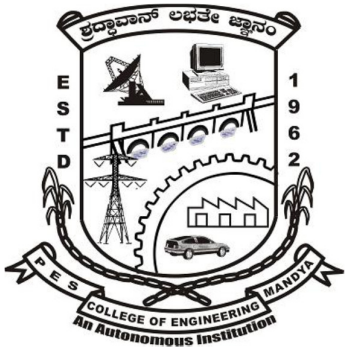
Scheme & Syllabus
of
M.Tech in CAD of Structures
(With effect from 2020-2021 Academic year)

Outcome Based Education
With
Choice Based Credit System

ಪಠ್ಯಕ್ರಮ

(ಶೈಕ್ಷಣಿಕವರ್ಷ 2020–21)



P.E.S. College of Engineering, Mandya - 571 401, Karnataka

(An Autonomous Institution Affiliated to VTU, Belagavi
Grant -in- Aid Institution (Government of Karnataka), World Bank Funded College (TEQIP)
Accredited by NBA & NAAC and Approved by AICTE, New Delhi.)

ಪಿ.ಇ.ಎಸ್. ತಾಂತ್ರಿಕಮಹಾವಿದ್ಯಾಲಯ

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Preface

PES College of Engineering, Mandya, started in the year 1962, has become autonomous in the academic year 2008-09. Since, then it has been doing the academic and examination activities successfully. The college is running 6 Postgraduate programs. It consists of 4 M.Tech programs, which are affiliated to VTU. Other postgraduate programs are MBA and MCA.

India has become a Permanent Member by signing the Washington Accord. The accord was signed by the National Board of Accreditation (NBA) on behalf of India on 13th June 2014. It enables not only the mobility of our degree globally but also establishes equivalence to our degrees with that of the member nations such as Taiwan, Hong Kong, Ireland, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Turkey, Australia, Canada and Japan are among 16 signatories to the international agreement besides the US and the UK. Implementation of Outcome Based Education (OBE), has been the core issue for enabling the equivalence and of Indian degrees and their mobility across the countries.

Our Higher Educational Institution has adopted Credit Based system (CBCS) based semester Structure with OBE Scheme and grading system which provides the flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. There lies a shift in thinking, teaching and learning process moving towards students Centric from Teachers Centric Education which enhances the knowledge, skills & moral values of each student.

Choice Based Credit System (CBCS) provides the options for the students to select from the number of prescribed courses. The CBCS provides a 'cafeteria' type approach in which the students can choose electives from a wide range of courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, adopt an interdisciplinary approach for learning which enables integration of concepts, theories, techniques. These are greatly enhances the skill/employability of students.

In order to increase the Industry Institute Interaction, Internship have been added to the existing curriculum of 2020-21. Further, Research Methodology & IPR and two Self Study Courses have been introduced to enhance their Research ability and Self Learning ability respectively. Lab Components are also included in I & II Semester.

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Deputy Dean (Academic)
Associate Professor,
Dept. of CS & Engg

Dr. Nagarathna
Dean (Academic)
Professor
Dept. of CS & Engg

P.E.S. College of Engineering, Mandya

VISION

"PESCE shall be a leading institution imparting quality Engineering and Management education developing creative and socially responsible professionals

MISSION

- Provide state of the art infrastructure, motivate the faculty to be proficient in their field of specialization and adopt best teaching-learning practices.
- Impart engineering and managerial skills through competent and committed faculty using outcome based educational curriculum.
- Inculcate professional ethics, leadership qualities and entrepreneurial skills to meet the societal needs.
- Promote research, product development and industry-institution interaction.

Department of Civil Engineering

Vision

To attain Excellence in imparting quality civil engineering education to meet the societal needs.

Mission

- Impart civil engineering and managerial skills with state of art infrastructure, competent and committed faculty using outcome based educational curriculum.
- Promote research, project management and consultancy
- Inculcate professional ethics, leadership qualities and entrepreneurial skills to meet the societal needs.

The Program Educational Objectives (PEOs)

Graduates will be able to

- Apply technical competence in the field of Civil Engineering with a strong background in basic science and mathematics.
- Analyse and interpret data to design or evaluate civil engineering systems to satisfy societal needs with the use of modern tools including higher education.
- Function effectively as an individual and or to work in a team on multispecialized civil engineering projects with professional ethics and effective communication skills inculcating the habit of life-long learning.

Program Specific Outcomes (PSOs)

The Program specific outcomes have been derived from the PSC's defined by ASCE. By the time of graduation, Civil Engineering students will be able to

PSO1: Apply knowledge of basic science to analyze and solve problems in the core area of Civil Engineering such as Structural, Geotechnical, Transportation, Environmental, Hydraulics and Water resources engineering.

PSO2: Analyze, Plan, design, quality assessment and cost estimate of Civil Engineering structures with professional ethics.

PSO3: Work in a consulting organization or can be an entrepreneur to investigate and supervise Civil Engineering structures using modern tools and technology to provide sustainable solutions to meet the societal needs.

M.Tech. in Computer Aided Design of Structures

Semester Wise Credits

Sl. No.	Semester	Credits
1.	I	24.00
2.	II	24.00
3.	III	22.00
4.	IV	18.00
TOTAL		88.00

Grading system

Marks	Grade
90 – 100	S
75 – 89	A
66 – 74	B
56 – 65	C
50 – 55	D
45 – 49	E
< 45	F

Notations in the Scheme

CIE	Continuous Internal Evaluation
SEE	Semester End Examination
L	Lecture
T	Tutorial
P	Practical/Project

Teaching & Examination for M.Tech Computer Aided Design of Structures

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 and FEM	04	--	--	50	50	100	4
2.	P20 MCAD 12	Structural Dynamics-Theory and Computation	04	--	--	50	50	100	4
3.	P20 MCAD 13	Theory of Elasticity and Plasticity	04	--	--	50	50	100	4
4.	P20 MCAD 14X	Professional Elective – I	04	--	--	50	50	100	4
5.	P20 MCAD 15X	Professional Elective – II	04	--	--	50	50	100	4
6.	P20 MCAD L16	Structural Engineering Laboratory	--	--	04	50	50	100	2
7.	P20 MCAD17	Mini Project	--	--	--	50	50	100	2
Total			**20**	--	**04**	**350**	**350**	**700**	**24**

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	04	--	--	50	50	100	4
2.	P20MCAD22	Structural Stability Analysis Classical and FE Approach	04	--	--	50	50	100	4
3.	P20MCAD23	Structural Design –RCC Structures	04	--	--	50	50	100	4
4.	P20MCAD24X	Professional Elective – III	04	--	--	50	50	100	4
5.	P20MCAD25X	Professional Elective – IV	04	--	--	50	50	100	4
6.	P20MCAD26	Project Phase – I	-	--	--	100	--	100	2
7.	P20MCADL27	Structural Software Laboratory	-	--	04	50	50	100	2
Total			**20**	--	**04**	**400**	**300**	**700**	**24**

Professional Elective III			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.	P20MHSM31	Research Methodology and IPR	04	--	--	50	50	100	4
2.	P20MCAD32	Self study course -1	--	--	--	100	--	100	3
3.	P20MCAD33	Self study course -2	--	--	--	100	--	100	3
4.	P20 MCAD 34	Technical Seminar	--	--	--	100	--	100	2
5.	P20 MCAD 35	Project Phase – II	--	--	--	100	--	100	4
6.	P20 MCAD36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters)			50	50	100	6
Total			**04**	**--**	**--**	**500**	**100**	**600**	**22**

Self Study Course		
SL. NO	**Course Code**	**Course Title**
1	P20MCAD32	Special Concrete
2	P20MCAD33	Formwork Techniques and Design

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	4
2.	P20 MCAD 42	Project Thesis Evaluation	--	--	--	100	--	100	6
3.	P20 MCAD 43	Project Viva - Voce]	--	--	--	--	100	100	6
4.	P20 MCAD 44	Term Paper	--	--	--	100	--	100	2
Total			**--**	**--**	**--**	**300**	**100**	**400**	**18**

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 should be chosen from the available 12 weeks NPTEL online courses recommended by the Department. The student can undergo NPTEL course registration during II / III Semester and the credit will be considered in III Semester. The 100 marks CIE assessment is based on the final NPTEL score (i.e. Online assignments: 25% + Proctored exam: 75%). The NPTEL score will be mapped directly to the CIE marks only if he /she has completed the NPTEL course (i.e. Certification). Those, who do not take-up/ Complete the NPTEL course shall be declared as failed and have to complete during the subsequent examination after satisfying the NPTEL requirements.

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. Mini Project:

- Mini Project shall comprise of an exercise assigned to a student similar to major projects.
- The topics may be related to the field of their UG Programme, that address the social issues.
- A report (not less than 20 A4 pages) to be submitted, detailing the solution to the problem / concept worked out during the semester.
- The work may be evaluated for award of Internal Assessment marks (CIE) based on a presentation / demonstration and viva voce, by a committee coordinated by the Course coordinators.

8. Project Work: The Project Work carries 22 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 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 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.

9. 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 : 4-0-0 : 4**	**Credits : 4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage : CIE : 50% , SEE : 50%**	
Prerequisites : Structural Analysis			

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.	**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: Use FE Tool for the analysis of structural elements.	**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, 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 Title : STRUCTURAL DYNAMICS - THEORY AND COMPUTATION			
Course Code : P20MCAD12	**Semester : I**	**L-T-P : H : 4-0-0 : 4**	**Credits : 4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage : CIE : 50%, 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.	**10 Hrs**
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: Use FE Tool / Programme to get mass matrix and element	**10 Hrs**

matrix of two noded beam elements.		
Text Books :		
1	Mario Paz, ***"Structural Dynamics, Theory and Computation",*** CBS Publisher and Distributors, New Delhi.	
2	Madhujit Mukhopadyay, ***"Vibrations, Dynamics and Structural Systems"***, Oxford Publishers, New Delhi.	
3	Damodaraswamy S.R, Kavitha S***, "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 Title :THEORY OF ELASTICITY AND PLASTICITY			
Course Code: P20MCAD13	**Semester : I**	**L-T-P- H : 4-0-0 : 4**	**Credits : 4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage : CIE : 50% , SEE : 50%**	
Prerequisites: 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 plastic behavior of materials and theories of failures.

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.	**12 Hrs**
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.	**10 Hrs**
UNIT -III	
Stress-Strain Relationship: Hooke'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.	**10 Hrs**
UNIT -IV	
Applications Problems: Solution of some simple beam problems, including working out of displacement components. Applications in polar coordinates: Axi- symmetric stress distribution, Analysis of Thick cylinders, Hollow 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 Pure bending of curved bars.	**10 Hrs**

UNIT -V	
Theory of Plasticity: Stress –strain diagram in simple tension, perfectly elastic, Rigid – Perfectly plastic, Linear work – hardening, Elastic Perfectly plastic, Elastic Linear work hardening materials, Failure theories, yield conditions, stress – space representation of yield criteria through Westergard stress space, Tresca and Von-Mises criteria of yielding.	
Self Study Component: Elastic plastic problems in bending and torsion.	**10 Hrs**

Text Books:	
1	Timoshenko and Goodier, ***"Theory of elasticity",*** McGraw Hill Book Company, 1983.
2	Valliappan. S, ***"Continuum Mechanics fundamentals",*** Oxford and IBH.
3	Chakrabarty J, :***Theory of Plasticity***", McGraw-Hill Book Company, New York 1990

Reference Books :	
1	Srinath. L.S., ***"Advanced Mechanics of Solids"***, Tata McGraw-Hill Publishing Co ltd., New Delhi.
2	Sitharam T.G. and Govindaraju L, ***"Elasticity for Engineers",*** IK International Publishing house Pvt, Ltd.
3	Irving H.Shames and James, M.Pitarresi, ***"Introduction to Solid Mechanics***", Prentice Hall of India Pvt. Ltd., New Delhi -2002.
4	Chen W. F and Han D. J., ***"Plasticity for structural Engineers"***, Springer-Verlag., NY, 1988.

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 plasticity to understanding the plastic behavior of materials and theories of failure.

Course Title : REHABILITATION OF STRUCTURES			
Course Code : P20MCAD141	**Semester : I**	**L-T-P : H : 4-0-0 : 4**	**Credits : 4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage : 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.	
Self Study Component: Corrosion protection techniques.	**10 Hrs**
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, permeability test, and non destructive testing systems – NDT methods, ultrasonic pulse velocity test, pulse echo method, electromagnetic methods.	
Self Study Component: Acoustic emissions, radiographic methods.	**10 Hrs**
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, cementitious 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.	

Self Study Component: Polymeric materials and coatings, SFRC.	**12 Hrs**

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.

Self Study Component: Near Surface Mounted technique.	**10 Hrs**

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.

Self Study Component: Steps to reduce repairs and replacement, normal breakup, demolition tools and materials, general information regarding demolition.	**10 Hrs**

Text Books :

1	Vadivelli B, ***"Rehabilitation of Concrete Structures",*** Standard Publishers and Distributors, Delhi.
2	Bhattacharjee J. ***"Concrete Structures Repair, Rehabilitation and Retrofitting".*** CBS Publishers and distributors,Pvt.Ltd.
3	Alexander Newman ***"Structural Renovation of Buildings"***, McGraw Hill, 2009.

Reference Books :

1	Poonam I. Modi & Chirag N.Patel by ***"Repair and Rehabilitation of Concrete Structures".***
2	Allen R T and S.C. Edwards, Blakie and sons ***"Repair of concrete Structures",*** UK, 1987.
3	Santhakumar, ***"Training course notes on damage assessment and Repair in low cost housing",*** 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 Title : DESIGN OF CONCRETE BRIDGES			
Course Code : P20MCAD142	**Semester : I**	**L-T-P : H : 4 –0 – 0 : 4**	**Credits : 4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage : CIE : 50%, SEE : 50%**	
Prerequisites: Design of Reinforced Concrete Structures, Design of Prestressed Concrete Structures.			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Recall the load flow mechanisms in designing of slab culvert.
2	Analyse Box culvert and Pipe culvert.
3	Apply the concepts in proportioning and design of T-beam bridges.
4	Recall the knowledge of PSC in designing of PSC bridges.
5	Apply the knowledge of support condition in designing of Balanced cantilever Bridge.

Course content	
UNIT –I	
Introduction & Design of Slab Culvert: Historical Developments, Selection for Bridges, Classification of Bridges, Forces on Bridges, IRC Loadings, 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 & Pipe culvert: Loading Cases, IRC Class AA Tracked Vehicle, IRC Class AA Wheeled Vehicle, IRC Class A Loading, Moment Distribution, Structural Design of Box Culvert, and Structural Design of Pipe Culvert.	
Self Study Component: Reinforcement detail of pipe culvert & Box Culvert.	**10 Hrs**
UNIT –III	
T Beam Bridge: Slab Design: Proportioning of Components, Analysis of Slab using IRC Loadings, 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 massonet method.	**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: Concept of prestressed concrete cellular Box Girder,	**10 Hrs**

bridge deck.	
UNIT –V	
Balanced Cantilever Bridge: Introduction & Proportioning of Components, Design of Simply Supported Portion, Design of Simply Supported Portion, Design of Cantilever Portion, and Design of Articulation.	
Self Study Component: Detailing of balanced cantilever bridges.	**12 Hrs**

Text Books :	
1	Johnson Victor D, ***"Essentials of Bridge Engineering",*** Oxford & IBH Publishing Co. New Delhi.
2	Raina V.K ***"Concrete Bridge Practise",*** Tata McGraw Publishing Co. New Delhi.
3	Jagadeesh T R and Jayaram M.A, ***"Design of Bridge Structures",*** Prentice hall of India.

Reference Books :	
1	Bindra S P, DhanpatRai & Sons ***"Principles and Practice of Bridge Engineering"***, New Delhi.
2	Krishna Raju N, ***"Design of Bridges",*** Oxford & IBH Publishing Co. New Delhi.
3	Relevant ***IRC codes***.
4	Relevant ***IS codes.***

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 & Pipe 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 and balanced Cantilever bridges subjected to various load combinations.

Course Title : RELIABILITY ANALYSIS AND DESIGN OF STRUCTURAL ELEMENTS			
Course Code:P20MCAD151	**Semester : I**	**L-T-P : H : 4 – 0 – 0 : 4**	**Credits : 4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage : CIE : 50% , SEE : 50%**	
Prerequisites: Engineering Mathematics			

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.	**10 Hrs**
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.	**10 Hrs**
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.	**10 Hrs**
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.	**10 Hrs**
UNIT –V	
Reliability analysis by Simulation techniques: 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.	**12 Hrs**

Text Books :	
1	Ranganthan R, ***"Reliability Analysis and Design of Structures",*** Tata McGraw Hill publishing Co. Ltd., New Delhi.
2	Srinath L S, ***"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 Tang W.H., ***"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 Title : ADVANCES IN ARTIFICIAL INTELLIGENCE			
Course Code : P20MCAD152	**Semester : I**	**L-T-P : H : 4-0-0 : 4**	**Credits : 4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage: 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, nature of 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	
Learning: 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	
Robotics: 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",*** Pearson Education, 2007.
2	Yagna Narayana B., ***"Artificial Neural Networks"***, PHI, 2004.

3	Krishnamoorthy C.S., S. Rajeev., ***"Artificial intelligence and expert systems for engineers"***, CRC Press, Year: 1996.

Reference Books :	
1	Rich E and Knight K., ***"Artificial Intelligence",*** 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",*** Thomson. 2005.
4	Ivan Bratka ***"PROLOG Programming for Artificial Intelligence",*** 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 Title : STRUCTURAL ENGINEERING LABORATORY			
Course Code : P20MCADL16	**Semester : I**	**L-T-P : H : 0-0-4 : 4**	**Credits : 2**
Contact Period : 39Hrs	**Exam Hours : 3Hrs**	**Weightage : CIE : 50%, SEE : 50%**	
Prerequisites: Concrete Technology			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Hands on experience in testing and quality control of concrete making materials to design concrete mixes for different ranges of strength and workability.
2	Design normal concrete mixes and SCC.
3	Train the students to handle non-destructive testing instruments and to analyze the data obtained for quality assessment of concrete.

	Course content
1.	Mix proportion and fresh properties of normal strength concrete.
2.	Mechanical properties of normal strength concrete.
3.	Mix proportion and fresh properties of SCC.
4.	Mechanical properties of SCC.
5.	NDT on structural elements using i. UPVT ii. Rebound hammer iii. Rebar locator iv. Corrosion Analyzer.

Text Books :	
1	Shetty M.S, ***"Concrete Technology",*** S. Chand & Co. Ltd, New Delhi.
2	Malhotra, V. M., and Nicholas J. Carino, ***"Handbook on nondestructive testing of concrete"***, CRC Press, 2004.
3	Naville AM, ***"Properties of Concrete",*** ELBS Publications, London.

Reference Books :	
1	Harmer E. Davis, George Earl Troxell, and George F. W. Hauck, ***"The Testing of Engineering Materials"***, McGraw-Hill Book Company, New York.
2	Bungey, J.H., Millard, S.G. and Grantham, M.G. (1982), ***"Testing of Concrete in Structures"***, Taylor and Francis, London.
3	Mehta P.K., ***"Properties of Concrete"***, Tata McGraw Hill Publications, New Delhi.
4	Relevant **BIS codes**.

Course Outcomes

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

1. Characterize and mix design of normal strength concrete.
2. Characterize and mix design of SCC.
3. Assess the quality of existing structural elements using NDT methods.

Course Title : SEISMIC RESISTANT DESIGN OF STRUCTURES			
Course Code : P20MCAD21	**Semester : II**	**L-T-P : H : 4-0-0 : 4**	**Credits : 4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage: CIE : 50% , SEE : 50%**	
Prerequisites : Structural Dynamics			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Fundamentals of engineering seismology and causes for earthquake and Evaluate seismic response of structures.
2	Irregularities in building which are detrimental to its earthquake performance.
3	Detail the structural members for Ductile requirements and concepts of Earthquake Resistant Masonry structures.
4	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.	**10 Hrs**
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. Design response spectra - Evaluation of earthquake forces – (IS1893–2016). Effect of earthquake on different types of structures.	
Self Study Component: Liquefaction of soils, concept of Pushover Analysis.	**10 Hrs**
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: Comparison of codal changes in planning consideration (IS1893 Part-I 2002 with IS1893 Part-I 2016).	**10 Hrs**
UNIT -IV	
Ductility Considerations in Earthquake Resistant Design of RC Buildings: Introduction-Impact of Ductility' Requirements for Ductility- Assessment of ductility- Factors-affecting Ductility- Ductile detailing considerations as per IS 13920. Behaviour of beam, columns and joints in RC buildings during earthquakes-Vulnerability of open ground storey and short columns during earthquakes. **Earthquake Resistant 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. Capacity Design, Capacity Design for Beams and columns- Case studies.	**12 Hrs**

UNIT -V	
Seismic Base Isolation and Retrofitting: Basic concept of seismic base isolation-Seismic Isolation systems. Seismic retrofitting strategies of RC buildings, Retrofitting of Masonry buildings.	
Self Study Component: Worked examples.	**10 Hrs**

Text Books :	
1	Pankaj Agarwal and Manish Shrikhande, ***"Earthquake Resistant Design of Structures"***, Prentice Hall of India, 2006.
2	Duggal S K ***"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	Tomazevic Miha***,"Earthquake resistant designs of masonry building"***.

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. Predict the sources of earthquakes understanding seismology and conceptually design the buildings
2. Apply the Response Spectrum Analysis Method and static equivalent method for the determination of lateral loads on the buildings
3. Apply the knowledge of engineering to conceptually design of structural systems against earthquakes.
4. Apply ductility requirements for the design of structural components and summarize the seismic evaluation and retrofitting of structures.

Course Title : STRUCTURAL STABILITY ANALYSIS – CLASSICAL AND FE APPROACH			
Course Code : P20MCAD22	**Semester : II**	**L-T-P : H : 4-0-0 : 4**	**Credits : 4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage : 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.	**10 Hrs**
UNIT -II	
Buckling of frames and beams. Elastic, 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.	**12 Hrs**
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.	**10 Hrs**

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.	**10 Hrs**
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.	**10 Hrs**

Text Books :	
1	Stephen P. Timoshenko, James M. Gere, ***"Theory of Elastic Stability"***, 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, "***Concepts and Applications of Finite Element Analysis",*** John Wiley and Sons, New York.
2	Ray W Clough and J Penzien, ***"Dynamics of Structures"***, 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 Title : STRUCTURAL DESIGN- RCC STRUCTURES			
Course Code : P20MCAD23	**Semester : II**	**L-T-P : H : 4–0– 0 : 4**	**Credits : 4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage : CIE : 50%, SEE : 50%**	
Prerequisites : Design of Reinforced Concrete Structures			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	Understand the concept of moment redistribution in RC structures.
2	Apply the knowledge required for safe, serviceable and economic design as per codal provisions.
3	Understand the load distribution concept in designing of RC frame.
4	Analyze and design of storage structures.
5	Understand the concept of Deep beam.

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: Concept of circular slabs.	**10 Hrs**
UNIT –III	
Design of R.C Frame: Introduction, Portal frame, Structural layout, Estimation of loads, Load combinations, Analysis, Design of elements of frames, Design example.	
Self Study Component: Detailing of structural elements.	**10 Hrs**
UNIT –IV	
Design of Silos and Bunkers: Introduction, Design of Rectangular bunkers, Design of Silos by Janssen's &Airy's theory	
Self Study Component: Concept of circular Bunkers.	**10 Hrs**
UNIT –V	
Design of Reinforced Concrete Deep Beams: Introduction – Minimum thickness –Design Steps of Deep beams – design by IS 456.	
Self Study Component: Detailing of Deep beams.	**10 Hrs**

Text Books :	
1	Shah H.J, "***Advanced Reinforced Concrete Structures",*** Vol-II, Charator publishers, 2014.
2	Gambhir M.L, "***Design of Reinforced concrete Structures"***, PHI Learning private limited, New Delhi, 2011.
3	Park R. and Paulay, T., ***"Reinforced Concrete Structures",*** John Wiley and Sons.

Reference Books :	
1	Krishna Raju N***,"Advanced Reinforced concrete Design",*** CBSRD,1986.
2	Punmia B.C, ***"Reinforced concrete Design",*** CBS Publishers.
3	Unikrishnan Pillai & Devdas Menon, "***Reinforced Concrete Design",*** TMH publication.
3	Relevant IS codes.

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 Title : ADVANCED DESIGN OF STEEL STRUCTURES			
Course Code : P20MCAD241	**Semester : II**	**L-T-P- H : 4-0-0 : 4**	**Credits :4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage : CIE : 50% , SEE : 50%**	
Prerequisites: Design of steel structures			

Course Learning Objectives (CLO's)	
This Course aims to,	
1	To understand the concepts in the design of laterally unrestrained beams.
2	To be able to apply the principles of design of steel members subjected to combined forces.
3	To incorporate the principles of structural safety, economy and sustainability in the designs of steel beams with web openings.
4	Understand the principles involved in the design of cold-formed steel structural members.
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: Examples Problems.	**12 Hrs**
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-Study Component: Examples Problems.	**10 Hrs**
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-Study Component: Vierendeel girders.	**10 Hrs**
UNIT -IV	
Cold formed steel sections: Techniques and properties, advantages, typical profiles, Stiffened and an un-stiffened element, Local buckling effects, effective section properties, IS: 811 code provisions- numerical examples, beam design, column design.	
Self-Study Component: Concepts of connections.	**10 Hrs**

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.	**10 Hrs**

Text Books:	
1	Subramanian N, ***"Design of Steel Structures",*** Oxford, IBH.
2	Duggal.S.K. ***"Design of Steel structures",*** Tata McGraw Hill Education, 2000.
3	Gambhir M L ***"Fundamentals of structural steel design",*** Tata McGraw Hill Education.

Reference Books :	
1	Ramchandra & Virendra Gehlot, ***"Design of Steel Structures"***, Scientific Publishers
2	***"INSDAG Teaching Resource*** ".
3	Das P K and Srimani S L, ***"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. Apply the design concepts involved with laterally unrestrained beams and structural members subjected to combined forces in analyzing 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. Apply the 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 Title : DESIGN OF TALL STURCTURES			
Course Code : P20MCAD242	**Semester : II**	**L-T-P-H: 4–0–0 : 4**	**Credits : 4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage : CIE: 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.	**12 Hrs**
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 –Multistorey Box Systems.	
Self Study Component: Behaviour of Shear Walls under Lateral Loading.	**10 Hrs**
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.	**10 Hrs**
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.	**10 Hrs**
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.	**10 Hrs**

Text Books :	
1	Taranath B.S. ***"Structural Analysis and Design of Tall Buildings",*** McGraw Hill, 1998.
2	Bryan Stafford Smith and Alex Coull, ***"Tall Building Structures ",*** Analysis and Design, John Wiley and Sons, Inc., 1991.
3	Coull A, Smith and Stafford B, ***"Tall Buildings",*** McGraw Hill, 1998.

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	Relevant ***IS codes***.

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 Title : COMPOSITE AND SMART MATERIALS			
Course Code : P20MCAD251	**Semester : II**	**L-T-P : H : 4-0-0 : 4**	**Credits : 4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage : 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.	**10 Hrs**
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: Concept of sensors.	**10 Hrs**

Textbooks:	
1	Robert 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, ***"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 Title : ANALYSIS OF PLATES			
Course Code : P20MCAD252	**Semester : II**	**L-T-P : H : 4-0-0 :4**	**Credits : 4**
Contact Period : 52Hrs	**Exam Hours : 3Hrs**	**Weightage :CIE : 50% ,SEE : 50%**	
Prerequisites : 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.	**10 Hrs**
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",*** 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 Title : STRUCTURAL SOFTWARE LABORATORY			
Course Code : P20MCADL27	**Semester : II**	**L-T-P : H : 0 – 0 – 4 : 4**	**Credits : 2**
Contact Period : 39Hrs	**Exam Hours : 3Hrs**	**Weightage : CIE: 50%, SEE: 50%**	
Prerequisites: Design of Reinforced Concrete Structures, 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 of Trusses using FEM Software.
2	Static Analysis of Building Structures using FEM Software.
3	Dynamic Analysis of Building Structures using FEM Software
4	Analysis of Elevated water tank using FEM Software.
5	Analysis of slab panel resting on column supports-Drop panels, Capitals using FEM Software.
6	Stress analysis of cantilever beam, simply supported beam and fixed beam using FEM Software.
7	Pushover Analysis of R.C Structures using FEM Software.

Text Books :	
1	Trevor Jones D, ***"Analysis and Design of structures",*** A practical guide to modeling book.
2	Pankaj Agarwal and Manish Shrikhande, ***"Earthquake Resistant Design of Structures",*** Prentice Hall of India.
3	Robert D Cook et al, ***"Concepts and Applications of Finite Element Analysis",*** John Wiley and Sons, New York.

Reference Books :	
1	Saeed Moaveni, Minnesota, ***"Finite Element Analysis, Theory and application with ANSYS."***
2	Mankato, State University, ***"CSI Analysis Reference manual-ETABS 2013".***
3	Sharma T.S, ***"Design of R.C.C Buildings using Staad Pro V8i with Indian Examples-Static & dynamic methods",*** Educreation Publishing.
4	Relevant ***IS Codes***.

Course Outcomes

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

1. Analyze the static and dynamic behavior of R.C building.
2. Understand the elements of finite element modeling, specification of loads and boundary condition, performing analysis.
3. Apply the concept of FEM to analyze the structural components using standard software package.
4. Optimize a structural system by evaluating to non-linear static analysis.

Course Title : SPECIAL CONCRETE			
Course Code : P20MCAD32	**Semester: III**	**L–T–P–H : 0-0-0:0**	**Credits: 3**
Contact Period :	**Exam Hours : 3Hrs**	**Weightage : 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	
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.	
Self Study Component: Self Study Component: Mix proportioning of Concrete: Principles and methods.	**10 Hrs**
UNIT -II	
Light Weight concrete: Introduction, classification, properties, strength and durability, mix proportioning and problems. High density concrete: Radiation shielding ability of concrete, materials for high density concrete, mix proportioning, properties in fresh and hardened state, placement methods.	
Self Study Component: placement methods in fresh and hardened state.	**10 Hrs**
UNIT -III	
Ferro cement: Ferrocement materials, mechanical properties, cracking of ferrocement, strength and behaviour in tension, compression and flexure, Design of ferrocement in tension, ferrocement constructions, durability, and applications.	
Self Study Component: Applications of Ferro cement.	**12 Hrs**
UNIT -IV	
Fibre reinforced concrete: Fibre materials, mix proportioning, distribution and orientation, interfacial bond, properties in fresh state, strength and behavior in tension, compression and flexure of steel fibre reinforced concrete, mechanical properties, crack arrest and toughening mechanism, applications.	
Self Study Component: Applications of Ferro fibre 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	Kumar Mehta P and Paulo J. M. Monteiro, ***"Concrete - Microstructure, Properties, and Materials"***, McGraw-Hill, 2006**.**
3	Gambhir M.L***, "Concrete Technology",*** McGraw-Hill , 2009,
4	Santhakumar A R, ***"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.
5	Paul and Pama, "Ferro Cement", AIT, Bangkok, 1978.

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 Title : FORMWORK TECHNIQUES & DESIGN			
Course Code : P20MCAD33	**Semester : III**	**L-T-P : H : 0-0-0:0**	**Credits : 3**
Contact Period :	**Exam Hours : 3Hrs**	**Weightage : 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.	**12 Hrs**
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.	**10 Hrs**
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.	**10 Hrs**
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.	**10 Hrs**
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.	**10 Hrs**

Text Books :	
1	Robert L. Peurifoy and Garold D. Oberlender, ***"Formwork for Concrete Structures",*** McGraw-Hill, 1996.
2	Hurd, M.K., ***"Formwork for Concrete",*** Special Publications, 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 Title: Research Methodology and IPR			
Course Code: P20MHSM31	**Sem: III**	**L-T-P-H: 4:0:0:4**	**Credits - 4**
Exam: 3 Hrs		**Weightage: CIE:50; SEE:50**	

Course Content

Unit -1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.

Unit – 2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

Unit – 3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale. Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

Unit – 4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.

Unit – 5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention onBiological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, 17 Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention

for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.

Course outcomes:

1. Discuss research methodology and the technique of defining a research problem
2. Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
3. Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
4. Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
5. Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.

Sl. No.	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Research Methodology: Methods and Techniques C.R. Kothari, Gaurav Garg New Age International 4th Edition, 2018	C.R. Kothari, Gaurav Garg New Age International 4th Edition, 2018	New Age International	4th Edition, 2018
2	Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2)	Ranjit Kumar	SAGE Publications	3rd Edition, 2011
3	Study Material (For the topic Intellectual Property under module 5)	Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament,		
Reference Books				
1	Research Methods: the concise knowledge base Trochim Atomic Dog Publishing 2005	Trochim	Atomic Dog	Publishing 2005
2	Conducting Research Literature Reviews: From the Internet to Paper	Fink A	Sage Publications	2009