams and frames.	**3**	**1**	**3**	**2**	**3**
4	Grasp the concept of lateral buckling of beams, torsional buckling of beams and buckling of rectangular plate type structures.	**3**	**2**	**3**	**3**	**3**

Course Title : STRUCTURAL DESIGN- RCC STRUCTURES			
Course Code : P20MCAD23	**Semester : II**	**L-T-P : H : 3 – 2 – 0 - 5**	**Credits :04**
Contact Period :52 Hrs	**Exam Hours : 3 Hrs**	**Weight age : CIE:50% SEE:50%**	
Prerequisites : Design of Reinforced Concrete Structures			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	provide a detailed study of fundamental concepts for the design of RC structural elements,
2	The Professional knowledge required for safe, serviceable and economic design as per codal provisions
3	The design of storage structures
4	The concept of moment redistribution in RC structures
5	Explain the underlying theory for the provisions in IS standards.

Course content	
UNIT -I	
Redistribution of Moments in RC Beams: 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 – Modification of clear distance between bars in beams (for limiting crack width) with redistribution – Moment–curvature Relations of Reinforced Concrete sections. Curtailment of tension Reinforcement code procedure – Numerical examples.	
Self Study Component : Analysis and design of Corbels	**12 Hrs**
UNIT -II	
Design of waffle slab & Flat slab: Introduction, Design of waffle slabs, proportioning of flat slab, Direct design method-limitations of direct design method, distribution of moments in column strips and middle strip-shear in flat slabs. Analysis of flat slab with and without drop – Design Examples.	
Self Study Component: Design of circular slabs.	**10 Hrs**
UNIT -III	
Design of R.C Frame: Introduction, Example frame, Structural layout, Estimation of loads, Load combinations, Analysis, Design of elements of frames, Use of computer software for analysis and design. Design example.	
Self Study Component : Detailing of structural elements	**10 Hrs**

UNIT -IV	
Design of storage structure (Silos and Bunkers): Introduction, Design of Rectangular bunkers, Design of Silos by Janssen's &Airy's theory	
Self Study Component: Design of circular Bunkers.	**10 Hrs**
UNIT -V	
Design of Reinforced Concrete Deep Beams: Introduction – Minimum thickness -Steps of Designing Deep beams – design by IS 456.	
Self Study Component : Detailing of Deep beams	**10 Hrs**

Text Books :	
1	S. Pillai, Devdas Menon- "Reinforced Concrete Design", 3rd Edition,TMH publication.
2	Varghese. P.C.,"Advanced Reinforced Concrete design", prentice, Hall of India, Neevpeth.
3	Park R. and Paulay, T., "Reinforced Concrete Structures", John Wiley and Sons

Reference Books :	
1	Krishna Raju – "Advanced R.C. Design", CBSRD,1986,
2	Punmia B.C "Reinforced concrete Design", CBS Publishers.
3	IS 456 - 2000 Indian Standard Plain and Reinforced Concrete Course Code of Practice (Fourth Revision) BIS New Delhi

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to

1. Apply the concept of redistribution of moments in design.
2. Design a flat slabs and waffle slabs subjected to various load combinations.
3. Analyze a complex civil engineering structure consisting of structural elements mentioned above.
4. Design RCC deep beam, bunkers and silos using Janssen's & Airy's theory.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Apply the concept of redistribution of moments in design.	**2**		**2**	**1**	**1**
2	Design a flat slabs and waffle slabs subjected to various load combinations.	**2**	**1**	**2**	**2**	**2**
3	Analyze a complex civil engineering structure consisting of structural elements mentioned above.	**2**	**1**	**2**	**2**	**2**
4	Design RCC deep beam, bunkers and silos using Janssen's & Airy's theory.	**2**	**1**	**2**	**2**	**2**

Course Title : ADVANCED DESIGN OF STEEL STRUCTURES			
Course Code : P20MCAD241	**Semester : II**	**L-T-P- H : 3-2-0-5**	**Credits :4**
Contact Period : 52Hrs	**Exam Hours : 3 Hrs**	**Weight age : CIE :50% , SEE : 50%**	
Prerequisites: Knowledge on basic design of structural steel elements using limit state method and basics of structural analysis.			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Understand the advanced principles of the design of hot-rolled and cold-formed steel structural members.
2	To understand the advanced concepts in the design of structural steel by limit state method of design.
3	To be able to apply the principles of design of steel elements to the advancements in the field of steel structures.
4	To incorporate the principles of structural safety, economy and sustainability in all the designs of steel elements.
5	To understand the principles involved in the design of steel structures subjected to elevated temperatures and fire resistance of steel members.

Course content	
UNIT -I	
Laterally Unrestrained Beams: Lateral buckling of beams, factors affecting lateral stability, IS 800 code provisions, design approach. Lateral buckling strength of cantilever beams, continuous beams, beams with continuous and discrete lateral restraints, mono- symmetric and non-uniform beams – Design Examples.	
Self-Study Component : Design Examples.	**12Hrs**
UNIT -II	
Members Subjected to Combined Forces: **Beam Columns in Frames**: Behavior of short and long beam-columns, effects of slenderness ratio and axial force on modes of failure, biaxial bending, strength of beam columns, effective length of columns-, methods in IS: 800 – Examples.	
Self-StudyComponent: Design of Purlins.	**10Hrs**
UNIT -III	
Steel Beams with Web Openings: Shape of the web openings, practical guide lines, and force distribution and failure patterns, analysis of beams with perforated thin and thick webs, design of castellated beams.	
Self-StudyComponent: Vierendeel girders.	**10Hrs**
UNIT -IV	
Cold formed steel sections: Techniques and properties, advantages, typical profiles, Stiffened and un-stiffened elements, Local buckling effects, effective section properties, IS: 811 code provisions- numerical examples, beam design, column design.	
Self-Study Component: Tubular sections: Design principles of rounded tubular structures, permissible stresses, design of tension members, compression	**10Hrs**

members and beams, connections.	
UNIT -V	
Fire Resistance: Fire resistance level, Period of Structural Adequacy, Properties of steel with temperature, Limiting Steel temperature, Protected and unprotected members-Numerical Examples, Methods of fire protection.	
Self-Study Component: Fire resistance ratings.	**10Hrs**

Text Books:	
1	N. Subramanian, "Design of Steel Structures", Oxford,IBH.
2	Duggal.S.K.,"Design of Steel structures", Tata McGraw-Hill Education, 2000.
3	Dr. B.C. Punmia and Jain and Jain ,"Design of Steel Structures", Laxmi Publications

Reference Books :	
1	Dr.Ramchandra & Virendra Gehlot, "Design of Steel Structures", Scientific Publishers
2	INSDAG Teaching Resource Chapter 11 to 20: www.steel-insdag.org
3	P.K.Das and S.L.Srimani, "Hand book for the design of Castellated beams", Oxfoed & IBH publication CO.
4	Relevant Indian Standard Code books-IS 800: 2007, IS 801, IS 810, IS 811and SP 6(1)-1984 or Steel Table

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to

1. Appreciate the behaviour of laterally unsupported beams and the factors affecting it behaviour so as to be able to relate them to the design concepts involved with laterally unsupported beams. And apply the knowledge of structural members subjected to combined forces (axial and Bending moments) in analysing and designing such members.
2. Understand the influence of web openings on the structural behaviour of beams and to extend this concept for the design of castellated beams and Vierendeel girders.
3. Appreciate the behavior and design concepts involved with light gauge steel structures and tubular structures.
4. Apply the knowledge of structural members subjected to fire and able to know the methods of fire protection.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Appreciate the behaviour of laterally unsupported beams and the factors affecting it behaviour so as to be able to relate them to the design concepts involved with laterally unsupported beams. And apply the knowledge of structural members subjected to combined forces (axial and Bending moments) in analysing and designing such members.	**2**		**1**	**2**	
2	Understand the influence of web openings on the structural behaviour of beams and to extend this concept for the design of castellated beams and Vierendeel girders.	**2**		**1**	**2**	
3	Appreciate the behavior and design concepts involved with light gauge steel structures and tubular structures.	**2**		**1**	**2**	
4	Apply the knowledge of structural members subjected to fire and able to know the methods of fire protection.	**2**	**1**	**1**	**2**	

Course Title : DESIGN OF TALL STURCTURES			
Course Code : P20MCAD242	**Semester : II**	**L-T-P-H: 3 – 2 – 0 - 5**	**Credits :04**
Contact Period : 52 Hrs	**Exam Hours : 3 Hrs**	**Weight age : 50% SEE:50%**	
Prerequisites :Advanced Design of Reinforced Concrete Structures			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	To understand the behaviour of high rised buildings under different loads
2	To present different methods for the design including integration with finite element procedures
3	To explain the underlying theory for the provisions in IS standards
4	To understand the concepts of deep beam systems
5	To understand different framing system and their comparison-drift and dynamic response of building.

Course content	
UNIT -I	
Introduction The Tall Building in the Urban Context - The Tall Building and its Support Structure - Development of High Rise Building Structures. Dead Loads - Live Loads-Construction Loads -Snow, Rain, and Ice Loads - Wind Loads-Seismic Loading – Water and Earth Pressure Loads - Loads - Loads Due to Restrained Volume Changes of Material - Impact and Dynamic Loads - Blast Loads -Combination of Loads.	
Self Study Component: General Planning Considerations.	**10Hrs**
UNIT -II	
The vertical structure plane Dispersion of Vertical Forces- Dispersion of Lateral Forces - Optimum Ground Level Space - Shear Wall Arrangement. The Floor Structure or Horizontal Building Plane Floor Framing Systems-Horizontal Bracing- Composite Floor Systems the High - Rise Building as related to assemblage Kits Skeleton Frame Systems - Load Bearing Wall Panel Systems - Panel – Frame Systems –Multistory Box Systems.	
Self Study Component : Behaviour of Shear Walls under Lateral Loading	**10Hrs**
UNIT -III	
Common high-rise building structures and their behaviour under load The Bearing Wall Structure- The Shear Core Structure - Rigid Frame Systems- The Wall - Beam Structure: Interspatial and Staggered Truss Systems - Frame - Shear Wall Building Systems - Flat Slab Building Structures - Shear Truss - Frame Interaction System with Rigid - Belt Trusses - Tubular Systems-Composite Buildings - Comparison of High - Rise Structural Systems Other Design Approaches Controlling Building Drift Efficient Building Forms.	
Self Study Component: The Counteracting Force or Dynamic Response.	**10Hrs**
UNIT -IV	
Approximate structural analysis and design of buildings Approximate Analysis of Bearing Wall Buildings The Cross Wall Structure - The Long Wall Structure The Rigid Frame Structure Approximate Analysis for Vertical Loading – Approximate Analysis for Lateral Loading - Approximate Design of Rigid Frame Buildings-Lateral Deformation of Rigid Frame Buildings	

The Rigid Frame - Shear Wall Structure - The Vierendeel Structure.	
Self Study Component: The Hollow Tube Structure.	**10Hr**
UNIT -V	
Other high-rise building structure Deep - Beam Systems -High-Rise Suspension Systems - Pneumatic High -Rise Buildings - Space Frame Applied to High - Rise Buildings.	
Self Study Component : Capsule Architecture	**10Hrs**

Text Books :	
1	Wolfgang Schuller - " High - rise building Structures", John Wiley and Sons, New York 1976.
2	Bryan Stafford Smith and Alex Coull, " Tall Building Structures ", Analysis and Design, John Wiley and Sons, Inc., 1991.
3	Coull, A. and Smith, Stafford, B. " Tall Buildings ", Pergamon Press, London, 1997.

Reference Books :	
1	LinT.Y. and Burry D.Stotes, "Structural Concepts and Systems for Architects and Engineers ", John Wiley, 1994.
2	Lynn S.Beedle, "Advances in Tall Buildings", CBS Publishers and Distributors, Delhi,
3	Taranath.B.S.,"Structural Analysis and Design of Tall Buildings", McGraw Hill,1998.

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to

1. Describe tall structures and the types of load acting on tall structures.
2. Explain dispersion of lateral forces, flooring system, wall panel system and multi-story box system.
3. Discuss different framing system and their comparison-drift and dynamic response of building.
4. Design of tall structure by approximate method.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Describe tall structures and the types of load acting on tall structures.	**2**		**2**	**2**	**2**
2	Explain dispersion of lateral forces, flooring system, wall panel system and multi-story box system.	**2**		**2**	**2**	**2**
3	Discuss different framing system and their comparison-drift and dynamic response of building.	**1**		**2**	**2**	**2**
4	Design of tall structure by approximate method.	**2**		**2**	**2**	**2**

Course Title : COMPOSITE AND SMART MATERIALS			
Course Code : P20MCAD251	**Semester : I**	**L-T-P : H : 3-2-0-5**	**Credits :**
Contact Period : 52 Hrs	**Exam Hours : 3Hrs**	**Weight age : CIE :50% , SEE : 50%**	
Prerequisites: Structural Analysis and Strength materials.			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Analyse the environmental effect on materials and their components.
2	Study various composite materials and their characteristics.
3	Familiarize with different materials of building construction.
4	Focus on the stability properties of materials.
5	Understand actuators and sensors.

Course content	
UNIT -I	
Introduction to Composite materials: Classifications and applications. Of fibers, volume fraction and load distribution among constituents, minimum & critical volume fraction, compliance & stiffness matrices, coupling. Numerical problems	
Self Study Component: Sand witch structure faces and core materials.	**12 Hrs**
UNIT -II	
Anisotropic elasticity: Unidirectional and anisotropic lamina, thermo-mechanical properties, micro- mechanical analysis, classical composite lamination theory, Cross and angle–play laminates, symmetric, anti-symmetric and general asymmetric laminates, mechanical coupling, laminate stacking, Numerical problems.	
Self Study Component : Laminate stacking	**10 Hrs**
UNIT -III	
Analysis of simple laminated structural elements: Ply-stress and strain, lamina failure theories - first fly failure, environmental effects, manufacturing of composites. Numerical problems.	
Self Study Component: Thermal stresses in laminates.	**10Hrs**
UNIT -IV	
Smart materials: Introduction, Types of smart structures, actuators & sensors, embedded & surface mounted, piezoelectric coefficients, phase transition, piezoelectric constitutive relation.	
Self Study Component: Application of smart materials.	**10 Hrs**
UNIT -V	
Actuators and sensors: Single and dual actuators, pure extension, pure bending, bending extension relations, uniform strain beam model, symmetric induced strain actuators, bonding shearing force, Bernoulli's-Euler beam models, embedded actuators, asymmetric induced strain actuators, in uniform strain and Euler-Bernoulli models. Uniform strain model, energy principal formulation.	
Self Study Component: Extension-bending and torsion model.	**10 Hrs**

Text Books :	
1	Robart M Jones, Mechanic of Composite Materials, McGraw Hill Publishing Co, 2015.
2	Bhagwan D Agarawal, and Lawrence J Brutman, Analysis and Performance of Fiber Composites, John Willy and Sons, 2006.
3	Madujit Mukhopadyay, Mechanics of composite materials and structures, University Press, 2004.

Reference Books :	
1	Mercedes C. Reaves and Lucas G. Horta, Piezoelectric actuator modeling using MSC/NASTRAN and MATLAB. NASA/TM-2003-212651, Langley Research Center, Hampton, Virginia, 2003.
2	Crawley E F. and Delius J, Use of piezoelectric actuators elements of intelligent structures, A journal Vol 25, No 10 Oct 1987, Pp 1373-1385.
3	Ceawley E. and Anderson E., Detailed models of Piezo-ceramics actuation of beams, Proceedings of the 30th AIAA/ASME/ASCE/ASC – Structural dynamics and materials conference, Washington DC, April 1989.
4	Inderjit h Chopra, Lecture notes on Smart Structures, Department of Aerospace Engg., University of Maryland.

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to

1. Carry out classification and application of various types of fibres.
2. Explain thermo-mechanical properties of materials.
3. Analyse environmental effects and failure theories of composite materials.
4. Familiarize with smart materials and structures.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Carry out classification and application of various types of fibres.	**3**	**2**		**2**	
2	Explain thermo-mechanical properties of materials.	**3**	**2**	**2**		
3	Analyse environmental effects and failure theories of composite materials.	**2**	**3**		**3**	
4	Familiarize with smart materials and structures.	**3**			**2**	

Course Title : ANALYSIS OF PLATES			
Course Code : P20MCAD252	**Semester : II**	**L-T-P : H : 3-2-0-5**	**Credits :4**
Contact Period : 52Hrs	**Exam Hours : 3 Hrs**	**Weight age : CIE50 : , SEE 50:**	
Prerequisites : Basic Strength of Materials			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Learn basic concepts in theory of plates with small deflections and analysis of thin circular plates.
2	Use Navier's solution to analyse SSSS thin plates with small deflections.
3	Use Levy's solution to analyse Rectangular Plates with Different Edge Conditions with small deflections.
4	Use FDM to analyse thin plates with small deflections.
5	Understand the concepts of folded plates.

Course content	
UNIT –I	
Bending of Plates: Introduction - Slope and curvature of slightly bent plates – relations between bending moments and curvature in pure bending of plates – Differential equation for cylindrical bending of long rectangular plates, Differential equation for symmetrical bending of laterally loaded circular plates – uniformly loaded circular plates with and without central cutouts, with two different boundary conditions (simply supported and clamped).	
Self Study Component: Strain energy in pure bending & centrally loaded clamped circular plate	**12 Hrs**
UNIT –II	
Simply supported rectangular plates: Differential equation of the deflection surface – boundary conditions. Simply supported rectangular plates subjected to harmonic loading. Navier's solution for simply supported plate subjected to udl, patch load and point load.	
Self Study Component: Hydrostatic pressure	**10Hrs**
UNIT –III	
Rectangular Plates with Different Edge Conditions: Bending of simply supported rectangular plates subjected to udl, Bending of rectangular simply supported plate subjected to a distributed moments at a pair of opposite edges, Bending of rectangular plates subjected to udl (i) two opposite edges simply supported and the other two edges clamped, (ii) three edges simply supported and one edge built-in	
Self Study Component : Bending of rectangular plates subjected to udl with all edges built-in	**10 Hrs**
UNIT –IV	
Finite Difference Approach: Application of finite difference technique for the analysis of isotropic rectangular plates subjected to uniformly distributed lateral loads.	
Self Study Component: Use of standard computer packages for the analysis of Plates.	**10 Hrs**
UNIT –V	
Folded Plate: Introduction, Advantages Assumptions, and Analysis of Folded Plates by	

Whitney's Method.	
Self Study Component: Simpson's Method.	**10 Hrs**

Text Books :	
1	Timoshenko and Krieger, "Theory of Plates and Shells", McGraw-Hill International Book Company.
2	Chandrashekara K, "Theory of Plates", University Press.
3	Robert D Cook et al, "Concepts and Applications of Finite Element Analysis", 3rd Edition, John Wiley and Sons, New York.

Reference Books :	
1	Szilard. R, "Theory and analysis of plates-classical and numerical methods" Prentice Hall.
2	Ugural A C, "Stress in Plates and shells", McGraw-Hill International Book Company
3	Bathe.K.J, "Finite element procedures in Engineering Analysis", PHI,New Delhi
4	Bhavikatti S.S., "Advance Design of RCC Design", New Age International (P) Limited, Publishers, New Delhi.

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to

1. Apply knowledge of mathematics, science, and engineering related to plate theory.
2. Obtain the solution for thin plates subjected to different types of loadings under different boundary conditions using various methods for small deflections.
3. Apply the principles of FDM to analyse thin plates with small deflections.
4. Understand & analyse folded plates.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Apply knowledge of mathematics, science, and engineering related to plate theory.	**3**		**2**	**2**	**2**
2	Obtain the solution for thin plates subjected to different types ofloadings under different boundary conditions using various methods for small deflections.	**2**		**3**	**2**	**2**
3	Apply the principles of FDM to analyse thin plates with small deflections.	**2**		**3**	**2**	
4	Understand & analyse folded plates.	**2**		**2**	**1**	**3**

Course Title : STRUCTURAL SOFTWARE LABORATORY- II			
Course Code : P20MCADL27	**Semester : II**	**L-T-P : H : 0 – 0 – 4-4**	**Credits : 02**
Contact Period : 39 Hrs	**Exam Hours : 3 Hrs**	**Weight age : CIE:50% SEE:50%**	
Prerequisites : Design of Earthquake Resistant Structures			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	To use industry standard software's in a proficient manner besides knowing the theoretical concepts of structural analysis

	Course content
1	Analysis and design of transmission towers and other steel structures-for different load combinations
2	Analysis and design of Elevated water tank using SAP 2000.
3	FE Analysis of framed structures due to seismic force using modal dynamics.
4	FE Analysis of slab panel resting on column supports-Drop panels, Capitals
5	Stress analysis of cantilever beam, simply supported beam and fixed beam using ANSYS.
6	Stress analysis of Plate with hole using ANSYS.

Reference Books :	
1	Finite Element Analysis: Theory and application with ANSYS , 2008, 3rd edition ,Saeed Moaveni,Minnesota.
2	State University,Mankato CSI Analysis Reference manual-ETABS 2013

Course Outcomes

After learning all the units of the course, the student is able to

1. Use standard software packages for analyze and design of RC and steel structures.
2. Apply the concept of FEM to analyze the structural component using standard software package.
3. Understand the elements of finite element modeling, specification of loads and boundary condition, performing analysis and interpretation of results for final design.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Use standard software packages for analyze and design of RC and steel structures.	**2**	**1**	**2**	**2**	**3**
2	Apply the concept of FEM to analyze the structural component using standard software package.	**2**	**1**	**2**	**2**	**3**
3	Understand the elements of finite element modeling, specification of loads and boundary condition, performing analysis and interpretation of results for final design.	**3**	**2**	**3**	**2**	**2**

Course Title : SPECIAL CONCRETE			
Course Code:P20MCAD32	**Semester: III**	**L–T–P–H :**	**Credits: 3**
Contact Period :	**Exam Hours : 3 Hrs**	**Weight age : CIE : 50% , SEE : 50%**	
Prerequisites : - NIL			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Give an insight to the conventional concrete, properties of its constituent's materials and mix proportioning.
2	To study the Microstructure of Mortar and concrete and Application of Nano materials in construction industry and micro fine cement
3	To study the different types of concrete and its properties
4	To gain the knowledge of improvent of concrete in the present scenario and failure due to cracks.
5	Learn Mix design for various types of concrete as per codal provisions.

Course content
UNIT -I
Review of conventional concrete - Introduction to concrete as a construction material. Components of modern concrete and developments in the process and constituent materials: Role of constituents, Development in cements and cement replacement materials, pozzolona, fly ash, silica fume, rice husk ash, recycled aggregates, chemical admixtures. Mix proportioning of Concrete: Principles and methods
Self Study Component: Different types of Cements - composition and application. Hydration of Cement and Structure of hydrated Cement. **10 Hrs**
UNIT -II
Microstructure of Mortar and concrete - Interfacial transition zone in concrete and its influence on strength, behavior and properties of concrete, Significance of properties of fresh and hardened concrete, Application of Nano materials in construction industry and micro fine cement. Durability of concrete - permeability, chemical attack, sulphate attack, , corrosion and carbonation of concrete
Self Study Component: Alkali Aggregate Reaction **10 Hrs**
UNIT -III
Neo Concrete: High density concrete: Materials, properties and Placement method of high density concrete, Light weight concrete. Introduction and classification, Properties of Light weight concrete. Fiber reinforced concrete- Fibers types and properties, Behavior of FRC, Ferro cement - materials, properties and application, Recycled concrete.
Self Study Component: Design of Ferro cement in tension **12 Hr**
UNIT -IV
Progress in concrete Technology: Ready mixed concrete - manufacture, transporting, placing and precautions. Proportions, properties and uses of High strength Concrete, Self-consolidating concrete, Polymer impregnated concrete, High performance concrete and Roller compacted concrete, Porous concrete, Engineered cementations composites and smart concrete.

Self Study Component: crack arrest and toughening mechanism in Fiber reinforced concrete. **10 Hrs**
UNIT -V
Special Concrete & Mix design: Pump able concrete and its applications. Concept of mix design, variables in proportioning, exposure conditions, and procedure of mix design as per relevant codal provisions and numerical examples of mix design of Conventional concrete, Self compacting concrete, and Geopolymer concrete.
Self Study Component: Bacterial concrete. **10 Hrs**

Text Books :	
1	Neville A.M, "Properties of Concrete" Pearson Education Asia, 2000
2	. P. Kumar Mehta and Paulo J. M. Monteiro, 2006. Concrete - Microstructure, Properties, and Materials, 3rd Edition, McGraw-Hill,
3	M L Gambhir, Concrete Technology, 2009, 4th Ed., McGraw-Hill
4	A.R.Santhakumar, (2007) "Concrete Technology"-Oxford University Press, New Delhi, 2007

Reference Books :	
1	Short A and Kinniburgh.W, "Light Weight Concrete"- Asia Publishing House, 1963
2	Aitcin P.C. "High Performance Concrete"-E and FN, Spon London 1998
3	Rixom.R. and Mailvaganam.N., "Chemical admixtures in concrete"- E and FN, Spon London 1999
4	Rudnai.G., "Light Weight concrete"- Akademiaikiado, Budapest, 1963

Course Outcomes

After learning all the units of the course, the student is able to

1. Reproduce the basic knowledge of mathematics, science and engineering in conventional concrete, properties of its constituent's materials and mix proportioning.
2. Able to understand and analyse Microstructure of Mortar and concrete and and apply the knowledge in the application of Nano materials in construction industry and micro fine cement.
3. To reproduce the knowledge of improvent of concrete and failure of concrete due to cracks.
4. Provide factual knowledge of Mix design for various types of concrete as per codal provisions.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Reproduce the basic knowledge of mathematics, science and engineering in conventional concrete, properties of its constituent's materials and mix proportioning.	**2**	**2**	**3**	**3**	**2**
2	Able to understand and analyse Microstructure of Mortar and concrete and apply the knowledge in the application of Nano materials in construction industry and micro fine cement.	**3**	**3**		**3**	**1**
3	To reproduce the knowledge of improving of concrete and failure of concrete due to cracks.		**2**	**3**	**3**	**1**
4	Understand the progress in recent concrete technologies and reproduce the different types of concrete with their pros and cons.	**2**	**2**		**2**	**1**

Course Title : Formwork Techniques & Design			
Course Code : P20MCAD33	**Semester : III**	**L-T-P : H : -**	**Credits : 3**
Contact Period : -	**Exam Hours : 3Hrs**	**Weight age : CIE : 50% , SEE : 50%**	
Prerequisites : NIL			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Make students differentiate between different formwork materials.
2	Understand the different kinds of pressures that are acting on formwork
3	Gain knowledge about different techniques involved in formwork.
4	Analyze the formwork members for bending moment, shear stress and deflection
5	Learn the design of formwork for walls and slabs with all the accessories.

Course content	
UNIT -I	
Form Materials- Lumber-types, allowable stresses of lumber - Plywood-types & grades, allowable stresses for plywood - Reconstituted wood – Plyforms & High density overlaid plyform – Hardboards – Fiber form tubes – Steel forms – Aluminum forms – Plastic forms, Form liners, Timber connectors – Nails – Lag screws – Toe nail connections – Form ties - Concrete anchors.	
Self Study Component : Adjustment factors for using lumber under different cases	
UNIT -II	
Pressure of concrete on formwork – Behavior of concrete - Lateral pressure of concrete on formwork – Lateral pressure of concrete on wall forms & problems – Lateral pressure of concrete on column forms & problems – effect of weight of concrete on pressure – Vertical loads on forms - Placement and consolidation of freshly placed concrete – wind loads on formwork systems.	
Self Study Component : Problems to determine vertical load on forms	
UNIT -III	
Formwork work Techniques- Flying Deck Forms – Slipfomrs – Forms for architectural concrete– Shores & Scaffolding-wood post shores, Ellis shores, Symons shores, horizontal shores, shoring formwork for multistoried structures, Tubular steel scaffolding frames, steel tower frames – Failures of formwork.	
Self Study Component :OSHA regulations for formwork and shoring	
UNIT -IV	
Analysis of Formwork members- Loads on structural members – Analysis of bending	

moments in beams with Concentrated loads, UDL – Bending stresses in beams & Stability of bending members, problems – Deflection of beams with single and multiple spans subjected to concentrated loads and UDL.
Self Study Component : Allowable span length based on moment, shear or deflection
UNIT -V
Design of formwork for wall & slab- Allowable pressure on plywood based on bending stress, rolling shear stress and deflection (no problems) – Design of forms for concrete wall – Design of forms for concrete slab.
Self Study Component : Minimum lateral force for design of forms for walls and slabs

Text Books :	
1	Robert L. Peurifoy and Garold D. Oberlender, "Formwork for Concrete Structures", Fourth Edition McGraw-Hill, 1996.
2	Hurd, M.K., "Formwork for Concrete", Special Publication No. 4 Sixth Edition, American Concrete Institute, Detroit, 1995.

Reference Books :	
1	Michael P. Hurst, "Formwork", Construction Press, London and New York, 1997.
2	Tudor Dinescu and Constantin Radulescu, "Slipform Techniques", Abacus Press, Turn BridgeWells, Kent, 1992.
3	Austin, C.K., "Formwork for Concrete", Cleaver – Hume Press Ltd., London 1996.
4	"Safety Requirements for Scaffolding", American National Standards Institute, New York, 1994.

Note: Self study is for 5 marks only in CIE and not in SEE

Course Outcomes

After learning all the units of the course, the student is able to

1. Differentiate between different formwork materials.
2. Understand the different kinds of pressures that are acting on formwork
3. Acquire the knowledge of different techniques involved in formwork.
4. Analyze and design formworks.

Course Articulation Matrix (CAM)

Sl. No	Course Outcomes (CO's)	Program outcomes (PO's)				
		1	2	3	4	5
1	Differentiate between different formwork materials.	**1**	**3**			
2	Understand the different kinds of pressures that are acting on formwork	**2**	**3**	**2**		
3	Acquire the knowledge of different techniques involved in formwork.		**2**	**2**	**1**	**3**
4	Analyze and design formworks		**2**	**3**	**1**	**3**