RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)

R.V.Vidyaniketan Post, Mysore Road

Bengaluru – 560 059

Scheme and Syllabus of I& II Semesters

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)

in

STRUCTURAL ENGINEERING

DEPARTMENT OF

CIVIL ENGINEERING

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VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

- To deliver outocme based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
- To create a conducive environment for interdisciplinary research and innovation.
- To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
- To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
- To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

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ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PHY	Physics
21.	CHY	Chemistry
22.	MAT	Mathematics

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DEPARTMENT OF CIVIL ENGINEERING
M.Tech in STRUCTURAL ENGINEERING

FIRST SEMESTER CREDIT SCHEME

Sl. No.	Course Code	Course Title	BoS	Credit Allocation			
				L	T	P	Total Credits
1	18MAT 11A	Applied Mathematics	Maths	4	0	0	**4**
2	18MST 12	Computational Structural Mechanics	CV	4	0	1	**5**
3	18MST 13	Advanced Design of Reinforced Concrete Structures	CV	4	0	1	**5**
4	18HSS 14	Professional Skills Development	HSS	0	0	0	**0**
5	18MST 1AX	Elective A	CV	4	0	0	**4**
6	18MST 1BX	Elective B	CV	4	0	0	**4**
Total number of Credits				**20**	**0**	**2**	**22**
Total Number of Hours / Week				**22**	**0**	**4**	

SECOND SEMESTER CREDIT SCHEME

Sl. No.	Course Code	Course Title	BoS	Credit Allocation			
				L	T	P	Total Credits
1	18MST 21	Structural Dynamics	CV	4	0	1	**5**
2	18MST 22	Mechanics of Deformable Bodies	CV	4	0	0	**4**
3	18IM 23	Research Methodology	IEM	3	0	0	**3**
4	18MST 24	Minor Project	CV	0	0	2	**2**
5	18MST 2CX	Elective C	CV	4	0	0	**4**
6	18MST 2DX	Elective D	CV	4	0	0	**4**
7	18XX 2G XX	Elective G (Global Elective)	Respective boards	3	0	0	**3**
Total number of Credits				**22**	**0**	**3**	**25**
Total Number of Hours / Week				**22**	**0**	**6**	

I Semester		
GROUP A: CORE ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	18MST 1A1	Repair and Rehabilitation of structures
2.	18MST 1A2	Design of form work
3.	18MST 1A3	Precast Concrete Structures
GROUP B: CORE ELECTIVES		
1.	18MST 1B1	Design of Sub Structures
2.	18MST 1B2	Advanced Structural Analysis
3.	18MST 1B3	Structural Health Monitoring
II Semester		
GROUP C: CORE ELECTIVES		
1.	18MST 2C1	Structural Reliability
2.	18MST 2C2	Design of Masonry Structures
3.	18MST 2C3	Advanced Pre Stressed Concrete
GROUP D: CORE ELECTIVES		
1.	18MST 2D1	Finite Element Method of Analysis
2.	18MST 2D2	Design of Bridges and Grade Separators
3.	18MST 2D3	Plate and Shells

GROUP E: GLOBAL ELECTIVES				
Sl. No.	**Host Dept**	**Course Code**	**Course Title**	**Credits**
1.	CS	18CS2G01	Business Analytics	3
2.	CV	18CV2G02	Industrial & Occupational Health and Safety	3
3.	IM	18IM2G03	Modeling using Linear Programming	3
4.	IM	18IM2G04	Project Management	3
5.	CH	18CH2G05	Energy Management	3
6.	ME	18ME2G06	Industry 4.0	3
7.	ME	18ME2G07	Advanced Materials	3
8.	CHY	18CY2G08	Composite Materials Science and Engineering	3
9.	PHY	18PH2G09	Physics of Materials	3
10.	MAT	18MA2G10	Advanced Statistical Methods	3

Semester: I Semester		
APPLIED MATHEMATICS **(Theory)** **(Common to AS, BT, CH, CV, IM, ME)**		
Course Code: 18MAT11A		**CIE Marks: 100**
Credits : L:T:P: 4:0:0		**SEE Marks: 100**
Hours: 47L		**SEE Duration: 3Hrs**

Course Learning Objectives:

1	Adequate exposure to learn statistical techniques, random phenomena for analyzing data to find the suitable mathematical/probability models for solving practical situation in engineering applications.
2	To learn fundamentals of linear algebra, solution of system of linear equations and eigen value problems used in various fields of engineering and science.
3	Explore the possibility of finding approximate solutions using numerical methods in the absence of analytical solutions of various systems.
4	Apply the concepts of optimization to solve engineering applications of optimization which have great importance in the field of engineering.

Unit-I	
STATISTICS Method of least squares, fitting of straight line, linearization of nonlinear laws, curve fitting by polynomials, correlation, coefficient of correlation, lines of regression, Spearman rank correlation.	**09 Hrs**
Unit -II	
PROBABILITY DISTRIBUTIONS Introduction to probability, Random variables-discrete and continuous random variables, important measures and moment generating functions, Standard distributions-Binomial, Exponential, Normal and Gamma distributions.	**09 Hrs**
Unit -III	
SYSTEM OF LINEAR EQUATIONS AND EIGEN VALUE PROBLEMS System of linear equations-LU decomposition and Gauss-Jordan method, Eigen value problems–bounds on eigen values, Power method and Inverse Power method, Eigen values and eigen vectors of real symmetric matrices-Jacobi method.	**09 Hrs**
Unit -IV	
NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS Boundary value problems (BVP's)–finite difference method for linear and nonlinear problems, Shooting method and Galerkin method. Finite differences-implicit and explicit scheme, Finite difference methods for parabolic, elliptic and hyperbolic partial differential equations, Finite element method and simple problems.	**10 Hrs**
Unit -V	
CONCEPTS OF ENGINEERING OPTIMIZATION Engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function and objective function surface. Multivariable optimization with inequality constraints-Kuhn-Tucker conditions, Constraint qualification, Genetic operators, Neural-Network-based Optimization. Optimization of Fuzzy systems.	**10 Hrs**

Course outcomes: On completion of the course, the student should have acquired the ability to

CO1	Identify and interpret the fundamental concepts of statistics, distributions, linear algebra, differential equations and optimization arising in various fields engineering.
CO2	Apply the knowledge and skills of statistical/numerical/optimization techniques to solve

	problems of least squares, probability distributions, linear equations, eigen value problems and differential equations.
CO3	Analyze the physical problem to establish statistical/mathematical model and use appropriate method to solve and optimize the solution.
CO4	Distinguish the overall mathematical knowledge gained to demonstrate the problems of least squares, probability distributions, linear equations, eigen value problems, differential equations and optimization arising in practical situations.

Reference Books:	
1	Theory and Problems of probability,Seymour Lipschutz and Marc lars Lipson, 2nd edition , Schaum's Outline Series, ISBN: 0-07-118356-6.
2	Introductory method of numerical analysis ,S. S. Sastry, 4th edition,2009,, Prentice-Hall India Pvt. Ltd, ISBN : 81-203-1266-X.
3	Numerical methods for scientific and engineering computation ,M K Jain, S. R. K. Iyengar, R. K. Jain, 6th edition,2012, New Age International Publishers, ISBN-13: 978-81-224-2001-2.
4	Engineering Optimization Theory and Practice ,Singiresu S. Rao, 3rd edition, New Age International (P)Ltd., ISBN: 81-224-1149-5.

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

COMPUTIONAL STRUCTURAL MECHANICS (Theory & Practice)		
Course Code:18MST12		**CIE Marks: 100+50**
Credits L: T: P : 4:0:1		**SEE Marks :100+50**
Hours: 48L:24P		**SEE Duration:3Hrs+3Hrs**

Course Learning Objectives (CLO):

Student will be able to

1. Apply the knowledge of different types of structures, to assess their degrees of freedom and indeterminacy.
2. Utilize concepts of matrix methods to model structural component.
3. Analyze the behavior of different types of structures.
4. Evaluate and compare beams, frames and trusses with different degrees of freedom.

Unit – I	**09Hrs**

Static and Kinematic indeterminacy of rigid jointed frames, trusses and grids. Concepts of stiffness and flexibility, Properties of stiffness and flexibility matrix. Relationship between stiffness matrix and flexibility matrix.

Unit – II	**10Hrs**

Development of structure stiffness matrices for two dimensional rigid jointed structures using basic fundamental approach, development of flexibility matrix for two dimensional determinate rigid jointed structures.

Unit – III	**10Hrs**

Displacement-transformation matrix using Stiffness Method, Development of global stiffness matrix for continuous beams, plane trusses and rigid plane frames (having not more than six degrees of freedom – 6x6 stiffness matrix) ,Analysis of continuous beams, plane trusses and rigid plane frames by stiffness method (having not more than 3 degrees of freedom – 3x3 stiffness matrix).Analysis considering effect of sinking of supports, temperature, linear and rotational springs.

Unit – IV	**9Hrs**

Development of element stiffness matrix, global stiffness matrix by direct stiffness method for two dimensional beams, frames and trusses (having not more than six degrees of freedom – 6x6 stiffness matrix), Analysis of continuous beams, plane trusses and rigid plane frames by direct stiffness method (having not more than 3 degrees of freedom – 3x3 stiffness matrix).

Unit – V	**10Hrs**

Principles of analysis of three dimensional space truss, grid structures using direct stiffness method-development of structure stiffness matrix. Numerical problems restricted to three degrees of freedom.

Unit – VI (Lab Component)

Analysis using Staad Pro Software

1) Analysis of two dimensional structures, plane trusses and rigid plane frames

Analysis using MATLAB Software

1) Analysis of plane trusses by displacement transformation stiffness method.
2) Analysis of rigid plane frames by displacement transformation stiffness method
3) Analysis of plane trusses by direct stiffness method
4) Analysis rigid plane frames by direct stiffness method

Expected Course Outcomes:

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

- CO1. Demonstrate the concepts of matrix methods to develop co-ordinate system for trusses, beams, and frames by force and displacement approach.
- CO2. Apply knowledge of local and global coordinate system to develop displacement transformation matrices.
- CO3. Analyze structures using matrix methods by analytical methods and software tools with different degrees of freedom
- CO4. Evaluate stress resultants and behaviour of structural elements under different boundary conditions.

Reference Books:

1.	Computational Structural Mechanics, S.Rajasekaran, G. Sankarasubramanian, 7th Edition, 2015,Prentice-Hall of India Pvt Ltd, , NewDelhi-110092.ISBN-13: 978-8120317345,ISBN-10:8120317343.
2.	Computer Analysis of Framed Structures, Damodar Maity, 2007, I K International Publishing House Pvt. Ltd., ISBN-13: 978-8189866198.
3.	Getting started with MatLab ,Rudra Pratap, 2010,Oxford University Press, ISBN: -13:978-0-19-806919-5
4.	Matlab An introduction with applications,Amos Gilat, 4th edition 2012, Wiley Publications, ISBN-13: 978-8126537204.

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

Total CIE is 20+50+30=100 Marks.

Continuous Internal Evaluation (CIE); Practical(50 Marks)

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical (50 Marks)

SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

ADVANCED DESIGN OF REINFORCED CONCRETE STRUCTURES (Theory &Practice)		
Course Code:18MST 13		**CIE Marks:100+50**
Credits :L: T: P : 4:0:1		**SEE Marks :100+50**
Hours :48L:24P		**SEE Duration: 3Hrs+3 Hrs**

Course Learning Objectives (CLO):

Student will be able to

1. Understand the design concepts of RCC elements
2. Apply the principles of RCC design
3. Analyze the forces and stresses in RCC structures
4. Design RCC structural elements

Unit – I	09 Hrs

Slabs: Yield line theory for analysis of slabs: Equilibrium and virtual work methods of analysis, Rectangular slabs and triangular slabs with various edge conditions – yield line patterns, Circular slabs.

Unit – II	10 Hrs

Grid floors and Flat slabs: General features, Rigorous and approximate methods of analysis, Design and detailing of grid floors. Design and detailing of flat slabs including unbalanced column moments.

Unit – III	10 Hrs

Water retaining structures: Design and detailing of rectangular and circular underground sump tanks with fixed and flexible base.

Unit – IV	09 Hrs

Silos (circular) and bunkers: analysis, design and detailing of side walls, hopper bottoms.

Unit – V	10 Hrs

Concept of Earthquake resistant design of RCC structures, Ductile detailing of RCC elements, Expansion and contraction joints.

Unit – VI (Lab Component)

Experiments will be performed using ETABS software, for building analysis and design:

1. Modelling, analysis and design of portal frames for varying loading conditions and comparison with manual calculations (One storey & one bay).
2. Modelling, analysis and design of Grid-floor system
3. Modelling, analysis and design of Flat-slab system
4. Modelling, analysis and design of Buildings with Shear wall system
5. Static and Dynamic analysis of multi-storeyed buildings
   a) Analysis of buildings by Equivalent lateral force method, and design of components.
   b) Analysis of buildings by Response Spectra method, and design of components.

Course Outcomes:

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

CO1: Apply principles of RCC to design slabs and walls

CO2: Estimate the loads to assess critical bending moments, shear forces and torsion

CO3: Design RCC walls and slabs subjected to various loading combinations

CO4: Draw detailing of reinforcement for RCC walls and slabs

Reference Books:

1. Reinforced Concrete Structures, R Park and T Paulay, 2nd Edition, 2013. John Wiley & Sons, USA,

	ISBN: 9780471659174.
2.	Design of Reinforced concrete Structures, S. Ramamrutham, 2nd Edition, 2015 Dhanpat Rai Publishing Co Pvt Ltd., ISBN 978-9384559984.
3.	Advanced Reinforced Concrete Design, P. C. Varghese, PHI Learning Pvt. Ltd., 2nd Edition, 2009, ISBN: 812032787X, 9788120327870.
4.	Earthquake resistant design of structures, Pankaj Agarwal and Manish Shrikhande, 3rd Edition, 2013, PHI learning Private Ltd,. ISBN 9788120328921.

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. **Total CIE is 20+50+30=100 Marks.**

Continuous Internal Evaluation (CIE); Practical(50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE): Total marks: 100+50=150
Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester: I						
PROFESSIONAL SKILL DEVELOPMENT (Common to all Programs)						
Course Code	**:**	**18HSS14**		**CIE Marks**	**:**	**50**
Credits L: T: P	**:**	**0:0:0**		**SEE Marks**	**:**	**Audit Course**
Hours	**:**	**24 L**				

Unit – I	**03 Hrs**
Communication Skills: Basics of Communication, Personal Skills & Presentation Skills – Introduction, Application, Simulation, Attitudinal Development, Self Confidence, SWOC analysis. **Resume Writing:** Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts. Theory and Applications.	
Unit – II	**08 Hrs**
Quantitative Aptitude and Data Analysis: Number Systems, Math Vocabulary, fraction decimals, digit places etc. Simple equations – Linear equations, Elimination Method, Substitution Method, Inequalities. **Reasoning** – a. **Verbal** - Blood Relation, Sense of Direction, Arithmetic & Alphabet. b. **Non- Verbal reasoning** - Visual Sequence, Visual analogy and classification. **Analytical Reasoning** - Single & Multiple comparisons, Linear Sequencing. **Logical Aptitude** - Syllogism, Venn-diagram method, Three statement syllogism, Deductive and inductive reasoning. Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. **Verbal Analogies/Aptitude** – introduction to different question types – analogies, Grammar review, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving	
Unit – III	**03 Hrs**
Interview Skills: Questions asked & how to handle them, Body language in interview, and Etiquette – Conversational and Professional, Dress code in interview, Professional attire and Grooming, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, and General HR interviews	
Unit – IV	**03 Hrs**
Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brain storming; Group discussion (Assertiveness) and presentation skills	
Unit – V	**07 Hrs**
Motivation: Self-motivation, group motivation, Behavioral Management, Inspirational and motivational speech with conclusion. (Examples to be cited). **Leadership Skills:** Ethics and Integrity, Goal Setting, leadership ability.	

Course Outcomes: After going through this course the student will be able to:	
CO1	Develop professional skill to suit the industry requirement.
CO2	Analyze problems using quantitative and reasoning skills
CO3	Develop leadership and interpersonal working skills.
CO4	Demonstrate verbal communication skills with appropriate body language.

Reference Books:	
1.	The 7 Habits of Highly Effective People, Stephen R Covey, 2004 Edition, Free Press, ISBN: 0743272455
2.	How to win friends and influence people, Dale Carnegie, 1st Edition, 2016, General Press, ISBN: 9789380914787
3.	Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan 2012 Edition, McGraw-Hill Publication ISBN: 9780071772204
4.	Ethnus, Aptimithra: Best Aptitude Book, 2014 Edition, Tata McGraw Hill ISBN: 9781259058738

Scheme of Continuous Internal Examination (CIE)

Evaluation of CIE will be carried out in TWO Phases.

Phase	**Activity**
I	After the completion of Unit 1 and Unit 2, students are required to undergo a test set for a total of 50 marks. The structure of the test will have two parts. Part A will be quiz based, evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
II	Students will have to take up second test after the completion Unit 3, Unit 4 and Unit 5. The structure of the test will have two parts. Part A will be quiz based evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
FINAL CIE COMPUTATION	
Continuous Internal Evaluation for this course will be based on the average of the score attained through the two tests. The CIE score in this course, which is a mandatory requirement for the award of degree, must be greater than 50%. The attendance will be same as other courses.	

REPAIR AND REHABILITATION OF STRUCTURES **(Group A:Core Elective)** **(Theory)**		
Course Code :18MST 1A1		**CIE Marks:100**
Credits: L: T: P : 4:0:0		**SEE Marks :100**
Hours : 48L		**SEE Duration:3 Hours**

Course Learning Objectives: Students are able to	
1	**Describe the causes of deterioration of concrete structures**
2	**Analyze the failures of concrete structures**
3	**Evaluate failures and deterioration in concrete structures**
4	**Develop repair techniques for deteriorated concrete structures**

UNIT – I	**9 Hours**
Deterioration: Introduction, Cause of Deterioration of Concrete Structures, Diagnostic Methods and Analysis, Preliminary Investigation, Experimental Investigations Using NDT, Load Testing, Corrosion Mapping, Core Drilling, Other Instrumental Methods.	
UNIT – II	**10 Hours**
Influence on serviceability and durability: Effects Due To Climate, Temperature, Chemicals, Wear and Erosion, Design and Construction Errors, Corrosion Mechanism, Effects Of Cover, Thickness and Cracking, Methods of Corrosion Protection, Corrosion Inhibitors, Corrosion Resistant Steels, Coatings, Cathodic Protection.	
UNIT – III	**10 Hours**
Maintenance and repair strategies: Definitions, Maintenance, Repair And Rehabilitation, Facets of maintenance, Importance Of Maintenance, Preventive Measures on Various Aspects, Inspection, Assessment Procedure for Evaluating a Damaged Structures, Causes of Deterioration, Testing Techniques.	
Unit – IV	**9 Hours**
Techniques Of Repair: Rust Eliminators, Polymers Coating for Rebar during Repair, Foamed Concrete, Mortar and Dry Pack, Gunite and Shotcrete, Epoxy Injection Mortar, Repair for Cracks, Shoring and Underpinning.	
UNIT-V	**10 Hours**
Repair to Structures: Repairs to Overcome Low Member Strength Deflection, Cracking Chemical Disruption, Weathering, Wear Fire, Leakage, Marine Exposure, Engineered Demolition Techniques for Dilapidated Structure, Case Studies.	

Course Outcomes:

1. Identify the causes of failure in concrete structures
2. Analyze failures in concrete structures
3. Evaluate causes for failures in deteriorated concrete structures
4. Develop simple and comprehensive solutions to rehabilitate deteriorated structures

Reference Books:

1.	Repair of concrete structures ,R T Allen and SC Edwards, Blakie and Sons ISBN 1352, 2009
2.	Learning for failure from deficiencies in design construction and service , Raikar R.N, 2008, R & D Center (SDCPL),.ISBN:12657-764-853-2318
3.	Rehabilitation of Concrete Structures, B Vedivelli, ,2013, Standard publishers and distributors, ISBN: 978-8180141102
4.	Distress and Repair of Concrete Structures, Norb Dellate Failure,Nov9,2009,Ist Edition,Woodhead Publishing Series in Civil and Structural Engineering,Woodhead Publishing.

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100
Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

DESIGN OF FORMWORK **(Group A:Core Elective)** **(Theory)**		
Course Code : 18MST 1A2		**CIE Marks:100**
Credits: L: T: P : 4: 0: 0		**SEE Marks:100**
Hours:48L		**SEE Duration:3 Hrs**

Course Learning Objectives: Students are able to learn

1	Formwork types, accessories required and materials used.
2	Formwork design principles required for Beams, Slabs, columns, Walls and Foundations.
3	Formwork design principles required for Special Structures.
4	Case studies on flying formwork and formwork failures.

Unit – I	**9Hours**

Introduction: Requirements and Selection of Formwork.
Formwork Materials- Timber, Plywood, Steel, Aluminium, Plastic, and Accessories. Horizontal and Vertical Formwork Supports.

Unit – II	**10Hours**

Formwork Design: Concepts, Formwork Systems and Design, for Tall Structures, Foundations, Walls, Columns, Slab and Beams.

Unit – III	**10Hours**

Formwork Design for Special Structures: Shells, Domes, Folded Plates, Overhead Water Tanks, Natural Draft Cooling Tower, Bridges.

Unit – IV	**9 Hours**

Flying Formwork: Table Form, Tunnel Form, Slip Form, Formwork for Precast Concrete, Formwork Management Issues –Pre- and Post-Award.

Unit-V	**10Hours**

Formwork Failures: Causes and Case studies in Formwork Failure, Formwork Issues in Multistorey Building Construction.

Course Outcomes:
After going through this course the student will be able to

CO1:	Select proper formwork, accessories and material.
CO2:	Design the form work for Beams, Slabs, columns, Walls and Foundations.
CO3:	Design the form work for Special Structures.
CO4:	Understand the working of flying formwork and Judge the formwork failures through case studies

Reference Books:

1	Formwork for Concrete Structures , Peurify, 2015,McGraw Hill Education India, ISBN-13: 978-9339221928.
2	Formwork for Concrete Structures ,Kumar Neeraj Jha, 2012, Tata McGraw Hill Education, ISBN: 9781259007330.
3	Modern Practices in Formwork for Civil Engineering Construction Works Dr. Janardan Jha and Prof. S K Sinha, Ist edition,2017, Laxmi Publications Pvt Ltd, ISBN-13: 978-9383828388.
4	Concrete Formwork Systems: 2 (Civil and Environmental Engineering Series), Awad S. Hanna, First Edition,1998, Vol. 2, CRC Press, ISBN-13: 978-0824700720.

Code Books:

1	IS 14687: 1999, False work for Concrete Structures - Guidelines, BIS.

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100
Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

PRECAST CONCRETE STRUCTURES **(Group A:Core Elective)** **(Theory)**		
Course Code: 18MST1A3		**CIE Marks:100**
Credits: L:T:P : 4:0:0		**SEE Marks :100**
Hours :48L		**SEE Duration:3Hrs**

Course Learning Objectives(CLO)

Student will be able

1	Understand precast concrete technologies.
2	Demonstrate manufacturing process, logistics and erection.
3	Analyze and recommend suitable type of precast element.
4	Design and detail precast concrete elements.

Unit – I	**09Hrs**

Concept of precast, precast products, standardization, precast accessories, types of precast constructions, methodologies, equipments and machineries, economy of prefabrication, Planning for Components of prefabricated structure, Disuniting of structures.

Unit – II	**10Hrs**

Choice of production setup, Manufacturing methods, Stationary and mobile production, Planning of production setup, Storage of precast elements, Dimensional tolerances, Acceleration of concrete hardening. Equipments for hoisting and erection Techniques for erection of different types of members like Beams, Slabs, Wall panels and Columns – Vacuum lifting pads. Logistics and transportation.

Unit – III	**10Hrs**

Types of pre-stress hollow core slabs, manufacturing methodology, load chart and curves, preparation of layout cutting list, loading sequence, production loading transportation and erection, services and maintenance.

UNIT – IV	**10Hrs**

Roof and floor panels, ribbed floor panels, wall panels, footings, Joints for different structural Connections, Effective sealing of joints for water proofing, Provisions for non-structural fastenings, Expansion joints in pre-cast construction. Designing and detailing of precast unit for factory structures, Purlins, Principal rafters, roof trusses, lattice girders, gable frames, Single span single storeyed frames, Single storeyed buildings, slabs, beams and columns.

Unit – V	**09Hrs**

Modular construction, types of precast elements, typical layout, joint details, shop drawings, design of precast columns, beams, panel, stairs and slab, mould fabrication, reinforcement details, casting, curing, stockyard and loading, transportation, site preparation and erection, finishing and handling over service and maintenance.

Expected Course Outcomes(CO):

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

CO1	Demonstrate the precast concrete concepts, types of precast construction and its advantages
CO2:	Identify precast plant set up for production and storage systems, plan logistics of precast elements
CO3:	Examine different types of pre-cast elements.
CO4:	Design of precast elements, manufacturing methods.

Reference Books:

1	Precast Concrete Structures ,Kim.S.Elliott,2002, Butterworth-Heinemann, An imprint of Elsevier

	Science.
2	Precast concrete structures, Hubert Bachmann and Alfred Steinle' First edition,2011, Ernst &Sohn, GmbH &Co., ISBN978-3-433-60096-2.
3	Multi –Storey Precast Concrete Framed Structures,Kim.S.Elliot and Colin K Jolly,2nd Edition, November 2013, Wiley-Blackwell , ISBN: 978-1-4051-0614-6.
4	PCI Journal– Proposed Design Requirements for Precast Concrete ,Prestressed Concrete Institute , PCI Committee on Building Code and PCI Technical Activities Committee.

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

DESIGN OF SUBSTRUCTURES **(Group B:Core Elective)** **(Theory)**		
Course Code: 18MST 1B1		**CIE Marks:100**
Credits: L: T: P: 4:0:0		**SEE Marks :100**
Hours:48L		**SEE Duration:3Hrs**

Course Learning Objectives: Students are able to

1	Understand the importance , planning , interpretation of Site investigation and foundation Engineering
2	Develop analytical skills in solving complex problems in design of shallow and deep foundations
3	Evaluate the soil shear strength parameters for various sub soil conditions, bearing capacity of soils and special problems in geotechnical engineering
4	Design the sub structures ,depending on both the type of soil and loading

Unit – I	**9Hours**

Soil investigation: Importance of soil investigations, methods of soil investigation, Basic requirements of foundation, Types and selection of foundations. Concept of soil shear strength parameters, Settlement analysis of footings, Shallow foundations in clay, Shallow foundation in sand & C-Φ soils, Footings on layered soils and sloping ground, Design for Eccentric or Moment Loads.

Unit – II	**10 Hours**

Shallow foundations: Bearing capacity of soil -plate load test, Design of reinforced concrete isolated, strip, combined and strap footings, mat foundation.Types of rafts, bearing capacity & settlements of raft foundation, Rigid methods, Flexible methods, soil-structure interaction.

Unit – III	**10Hours**

Pile Foundations: Load Transfer in Deep Foundations, Types of Deep Foundations, Ultimate bearing capacity of different types of piles in different soil conditions, Laterally loaded piles, tension piles & batter piles, Pile groups: Bearing capacity, settlement, uplift capacity, load distribution between piles, Proportioning and design concepts of piles..

Unit – IV	**09Hours**

Well foundations:, Analysis of well foundations, Design principles, Well construction and sinking. Foundations for tower structures: Introduction, Forces on tower foundations, Selection of foundation type, Stability and design considerations, Ring foundations – general concepts.

Unit-V	**10Hours**

Foundations in special cases:Foundation on expansive soils, under reamed pile foundation, Foundation for concrete Towers, chimneys, Reinforced earth retaining walls, Machine foundations and basic principles of design of machine foundation

Course Outcomes:

After going through this course the student will be able to

CO1:	Achieve Knowledge of interpreting the investigated data and design appropriate foundation system.
CO2:	Identify and evaluate the soil shear strength parameters, bearing capacity for various sub-soil profiles and loading conditions.
CO3:	Evaluate the behavior of structures subjected to various loading and ground conditions.
CO4:	Analyse and design shallow foundation , deep foundations and special foundations depending on the type of soil and loading

Reference Books:

1.	Analysis & Design of Substructures, Swami Saran ,2006, Oxford & IBH Pub. Co. Pvt. Ltd., ISBN:434-238-1343.

2.	Foundation Design ,W.C. Teng, 2003, Prentice Hall of India Pvt. Ltd ISBN:234-456-12343.
3.	Foundation Engineering, R.B. Peck, W.E. Hanson & T.H. Thornburn,Second Edition, 1984, Wiley Eastern Ltd., ISBN:2285-064-12328.
4.	Foundation Analysis and Design, J.E. Bowles, Fifth Ed., 2008,McGraw-Hill Int. Editions, ISBN:745-873-12854.

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

ADVANCED STRUCTURAL ANALYSIS **(Group B:Core Elective)** **(Theory)**		
Course Code: 18MST 1B2		**CIE Marks:100**
Credits: L:T:P: 4:0:0		**SEE Marks :100**
Hours:48L		**SEE Duration:3Hrs**

Course Learning Objectives (CLO):

Student shall be able to

1. Discuss concepts of stresses, moments, deformation and pressure in beams, columns and frames.
2. Apply concepts of mathematics to derive differential equations related to beams, columns and frames
3. Interpret the influence of Geometry on stresses, moments, deformation and shear of beams, columns and frames.
4. Calculate stresses, moments, deformation and pressure in beams, columns and frames

Unit – I	**09Hrs**

Beams on elastic foundations: Differential equations of elastic line interpretation of constants of integration, infinite beam with concentrated load, moment and UDL and problems related to infinite beams. Semi-infinite beams with concentrated load, moment and UDL, semi-infinite beam with fixed and hinged conditions, problems on semi-infinite beams.

Unit – II	**10Hrs**

Beam-Column: Governing differential equation for axial and lateral loads, analysis of beam columns subjected to axial and concentrated loads, axial and UDL, beam column with different end conditions.

Unit – III	**10Hrs**

Buckling of Columns: Assumptions, Euler's theory of buckling governing differential equation, prismatic columns with different end conditions, obtaining the characteristic equation for the critical load for non-prismatic columns, buckling of frames.

Unit – IV	**10Hrs**

Unsymmetrical bending of beams: Introduction, stresses in beams, deflections of beams subjected to unsymmetrical bending, problems related to unsymmetrical bending.

Shear Centre: introduction, shear center for symmetrical and unsymmetrical sections, problems related to shear center.

Unit – V	**09Hrs**

Plastic Analysis of Structures: Introduction, plastic moment of resistance, plastic modulus, shape factors, moment – curvature relationship, plastic hinge and mechanism, analysis of indeterminate beams and frames, upper and lower bound theorem, ultimate strength of fixed and continuous beams, applications of static and kinematic theorem for plastic analysis of beams and frames.

Expected Course Outcomes:

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

1. Explain concepts in analysis of Beams, Columns, and Frames
2. Derive Governing Differential Equations and Expressions for Deflection, Moments, and shear force in Beams, Columns and Frames.
3. Examine the influence of Geometry, Loads, Boundary conditions on the deflection, stresses, moments and shear force of Beams, columns, and frames.
4. Evaluate Deflection, moments, stresses and shear in beams, columns and frames

Reference Books:

1	Advanced Mechanics of Materials ,Boresi A.P., and Sidebottom O.M., 1985,, John Wiley and Sons in N.Y., ISBN 10: 0471843237 ISBN 13: 9780471843238
2	Mechanics of Materials ,William F. Riley, Leroy D. Sturges and Don H. Morris, 2001, John Wiley & Sons, New Delhi, ISBN: 978-0-471-43446-7
3	Advanced Mechanics of solids and structures, N. Krishna Raju and D.R. Gururaja, 1997,Narosa Publishing House, New Delhi, ISBN, 8173190666, 9788173190667.

4	Design of steel structures ,N.Subramanian, , Oxford University Press, ISBN-13:978-0-19-567681-5,ISBN-10:0-19-567681-5.

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

STRUCTURAL HEALTH MONITORING **(Group B:Core Elective)** **(Theory)**		
Course Code : 18MST 1B3		**CIE Marks:100**
Credits: L: T: P: 4:0:0		**SEE Marks:100**
Hours:48L		**SEE Duration:3 Hrs**

Course Learning Objectives: Students are able to learn	
1	Types of distress in the structure factors affecting distress and causes .
2	Concepts of Structural Safety, measures components and Materials
3	Methodologies' involved in evaluating health of structure using static field methods dynamic field tests.
4	Performance of structures using conventional and remote structural health monitoring

Unit – I	**9Hours**
Structural Health: Factors affecting Health of Structures, Causes of Distress, Regular Maintenance. **Structural Health Monitoring**: Concepts, Various Measures, Structural Safety in Alteration.	
Unit – II	**10 Hours**
Materials: Piezo–electric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique. **Structural Audit**: Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures.	
Unit – III	**10 Hours**
Static Field Testing: Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement.	
Unit – IV	**10 Hours**
Dynamic Field Testing: Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods	
Unit-V	**9 Hours**
Remote Structural Health Monitoring: Introduction, Hardware for Remote Data Acquisition Systems, Advantages, Case studies on conventional and Remote structural health monitoring	

Course Outcomes:

After going through this course the student will be able to

CO1:	Diagnose the distress in the structure understanding the causes and factors.
CO2:	Understand safety aspects ,components and materials used in Structural Health Monitoring.
CO3:	Assess the health of structure using static field methods and dynamic field tests.
CO4:	Analyse behavior of structures using remote structural health monitoring

Reference Books:

1	Structural Health Monitoring, Daniel Balageas, Claus Peter Fritzen, Alfredo Güemes,2006, John Wiley and Sons.
2	Health Monitoring of Structural Materials and Components Methods with Applications, Douglas E Adams, 2007,John Wiley and Sons.
3	Structural Health Monitoring and Intelligent Infrastructure, , J. P. Ou, H. Li and Z. D. Duan, Vol1,2006,Taylor and Francis Group, London, UK.
4	Structural Health Monitoring with Wafer Active Sensors, Victor Giurglutiu, 2007,Academic Press Inc.

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II		
STRUCTURAL DYNAMICS (Theory & Practice)		
Course Code: 18MST 21		**CIE Marks:100+50**
Credits: L:T:P: 4:0:1		**SEE Marks :100+50**
Hours: 48L:24P		**SEE Duration: 3 Hrs+3Hrs**

Course Learning Objectives (CLO):

Student will be able to

1. Understand the behavior of structures to various dynamic loads.
2. Identify analytical methods and procedures to analyse structures in a way that emphasize physical insight.
3. Apply principles of dynamics to real world problems
4. Develop mathematical models to predict the system responses.

Unit – I	**10 Hrs**

Introduction: Introduction to dynamic problems of Civil Engineering, Concept of degrees of freedom, D'Alemberts principle, Principle of virtual displacement and energy, Single degree of freedom systems, Examples of Single degree of freedom systems in Engineering, Free vibration of damped and undamped systems.

Unit – II	**10 Hrs**

Single degree of freedom systems subjected to sinusoidal loading, Resonance and its resonance diagram – support motion, Vibration isolation, transmissibility, Methods of damping measurements, Response of Single degree of freedom systems to arbitrary excitation, Duhamel integral solution, Response to suddenly applied load and triangular pulse loading, Principles of vibration measuring instruments.

Unit – III	**09 Hrs**

Dynamics of multi-Degree of freedom system, Natural Frequency and normal modes, Orthogonality of modal vectors, Shear building model without damping and with proportional damping, Approximate methods of frequency analysis, Rayleigh's method and matrix iteration methods.

Unit – IV	**09 Hrs**

Response of shear building with proportion damping, Superposition of normal modes, Example of a 3-storeyed frame subjected to ground motion.

Unit – V	**10 Hrs**

Continuous systems, Flexural vibration of beams, Simply supported and cantilever beams, Longitudinal vibrations of bars, Longitudinal waves in bars, Waves and vibration response of simply supported beams under uniformly distributed triangular pulse loading, Matrix formulation of beams with lumped masses.

Unit – VI (Lab Component)	

1. Dynamic models of Single degree of freedom systems and multi-degree of freedom systems using poly carbonate bars.
2. Demonstration of Single degree of freedom systems with base excitation low frequency, Resonant and high frequency excitation.
3. Cantilever beam (Poly carbonate or Meter Scale), Vibration by hand tapping, Demonstration of second mode with nodal point, Frequency measurement using Accelerometer.
4. 3-Storeyed frame with and without soft first story (Polycarbonate).
5. Vibration of multi-Storeyed modal (Aluminium) with sinusoidal base excitation, Frequency and mode shapes.

Expected Course Outcomes:

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

CO1: Idealize and model simple structures as discrete and continuous vibratory system.

CO2: Develop equations of motion for discrete and continuous vibratory system.

CO3: Evaluate the frequencies for various discrete and continuous vibratory system. **CO4:**Assess the dynamic response of various two and three dimensional models analytically, experimentally and numerically.	
Reference Books:	
1.	Structural Dynamics : Vibrations and Systems, Madhujit Mukophadhyay, Edition: 01, 2008,Publisher: ANE Books ISBN: 9788180520907, 8180520900
2.	Structural Dynamics: Theory and Computation, 2nd Edition, Mario Paz, CBS Publisher ISBN: 9788123909783, 8123909780
3.	Dynamics of Structures, R,W.clough and J.Penzien, McGraw – Hill Education, 2nd revised Edition, 1993, ISBN -10: 0071132414, ISBN -13: 978-0071132411.
4.	Theory of vibration with applications, Willaim Thomson; 4th edition, 1996, CRC Press ISBN -10: 0748743804, ISBN -13: 978-0748743803.

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Continuous Internal Evaluation (CIE); Practical(50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE): Total marks: 100+50=150
Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

MECHANICS OF DEFORMABLE BODIES (Theory)		
Course Code: 18MST 22		**CIE Marks:100**
Credits: L:T:P: 4:0:0		**SEE Marks:100**
Hours:48L		**SEE Duration:3Hrs**

Course Learning Objectives (CLO): Student will be able to

1	Understand the theoretical concepts of material behavior with particular emphasis on their elastic and plastic properties.
2	Explain the behaviour of bodies subjected to different loads
3	Analyze the behavior of elastic solids under different loading conditions.
4	Develop mathematical model to assess the behavior of two dimensional elastic solids.

Unit – I **10Hrs**

Analysis of stress

Introduction, stress, components of stress at a point in Cartesian coordinates (2D & 3D), plane stress problems, equilibrium equations, stresses on inclined plane, stress transformation, principal stresses, maximum shear stress, stress invariants hydrostatic and deviatoric stresses, octahedral stresses, boundary conditions. Stress components (2D & 3D) in polar coordinates, equilibrium equations.

Unit – II **9Hrs**

Analysis of strain

Strain, components of strain at a point in Cartesian coordinate's, plane strain problems, strain transformation, principal and octahedral strain. Strain Components in Polar Coordinate System.

Unit – III **10Hrs**

Stress strain relations and compatibility equations

Generalized Hooke's law, constitutive equations, lame's constants, compliance matrix, Saint vaint's principle of superposition, compatibility equations for 3 dimensional elements in Cartesian coordinates, compatibility equations for plane stress and plane strain problems in terms of stress components, Naviers equations, boundary value problem, stress compatibility equations in polar coordinate system. Constitutive Relations in Polar Coordinate System.

Unit – IV **9Hrs**

Two - Dimensional Problems in Cartesian and Polar Coordinates

Biharmonic equation in Cartesian coordinates, Airy's stress functions, polynomials, as stress functions. Stress functions for plane stress and plane strain, bending of cantilever and simply supported beams. Biharmonic equations in polar coordinates. Axisymmetric problems, thick walled cylinder subjected to internal and external pressures, Effect of circular hole on stress distribution.

Unit – V **10Hrs**

Torsion of Prismatic Bars: Saint Venant's Method, Prandtl's Membrane Analogy, Torsion of Rectangular Bar, Torsion of Thin Tubes.

Introduction to Plasticity

Strain Hardening, Idealized Stress- Strain curve, Failure theories , Yield Criteria, von Mises Yield Criterion, Tresca Yield Criterion, Plastic Stress-Strain Relations.

Expected Course Outcomes:

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

CO1: Explain the basic principles of Elasticity and plasticity

CO2: Analyse the behavior of objects under two and three dimensional state of stress

CO3: Evaluate the stress and strain in two and three dimensional problems.

CO4: Formulate equations governing the behavior of two and three dimensional solids.

Reference Books:

1.	Theory of Elasticity, Timoshenko & Goodier, 3rd edition, Tata McGraw-Hill Publishing Company,

	ISBN-10: 0070702608, ISBN-13: 978-0070070268.
2.	Elasticity for Engineers T G Sitaram & L Govindaraju, I K International Pvt Ltd, ISBN – 978-93-85909-34-4
3.	Advanced Mechanics of Solids, Srinath L.S, 3rd edition,2010, TataMcGraw Hill Publishing company ISBN-10: 0070858055 ISBN-13: 978-0070858053
4.	Theory of Plasticity, Chakrabarthy.T,3rd Edition, Tata Mc.Graw Hill Book Co,ISBN-10:9380931719 ISBN-13: 9789380931715.

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
RESEARCH METHODOLOGY (Common to all programs)						
Course Code	**:**	**18IM23**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hours**

Unit – I	
Overview of Research: Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial.	**07 Hrs**
Unit – II	
Data and data collection: Overview of probability and data types Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules. **Sampling Methods:** Probability sampling and Non-probability sampling	**08 Hrs**
Unit – III	
Processing and analysis of Data: Statistical measures of location, spread and shape, Correlation and regression, Hypothesis Testing and ANOVA. Interpretation of output from statistical software tools	**07 Hrs**
Unit – IV	
Advanced statistical analyses: Non parametric tests, Introduction to multiple regression, factor analysis, cluster analysis, principal component analysis. Usage and interpretation of output from statistical analysis software tools.	**07 Hrs**
Unit-V	
Essentials of Report writing and Ethical issues: Significance of Report Writing , Different Steps in Writing Report, Layout of the Research Report , Ethical issues related to Research, Publishing, Plagiarism **Case studies:** Discussion of case studies specific to the domain area of specialization	**07 Hrs**

Course Outcomes: After going through this course the student will be able to	
CO1	Explain the principles and concepts of research types, data types and analysis procedures.
CO2	Apply appropriate method for data collection and analyze the data using statistical principles.
CO3	Present research output in a structured report as per the technical and ethical standards.
CO4	Create research design for a given engineering and management problem situation.

Reference Books:	
1	Kothari C.R., Research Methodology Methods and techniques by, New Age International Publishers, 4th edition, ISBN: 978-93-86649-22-5
2	Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Pearson Education: New Delhi, 2006. ISBN: 978-81-77585-63-6
3	William M. K. Trochim, James P. Donnelly, The Research Methods Knowledge Base, 3rd Edition, Atomic Dog Publishing, 2006. ISBN: 978-1592602919
4	Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
MINOR PROJECT						
Course Code	**:**	**18MST24**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**0:0:2**		**SEE Marks**	**:**	**100**
Hours	**:**	**48P**		**SEE Duration**	**:**	**3 hrs**

GUIDELINES
1. Each project group will consist of maximum of two students. 2. Each student / group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey. 3. Allocation of the guides preferably in accordance with the expertise of the faculty. 4. The number of projects that a faculty can guide would be limited to four. 5. The minor project would be performed in-house. 6. The implementation of the project must be preferably carried out using the resources available in the department/college.

Course Outcomes: After completing the course, the students will be able to	
CO1	Conceptualize, design and implement solutions for specific problems.
CO2	Communicate the solutions through presentations and technical reports.
CO3	Apply resource managements skills for projects.
CO4	Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination

Evaluation will be carried out in 3 phases. The evaluation committee will comprise of 4 members: Guide, Two Senior Faculty Members and Head of the Department.

Phase	Activity	Weightage
I	Synopsys submission, Preliminary seminar for the approval of selected topic and objectives formulation	20%
II	Mid term seminar to review the progress of the work and documentation	40%
III	Oral presentation, demonstration and submission of project report	40%

** Phase wise rubrics to be prepared by the respective departments

CIE Evaluation shall be done with weightage / distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/ experimental setup 25%
- Conducting experiments/ implementation / testing 25%
- Demonstration & Presentation 15%
- Report writing 25%

Scheme of Semester End Examination (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

- Brief write up about the project 05%
- Presentation / Demonstration of the Project 20%
- Methodology and Experimental results & Discussion 25%
- Report 20%
- Viva Voce 30%

STRUCTURAL RELIABILITY **(Group C:Core Elective)** **(Theory)**		
Course code: 18MST 2C1		**CIE marks:100**
Credits: L: T: P: 4:0:0		**SEE marks :100**
Hours:48L		**SEE duration:3Hrs**

Course learning objectives (CLO):

1. To demonstrate uncertainty in structural engineering with respect to randomness of variables and knowledge of probability distributions.
2. To demonstrate principles of structural reliability in order to assess safety due to randomness of variables by various methods.
3. To evaluate system reliability for structural system.
4. To perform reliability based design.

Unit – I	**10 Hrs**
Probability mass function, probability density function, mathematical expectation, Chebyshev's theorem. Probability distributions: discrete distributions- binomial and poison distributions, continuous distributions- normal, lognormal distributions	
Unit – II	**10 Hrs**
Measures of reliability-factor of safety, safety margin, reliability index, performance function and limiting state. Reliability analysis-first order second moment method (FOSM), point estimate method (PEM)	
Unit – III	**10 Hrs**
Advanced first order second moment method (Hasofer-Lind's method). Simulation Techniques: Monte Carlo simulation- statistical experiments, confidence limits, sample size and accuracy, generation of random numbers- random numbers with standard uniform distribution, continuous random variables, discrete random variables.	
Unit – IV	**8 Hrs**
System Reliability of series, parallel and combined systems, evaluation of probability of survival for determinate and redundant structural system.	
Unit – V	**10 Hrs**
Reliability based design- Steel and RCC beams by FOSM and advanced FOSM, evaluation of geometrical dimension for given level of safety index	

Expected course outcomes:

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

CO1: Apply the theoretical principles of randomness of variables in structural engineering through density functions and probability distribution.

CO2: Analyze components of structure to assess safety using concepts related to structural reliability by various methods.

CO3: Evaluate the safety reliability index at system level.

CO4: Design beam element for given safety index.

Reference books:

1.	Structural Reliability Analysis and Design ,Ranganathan, R. ,1999, Jaico Publishing House, Mumbai, India.
2.	Reliability based Analysis and Design for Civil Engineers, Devaraj.V & Ravindra.R,2017, ,I.K.International Publishing House Pvt.Ltd,India
3.	Probability Concepts in Engineering Planning and Design, Volume –I & II, Ang, A. H. S., and Tang, W. H., 1984, John Wiley and Sons, Inc, New York.

4.	Probability, Reliability and Statistical Methods in Engineering Design ,Achintya Haldar and Sankaran Mahadevan ,2000, John Wiley and Sons. Inc.
5.	Statistics, Probability and Reliability for Civil and Environmental Engineers, Nathabdndu, T., Kottegoda, And Renzo Rosso, 1998, Mc Graw Hill International Edition, Singapore.

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

DESIGN OF MASONRY STRUCTURES **(Group C:Core Elective)** **(Theory)**		
Course Code: 18MST 2C2		**CIE Marks:100**
Credits: L: T: P: 4:0:0		**SEE Marks:100**
Hours:48L		**SEE Duration:3Hrs**

Course Learning Objectives: Students are able to

1	Understand masonry materials and its mechanical properties.
2	Explain the behavior of structural masonry
3	Demonstrate testing, analysis and design methodologies
4	Discuss construction practices, specifications and Design of masonry buildings

Unit – I	**8 Hours**
Introduction, Masonry units, materials and types: History of masonry, historical buildings, Masonry arches, domes and vaults: Components, classification and construction procedure.	
Unit – II	**10 Hours**
Characteristics of masonry constituents: Types of masonry units such as stone, bricks, concrete blocks, clay blocks and stabilized mud blocks. Properties of masonry units like strength, modulus of elasticity and water absorption. Masonry mortars – Classification and properties of mortars, selection of mortars.	
Unit – III	**10 Hours**
Strength of Masonry in Compression: Behaviour of Masonry under compression, strength and elastic properties, factors influencing of compressive strength masonry, Effects of slenderness and eccentricity, water absorption, curing, ageing and workmanship on compressive strength. Prediction of strength of masonry in Indian context.	
Unit – IV	**10 Hours**
Shear and Flexure Behavior of Masonry : Bond between masonry unit and mortar, test methods for determining flexural and shear bond strengths, test procedures for evaluating flexural and shear strength, factors affecting bond strength, effect of bond strength on compressive strength, flexure and shear strength of masonry. Concept of Earthquake resistant masonry buildings.	
Unit-V	**10 Hours**
Design of load bearing masonry buildings: concept of basic compressive stress, Permissible compressive stress, reduction factors. Increase in permissible stresses for eccentric vertical and lateral loads, permissible tensile and shear stresses, Effective height of walls and columns, opening in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action, lintels; Wall carrying axial load, eccentric load with different eccentricity ratios, wall with openings, freestanding wall; Design of load bearing masonry for buildings up to 3 to 8 storeys using BIS codal provisions.	

Course Outcomes:

After going through this course the student will be able to

CO1:	Choose appropriate masonry unit and mortar mixes for masonry construction.
CO2:	Distinguish wide range of materials for their suitability to arrive at feasible and optimal solutions for masonry constructions.
CO3:	Appraise knowledge of structural masonry for advanced research and construction procedures.
CO4:	Design masonry buildings for sustainable development.

Reference Books:

1.	Structural Masonry ,Hendry A.W, 2nd edition, Palgrave Macmillan, Macmillan Education Ltd. ,ISBN 10: 0333733096 ISBN 13:9780333733097.
2.	Masonry structures- Behavior and Design, Robert G Drysdale, Ahmad A Hamid, 3rd edition ,2008 Boulder, CO : Masonry Society, , ISBN 1929081332 9781929081332
3.	Structural Masonry, Jagadish K S, 2015, I K International Publishing House Pvt Ltd, ISBN – 10: 9384588660, ISBN 13: 978-9384588663.
4.	Structural Masonry,Sven Sahlin,1971,Prentice Hall Publisher: Prentice Hall, 1971, ISBN-

	10: 0138539375, ISBN-13: 978-0138539375
Code Books:	
1	IS 1905: 1987, Indian standard Specification for Code of Practice for Structural Use of Unreinforced Masonry.

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100
Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

ADVANCED PRE-STRESSED CONCRETE **(Group C:Core Elective)** **(Theory)**		
Course Code: 18MST 2C3		**CIE Marks:100**
Credits: L: T: P: 4:0:0		**SEE Marks:100**
Hours:48L		**SEE Duration:3 Hrs**

Course Learning Objectives (CLO):

Student will be able to:

1. Understand various types prestressed structural elements.
2. Analyze and determine loads and stresses in PSC Members
3. Apply knowledge of analytical solution in problem solving
4. Design and detailing of Prestressed structural elements.

Unit – I	**09 Hrs**

Design of Section for Flexure : Allowable stresses - Elastic design of simple beams having rectangular and I-section for flexure - kern lines - cable profile and cable layout. Design of Sections for Shear : Shear and Principal stresses - Improving shear resistance by different prestressing Techniques - horizontal, sloping and vertical prestressing - Analysis of rectangular and l-beam - Design of shear reinforcement - Indian code provisions, Importance of modulus of elasticity of Prestressing tendons, failures of prestressed concrete.

Unit – II	**10 Hrs**

Shear and Torsional resistance- ultimate shear resistance- Design of shear reinforcement in torsion.

Unit – III	**09 Hrs**

Composite sections of prestressed concrete beam and cast in situ RC slab analysis of stresses differential shrinkage deflections Flexural and shear strength of composite sections Design of composite sections.

Unit – IV	**10 Hrs**

Transfer of Prestress in Pretensioned Members : Transmission of prestressing force by bond Transmission length , Flexural bond stresses - lS code provisions - Anchorage zone stresses in post tensioned members - stress distribution in End block - Analysis by approximate, Guyon and Magnel methods -Anchorage zone reinforcement.

Unit – V	**10 Hrs**

Statically indeterminate Structures : Advantages & disadvantages of continuous Prestressed beams - Primary and secondary moments - P and C lines - Linear transformation concordant and non-concordant cable profiles -Analysis of continuous beams and simple portal frames (single bay and single story)

Expected Course Outcomes:

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

CO1: Identify various prestressed structural elements.

CO2: Apply analytical skills to evaluate performance of prestressed structural elements

CO3: Analyze prestressed structural elements with various considerations.

CO4: Design and detail prestressed structural elements for various loading conditions.

Reference Books:

1.	Prestressed Concrete ,N Krishnaraju, Tata McGraw- Hill Education, 2008,ISBN0070634440,9780070634442.
2.	Prestressed Concrete structures, Lin T. Y and H. Burns, 2009,Wiley Publication,ISBN: 978-0-471-01898-8
3.	Prestressed Concrete, N. Rajagopalan, 2nd Edition,2005,Narosa Publishing House.ISBN 2053 2005.
4.	Design of Prestressed Concrete, A. Nilson, 2nd edition, John Willey & Sons., ISBN 1765 1997.

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

FINITE ELEMENT METHOD OF ANALYSIS **(Group D:Core Elective)** **(Theory)**		
Course Code: 18MST 2D1		**CIE Marks:100**
Credits: L:T:P : 4:0:0		**SEE Marks:100**
Hours:48L		**SEE Duration:3Hrs**

Course Learning Objectives (CLO):

Student will be able to

1. Understand approximate methods of numerical analysis for structures; geometric and material non-linearity
2. Apply the concepts of shape function or interpolation function for formulation of stiffness matrix and load vector for bar, beam, truss, three noded and four noded elements
3. Analyse bar, beam, truss, three noded and four noded elements by finite element method
4. Explain the concept of condensation and minimization of matrix bandwidth, gauss quadrature and mesh refinement

Unit – I	**10 Hrs**

Basic concepts of elasticity – kinematics and static variables for various types of structural problems – approximate method of structural analysis – Rayleigh-Ritz method – Difference between Finite Difference Method and Finite Element Method – variational method and minimization of energy approach for element formulation – principles of finite element method – advantages & disadvantages – finite element procedure – finite elements both first and second order elements used for one, two and three dimensional problems.

Unit – II	**9 Hrs**

Nodal displacement parameters – convergence criteria – compatibility requirements – geometric invariance – shape function – polynomial form of displacement function – generalized and natural coordinates – Lagrangian interpolation function.

Unit – III	**10 Hrs**

Serendipity and Lagrangian family of elements – shape functions for one, two and three dimensional first and second order elements – Hermite shape function for beam formulation – Numerical problems to interpolate nodal variables using shape function. Formulation of one-dimensional bar element, two- and three-noded using Lagrangian shape function – numerical analysis of simple bars and plane trusses

Unit – IV	**10 Hrs**

Two noded beam element formulation using Hermite shape function – Jacobian transformation matrix – strain-displacement matrix – stiffness matrix – consistent load vector – Gauss quadrature for numerical integration – numerical analysis of simple beams. Iso-parametric elements – sub-parametric and super-parametric elements – Formulation of two-dimensional three-noded triangular (CST)

Unit – V	**9 Hrs**

Formulation of four-noded quadrilateral element, and its application to plane stress, plane strain and axis-symmetric problems – application of Gauss quadrature for numerical integration – Numerical problems. Element aspect ratio – mesh refinement vs. higher order elements – numbering of nodes to minimize bandwidth – static condensation technique – introduction to non-linear analysis – geometric and material non-linearity with examples.

Expected Course Outcomes:

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

CO1: Apply the principles of approximate numerical methods and identify non-linearity of structures

CO2: Use Finite Element Method for formulation of stiffness matrix and load vector for bar, beam, truss, three noded and four noded elements.

CO3: Solve continuum problems using finite element analysis

CO4: Illustrate the concept of condensation and minimization of matrix bandwidth, gauss quadrature and mesh refinement

Reference Books:	
1.	Finite Element Analysis – Theory and Programming ,C.S Krishnamoorthy, 1994, Tata McGraw-Hill, ISBN 0-07-462210-2
2.	Concepts and applications of finite element analysis,RD Cook, DS Malkus, ME Plesha and RJ Witt, 2002, Wiley
3.	The Finite Element Method: Its Basis and Fundamental,O.C Zienkiewicz and R.L Taylor, 2005 Butterwoth.
4.	Finite Element Procedures, KJ Bathe, 2002, Prentice Hall, ISBN 978-546-439-982
5.	Fundamentals of Finite Element Analysis, DV Hutton, (2004) ,Tata McGraw Hill.

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100
Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

DESIGN OF BRIDGES AND GRADE SEPARATORS **(Group D:Core Elective)** **(Theory)**		
Course Code: 18MST 2D2		**CIE Marks: 100**
Credits: L:T:P : 4:0:0		**SEE Marks: 100**
Hours:48L		**SEE : 3 Hrs**

Course objectives: This course will enable students to

1	Describe the types and components of a bridge with specifications for designing them for highways.
2	Discuss the use of different types of bridge bearings, their installation and maintenance aspects under the action of vehicular loads.
3	Examine the design aspects of bridge approaches for RCC, PSC and Steel bridges.
4	Analyze the loading conditions on the bridges and design the elements as per IRC load specifications.
5	Identify the quality control measures during the execution of bridges both for substructure and super structure portions of the bridge.

Unit – I	
Introduction: Historical Developments, Site Selection for Bridges, Classification of Bridges and Forces on Bridges. Bridge substructures: Abutments, Wing walls, Approaches, Grade separators and its types.	**09 Hours**
Unit – II	
Box Culvert: Different Loading Cases IRC Class AA Tracked, Wheeled and Class A Loading, working out the worst combination of loading, Moment Distribution, Calculation of BM & SF, Structural Design of Slab Culvert, with Reinforcement Details.	**10 Hours**
Unit – III	
T Beam Bridge Slab Design: Proportioning of Components Analysis of interior Slab & Cantilever Slab Using IRC Class AA Tracked, Wheeled Class A Loading, Structural Design of Slab, with Reinforcement Detail. T Beam Bridge Cross Girder Design: Analysis of Cross Girder for Dead Load & Live Load Using IRC Class AA Tracked, Wheeled Class A Loading A Loads, Structural Design of beam with Reinforcement Detail.	**10 Hours**
Unit – IV	
Bearings – Types of bearings, Bearings for slab bridges – Bearings for girder bridges – Design of Elastomeric bearing – Joints – Expansion joints, repair and rehabilitation of concrete bridges.	**10 Hours**
Unit – V	
PSC Bridges: Introduction to Pre and Post Tensioning, Proportioning of Components, Analysis and Structural Design of Slab, Analysis of Main Girder using COURBON's Method for IRC Class AA tracked vehicle, Calculation of pre-stressing force and eccentricity, cable profile and calculation of stresses, Design of End block and detailing of main girder.	**09 Hours**

Course outcomes:

After studying this course, students will be able to:

CO1	Explain the components of a bridge following the specifications for highways.

CO2	Compare different types of bridge bearings, their installation and maintenance aspects under the action of vehicular loads.
CO3	Analyse the IRC loading conditions for the design of bridges.
CO4	Evaluate the design aspects of bridge approaches for RCC, PSC and Steel bridges.

Reference Books:

1	Essentials of bridge Engineering, D.Johnson Victor,Oxford, IBH publishing company, ISBN, 8120417178, 9788120417175
2	Bridge Engineering"-Ponnuswamy, "McGraw Hill Publication, 1989, ISBN-10: 0070656959
3	Vazirani Ratwani & M.G.Aswani, Design of Concrete Bridges,2004, Khanna Publishers, New Delhi, ISBN-13. 978-81-7409-117-3. ISBN-10.
4	Dr. Krishna Raju, Design of Bridges 2001,Oxford & IBH Publishing company Limited, ISBN978-81-204-1741-0 788120 114 17410

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

PLATES AND SHELLS (Group D:Core Elective) (Theory)		
Course Code: 18MST 2D3		**CIE Marks:100**
Credits: L:P:T : 4:0:0		**SEE Marks:100**
Hours:48L		**SEE Duration:3 Hrs**

Course Learning Objectives:

1. Classify various types of Spatial structures.
2. Analyze spatial structures by various methods
3. Apply knowledge of analytical solution in problem solving
4. Design and detailing of spatial structures.

Unit – I	**9 Hrs**
Introduction to plate theory, Small deflection of laterally loaded thin rectangular plates of pure bending. Navier's solution for various lateral loading (No derivations), Numerical examples.	
Unit – II	**10Hrs**
Levy's solution for various lateral loading and boundary conditions (No derivations), Numerical examples. Energy methods for rectangular plates with clamped edges.	
Unit – III	**10Hrs**
Bending of circular plates with various edge conditions for both solid and annular plates.	
Unit – IV	**09Hrs**
Introduction to curved surfaces and classification of shells, membrane theory of spherical shells, Cylindrical shell, Hyperbolic paraboloid, Elliptic paraboloid.	
Unit – V	**10Hrs**
Design and detailing of cylindrical shells. Introduction to folded plates, analysis of folded plates by whitney's and simpson's method.	

Expected Course Outcomes:

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

CO1: Explain principles of analysis for special structures.

CO2: Apply analytical skills to evaluate performance of spatial structures

CO3: Analyze spatial structures using various methods

CO4: Evaluate deflection, moments and stresses in spatial structures for design and detailing

Reference Books:

1.	Theory of Plates and Shells ,Timosheko, S. and Woinowsky-Krieger, W,2nd Edition,1959, McGraw-Hill Co., New York, ISBN-10: 0070647798; ISBN-13: 978-0070647794
2.	Linear Elastic theory of thin shells. Volume I, J.E.Gibson B.G Neal,Elsevier, ISBN: 978-0-08-010944-2
3.	Stresses in Plates and Shells, Ugural.A.C,2nd edition,1999, McGraw-Hill, ISBN 10: 0070657300 ISBN 13: 9780070657304
4.	Theory and analysis of plates - classical and numerical methods, R. Szilard, 1994, Prentice Hall, ISBN-13: 9780139134265 ISBN: 0139134263

Continuous Internal Evaluation (CIE): Total marks: 100

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two

assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100
Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
BUSINESS ANALYTICS (Group G: Global Elective)						
Course Code	**:**	**18CS2G01**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Course Learning Objectives:

Graduates shall be able to

1. Formulate and solve business problems to support managerial decision making.
2. Explore the concepts, processes needed to develop, report, and analyze business data.
3. Use data mining techniques concepts to identify specific patterns in the data
4. Interpret data appropriately and solve problems from various sectors such as manufacturing, service, retail, software, banking and finance.

Unit – I	
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.	**07 Hrs**
Unit – II	
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	**07 Hrs**
Unit – III	
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, Predictive Analytics, Predicative Modelling, Predictive analytics analysis.	**07 Hrs**
Unit – IV	
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.	**08 Hrs**
Unit –V	
Decision Analysis: Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	**07 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Explore the concepts, data and models for Business Analytics.
CO2	Analyze various techniques for modelling and prediction.
CO3	Design the clear and actionable insights by translating data.
CO4	Formulate decision problems to solve business applications

Reference Books:	
1	Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Business analytics Principles, Concepts, and Applications FT Press Analytics, 1st Edition, 2014, ISBN-13: 978-0133989403, ISBN-10: 0133989402

2	Evan Stubs , The Value of Business Analytics: Identifying the Path to Profitability, John Wiley & Sons, ISBN:9781118983881 |DOI:10.1002/9781118983881,1st edition 2014
3	James Evans, Business Analytics, Pearsons Education 2nd edition, ISBN-13: 978-0321997821 ISBN-10: 0321997824
4	Gary Cokins and Lawrence Maisel, Predictive Business Analytics Forward Looking Capabilities to Improve Business, Wiley; 1st edition, 2013.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II		
INDUSTRIAL AND OCCUPATIONAL HEALTH AND SAFETY (Group G :Global Elective)		
Course Code: 18CV2G02		**CIE Marks:100**
Credits : L: T: P : 3:0:0		**SEE Marks :100**
Hours : 36L		**SEE Duration:3Hrs**

Course Learning Objectives :	
1	To understand the Industrial and Occupational health and safety and its importance.
2	To understand the different materials, occupations to which the employee can exposed to.
3	To know the characteristics of materials and effect on health.
4	To evaluate the different processes and maintenance required in the industries to avoid accidents.

UNIT – I	**7Hrs**

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

UNIT – II	**7Hrs**

Occupational health and safety: Introduction, Health, Occupational health: definition, Interaction between work and health, Health hazards, workplace, economy and sustainable development, Work as a factor in health promotion. Health protection and promotion Activities in the workplace: National governments, Management, Workers, Workers' representatives and unions, Communities, Occupational health professionals. Potential health hazards: Air contaminants, Chemical hazards, Biological hazards, Physical hazards, Ergonomic hazards, Psychosocial factors, Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.

UNIT – III	**8Hrs**

Hazardous Materials characteristics and effects on health: Introduction, Chemical Agents, Organic Liquids, Gases, Metals and Metallic Compounds, Particulates and Fibers, Alkalies and Oxidizers, General Manufacturing Materials, Chemical Substitutes, Allergens, Carcinogens, Mutagens, Reproductive Hazards, Sensitizers and Teratogens, Recommended Chemical Exposure Limits. Physical Agents, Noise and Vibration, Temperature and Pressure, Carcinogenicity, Mutagenicity and Teratogenicity. Ergonomic Stresses: Stress-Related Health Incidents, Eyestrain, Repetitive Motion, Lower Back Pain, Video Display Terminals.

UNIT – IV	**7Hrs**

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

UNIT – V	**7Hrs**

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

Expected Course Outcomes:
After successful completion of this course the student will be able to:

CO1	Explain the Industrial and Occupational health and safety and its importance.
CO2	Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.
CO3	Characterize the different type materials, with respect to safety and health hazards of it.
CO4	Analyze the different processes with regards to safety and health and the maintenance required in the industries to avoid accidents.

Reference Books:

5.	Maintenance Engineering Handbook, Higgins & Morrow, SBN 10: 0070432015 / ISBN 13: 9780070432017, Published by McGraw-Hill Education. Da Information Services.
6.	H. P. Garg, Maintenance Engineering Principles, Practices & Management, 2009,S. Chand and Company, New Delhi, ISBN:9788121926447
7.	Fundamental Principles of Occupational Health and Safety, Benjamin O. ALLI, Second edition,2008 International Labour Office – Geneva: ILO, ISBN 978-92-2-120454-1
8.	Foundation Engineering Handbook, 2008, Winterkorn, Hans, Chapman & Hall London. ISBN:8788111925428.

Continuous Internal Evaluation (CIE): Total marks: 100
Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100
Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
MODELING USING LINEAR PROGRAMMING (Group G: Global Elective)						
Course Code	**:**	**18IM2G03**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Linear Programming: Introduction to Linear Programming problem **Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables	**07 Hrs**
Unit – II	
Advanced Linear Programming : Two Phase simplex techniques, Revised simplex method **Duality:** Primal-Dual relationships, Economic interpretation of duality	**07 Hrs**
Unit – III	
Sensitivity Analysis: Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Post optimal analysis - changes affecting feasibility and optimality	**07 Hrs**
Unit – IV	
Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems.	**08 Hrs**
Unit –V	
Assignment Problem: Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).	**07 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Explain the various Linear Programming models and their areas of application.
CO2	Formulate and solve problems using Linear Programming methods.
CO3	Develop models for real life problems using Linear Programming techniques.
CO4	Analyze solutions obtained through Linear Programming techniques.

Reference Books:	
1	Taha H A, Operation Research An Introduction, PHI, 8th Edition, 2009, ISBN: 0130488089.
2	Philips, Ravindran and Solberg - Principles of Operations Research – Theory and Practice, John Wiley & Sons (Asia) Pvt Ltd, 2nd Edition, 2000, ISBN 13: 978-81-265-1256-0
3	Hiller, Liberman, Nag, Basu, Introduction to Operation Research, Tata McGraw Hill 9th Edition, 2012, ISBN 13: 978-0-07-133346-7
4	J K Sharma, Operations Research Theory and Application, Pearson Education Pvt Ltd, 4th Edition, 2009, ISBN 13: 978-0-23-063885-3.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
PROJECT MANAGEMENT (Group G: Global Elective)						
Course Code	**:**	**18IM2G04**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Introduction: Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS), Introduction to Agile Methodology.	**07 Hrs**
Unit – II	
Capital Budgeting: Capital Investments: Importance and Difficulties, phases of capital budgeting, levels of decision making, facets of project analysis, feasibility study – a schematic diagram, objectives of capital budgeting	**07 Hrs**
Unit – III	
Project Costing: Cost of Project, Means of Finance, Cost of Production, Working Capital Requirement and its Financing, Profitability Projections, Projected Cash Flow Statement, Projected Balance Sheet, Multi-year Projections, Financial Modeling, Social Cost Benefit Analysis	**08 Hrs**
Unit – IV	
Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Critical Path Method (CPM), Computerized project management	**07Hrs**
Unit-V	
Project Management and Certification: An introduction to SEI, CMMI and project management institute USA – importance of the same for the industry and practitioners. PMBOK 6 - Introduction to Agile Methodology, Themes / Epics / Stories, Implementing Agile. **Domain Specific Case Studies on Project Management:** Case studies covering project planning, scheduling, use of tools & techniques, performance measurement.	**07 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Explain project planning activities that accurately forecast project costs, timelines, and quality.
CO2	Evaluate the budget and cost analysis of project feasibility.
CO3	Analyze the concepts, tools and techniques for managing projects.
CO4	Illustrate project management practices to meet the needs of Domain specific stakeholders from multiple sectors of the economy (i.e. consulting, government, arts, media, and charity organizations).

Reference Books:	
1	Prasanna Chandra, Project Planning Analysis Selection Financing Implementation & Review, Tata McGraw Hill Publication, 8th Edition, 2010, ISBN 0-07-007793-2.
2	Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK Guide), 5th Edition, 2013, ISBN: 978-1-935589-67-9
3	Harold Kerzner, Project Management A System approach to Planning Scheduling & Controlling, John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.
4	Rory Burke, Project Management – Planning and Controlling Techniques, John Wiley & Sons, 4th Edition, 2004, ISBN: 9812-53-121-1

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

II Semester		
ENERGY MANAGEMENT (Group G: Global Elective)		
Course Code: 18CH2G05		**CIE Marks: 100**
Credits: L:T:P: 3:0:0		**SEE Marks: 100**
Hours: 36L		**SEE Hrs: 3**

Course Learning Objectives(CLO):

Students are able to:

1. Explain the importance of energy conservation and energy audit.
2. Understand basic principles of renewable sources of energy and technologies.
3. Outline utilization of renewable energy sources for both domestics and industrial application.
4. Analyse the environmental aspects of renewable energy resources.

Unit-I	**08 Hrs**
Energy conservation: Principles of energy conservation, Energy audit and types of energy audit, Energy conservation approaches, Cogeneration and types of cogeneration, Heat Exchangers and classification.	
Unit-II	**07 Hrs**
Wet Biomass Gasifiers: Introduction, Classification of feedstock for biogas generation, Biomass conversion technologies: Wet and dry processes, Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant their advantages and disadvantages.	
Unit -III	**07 Hrs**
Dry Biomass Gasifiers : Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems: Construction and operation of up draught and down draught gasifiers.	
Unit -IV	**07 Hrs**
Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, Types of solar cells and fabrication. **Wind Energy:** Classification, Factors influencing wind, WECS & classification.	
Unit -V	**07 Hrs**
Alternative liquid fuels: Introduction, Ethanol production: Raw materials, Pre-treatment, Conversion processes with detailed flow sheet. Gasification of wood: Detailed process, Gas purification and shift conversion, Biofuel from water hyacinth.	

Course outcomes (CO):

On completion of the course, the student should have acquired the ability to

CO1: Understand the use alternate fuels for energy conversion

CO2: Develop a scheme for energy audit

CO3: Evaluate the factors affecting biomass energy conversion

CO4: Design a biogas plant for wet and dry feed

Reference Books:

1	Nonconventional energy, Ashok V Desai, 5th Edition, 2011, New Age International (P) Limited, ISBN 13: 9788122402070.
2	Biogas Technology - A Practical Hand Book, Khandelwal K C and Mahdi S S, Vol. I & II, 1986, McGraw-Hill Education, ISBN-13: 978-0074517239.

3	Biomass Conversion and Technology, Charles Y Wereko-Brobby and Essel B Hagan, 1st Edition, 1996, John Wiley & Sons, ISBN-13: 978-0471962465.
4	Solar Photovoltaics: Fundamental Applications and Technologies, C. S. Solanki, 2nd Edition, 2009, Prentice Hall of India, ISBN:9788120343863.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks):
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/ field work 4) mini project.
Total CIE is 20+50+30 = 100 marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
INDUSTRY 4.0 **(Group G: Global Elective)**						
Course Code	**:**	**18ME2G06**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Introduction: Industrial, Internet, Case studies, Cloud and Fog, M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.	**07 Hrs**
Unit – II	
The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.	**07 Hrs**
Unit – III	
Data Analytics in Manufacturing: Introduction, Power Consumption in manufacturing, Anomaly Detection in Air Conditioning, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing. Internet of Things and New Value Proposition, Introduction, Internet of Things Examples, IoTs Value Creation Barriers: Standards, Security and Privacy Concerns. Advances in Robotics in the Era of Industry 4.0, Introduction, Recent Technological Components of Robots, Advanced Sensor Technologies, Artificial Intelligence, Internet of Robotic Things, Cloud Robotics.	**08 Hrs**
Unit – IV	
Additive Manufacturing Technologies and Applications: Introduction, Additive Manufacturing (AM) Technologies, Stereo lithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net Shaping, Advantages of Additive Manufacturing, Disadvantages of Additive Manufacturing. Advances in Virtual Factory Research and Applications, The State of Art, The Virtual Factory Software , Limitations of the Commercial Software	**07 Hrs**
Unit –V	
Augmented Reality: The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance , Assembly, Collaborative Operations , Training. Smart Factories: Introduction, Smart factories in action, Importance, Real world smart factories, The way forward. A Roadmap: Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.	**07 Hrs**

Reference Books:	
1	Alasdair Gilchrist, INDUSTRY 4.0 THE INDUSTRIAL INTERNET OF THINGS, Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
2	Alp Ustundag, Emre Cevikcan, Industry 4.0: Managing The Digital Transformation, Springer, 2018 ISBN 978-3-319-57869-9.
3	Ovidiu Vermesan and Peer Friess, Designing the industry - Internet of things connecting the physical, digital and virtual worlds, Rivers Publishers, 2016 ISBN 978-87-93379-81-7
4	Christoph Jan Bartodziej, The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Springer Gabler, 2017 ISBN 978-3-6581-6502-4.

Course Outcomes: After going through this course the student will be able to:	
CO1	Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals
CO2	Analyze the effectiveness of Smart Factories, Smart cities, Smart products and Smart services
CO3	Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits
CO4	Evaluate the effectiveness of Cloud Computing in a networked economy

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
ADVANCED MATERIALS (Group G: Global Elective)						
Course Code	**:**	**18ME2G07**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Classification and Selection of Materials: Classification of materials. Properties required in Engineering materials, Criteria of selection of materials. Requirements / needs of advance materials.	**07 Hrs**
Unit – II	
Non Metallic Materials: Classification of n on metallic materials, Rubber : Properties, processing and applications.Plastics : Thermosetting and Thermoplastics, Applications and properties. Ceramics : Properties and applications. Adhesives: Properties and applications. Optical fibers : Properties and applications. Composites : Properties and applications.	**07 Hrs**
Unit – III	
High Strength Materials: Methods of strengthening of alloys, Materials available for high strength applications, Properties required for high strength materials, Applications of high strength materials	**08 Hrs**
Unit – IV	
Low & High Temperature Materials Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.	**07 Hrs**
Unit –V	
Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials	**07 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Describe metallic and non metallic materials
CO2	Explain preparation of high strength Materials
CO3	Integrate knowledge of different types of advanced engineering Materials
CO4	Analyse problem and find appropriate solution for use of materials.

Reference Books:	
1	Donald R. Askeland, and Pradeep P. Fulay, The Science & Engineering of Materials, 5th Edition, Thomson, 2006, ISBN-13-978-0534553968
2	Gregory L. Timp, Nanotechnologym 1999th Editionmm Springer, 1999 ISBN-13: 978-0387983349
3	Dr. VD Kodgire and Dr. S V Kodgire, Material Science and Metallurgym 42nd Edition 2018, Everest Publishing House ISBN NO: 81 86314 00 8
4	N Bhatnagar, T S Srivatsan, Processing and Fabrication of Advanced Materials, 2008, IK International, ISBN: 978819077702

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II		
COMPOSITE MATERIALS SCIENCE AND ENGINEERING (Common to AS, BT, CH, CV, IM, ME)		
Course Code: 18CHY2G08		**CIE Marks: 100**
Credits: L:T:P : 3:1:0		**SEE Marks: 100**
Hours: 36L +12T		**SEE Duration: 3Hrs**

Course Learning Objectives:	
1	Understand the properties of composite materials.
2	Apply the basic concepts of Chemistry to develop futuristic composite materials for high-tech applications in the area of Engineering.
3	Impart knowledge in the different fields of material chemistry so as to apply it to the problems in engineering field.
4	Develop analytical capabilities of students so that they can characterize, transform and use materials in engineering and apply knowledge gained in solving related engineering problems.

Unit-I	
Introduction to composite materials Fundamentals of composites – need for composites – Enhancement of properties – Classification based on matrix- Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Constituents of composites, Interfaces and Interphases, Distribution of constituents, Types of Reinforcements, Particle reinforced composites, Fibre reinforced composites. Fiber production techniques for glass, carbon and ceramic fibers Applications of various types of composites.	**07 Hrs**
Unit – II	
Polymer matrix composites (PMC) Polymer resins – Thermosetting resins, Thermoplastic resins & Elastomers, Reinforcement fibres-Types, Rovings, Woven fabrics. PMC processes – Hand Layup Processes, Spray up processes – Compression Moulding – Injection Moulding – Resin Transfer Moulding – Pultrusion – Filament winding – Injection moulding. Glass fibre and carbon fibre reinforced composites (GFRP & CFRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Mechanical Testing of PMC- Tensile Strength, Flexural Strength, ILSS, Impact Strength- As per ASTM Standard. Applications of PMC in aerospace, automotive industries**.**	**08 Hrs**
Unit -III	
Ceramic matrix composites and special composites Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics – need for CMC – ceramic matrix – various types of ceramic matrix composites-oxide ceramics – non oxide ceramics – Aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering – Hot pressing – Cold Isostatic Pressing (CIPing) – Hot isostatic pressing (HIPing). Applications of CMC in aerospace, automotive industries-Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol-gel technique- Processing of Ceramic Matrix composites.	**07 Hrs**
Unit –IV	
Metal matrix composites Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, a spray process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties-applications of MMC in aerospace, automotive industries.	**07 Hrs**

Unit –V	
Polymer nano composites Introduction and Significance of polymer Nano composites. Intercalated And Exfoliated Nanocomposites. Classification of Nano fillers- nanolayers, nanotubes, nanoparticles. Preparation of Polymer Nano composites by Solution, In-situ Polymerization and melt mixing techniques. Characterization Of polymer nanocomposites- XRD, TEM, SEM and AFM. Mechanical and Rheological properties of Polymer Nano composites. Gas barrier, Chemical-Resistance, Thermal and Flame retardant properties of polymer nanocomposites. Optical properties and Biodegradability studies of Polymer nanocomposites, Applications of polymer nano-composites.	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the purpose and the ways to develop new materials upon proper combination of known materials.
CO2:	Identify the basic constituents of a composite materials and list the choice of materials available
CO3:	Will be capable of comparing/evaluating the relative merits of using alternatives for important engineering and other applications.
CO4:	Get insight to the possibility of replacing the existing macro materials with nano-materials.

Reference Books	
1	Composite Materials Science and Engineering, Krishan K Chawla, 3rd Edition Springer-verlag Gmbh, , ISBN: 9780387743646, 0387743642
2	The Science and Engineering of Materials, K Balani, Donald R Askeland,6th Edition-Cengage, Publishers, ISBN: 9788131516416
3	Polymer Science and Technology, Joel R Fried , 2nd Edition, Prentice Hall, ISBN: 9780137039555
4	Nanomaterials and nanocomposites, Rajendra Kumar Goyal , 2nd Edition, CRC Press-Taylor & Francis, ISBN: 9781498761666, 1498761666

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester : II		
PHYSICS OF MATERIALS (Group G: Global Elective)		
Course Code: 18PHY2G09		**CIE Marks: 100**
Credits: L:T:P: 3:0:0		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives (CLO):

Student are able to

1.Classify the crystals based on lattice parameters.
2.Explain the behavior of Dielectrics with change in frequency.
3.Classify the magnetic materials based on Quantum theory as well understand superconductors.
4.Explain direct and indirect bandgap semiconductors, polymer semiconductors and Photoconductive polymers.
5.Describe the behavior of Smart materials and its phases and apply to Engineering applications.

Unit-I	**07 Hrs**
Crystal Structure : Symmetry elements-seven crystals systems-Reciprocal lattice-Packing fraction, Lattice Vibration-Brillouin zones, Analysis of Crystal structure using XRD, Thermal properties.	
Unit-II	**07 Hrs**
Dielectric Materials: Basic concepts-Langevin's Theory of Polarisation-Clausius-Mossotti Relation-Ferro electricity-Piezoelectricity-Properties of Dielectric in alternating fields-The complex Dielectric Constant and Dielectric Loss, Polarizability as a function of frequency-Complex dielectric constant of non-polar solids-Dipolar relaxation, Applications.	
Unit -III	**07Hrs**
Magnetic Materials : Dia and Paramagnetic materials-Quantum theory of paramagnetic materials-Paramagnetic susceptibility of conduction electrons-Ferro-anti ferromagnetic materials-Superconductors and Applications..	
Unit -IV	**07 Hrs**
Semiconducting Materials Semiconductor-Direct and Indirect bonding characteristics-Importance of Quantum confinement-quantum wires and dots-Ferro electric semiconductors-applications-Polymer semiconductors-Photo conductive polymers, Applications.	
Unit -V	**08 Hrs**
Novel Materials Smart materials-shape memory alloys-shape memory effects-Martensitia Transformation functional properties-processing-texture and its nature.	

Reference Books:

1. Solid State Physics, S O Pillai, 6th Edition, New Age International Publishers, ISBN 10-8122436978.
2. Introduction to Solid State Physics, C.Kittel, 7th Edition, 2003, John Wiley & Sons, ISBN 9971-51-180.
3. Material Science, Rajendran V and Marikani, 1st Edition, Tata McGraw Hill, ISBN 10-0071328971.
4. The Science and Engineering of Materials, Askeland, Fulay, Wright, Balanai, 6th Edition, Cengage Learning, ISBN-13:978-0-495-66802-2.

Course Outcomes (CO's):
CO1: Analyse crystals using XRD technique.
CO2: Explain Dielectric and magnetic materials.
CO3:Integrate knowledge of various types of advanced engineering Materials.
CO4: Use materials for novel applications.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks):
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/ field work 4) mini project.
Total CIE is 20+50+30 = 100 marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

II Semester		
ADVANCED STATISTICAL METHODS (Global Elective)		
Course Code: 18MAT2G10		**CIE Marks: 100**
Credits: L:T:P:: 3:0:0		**SEE Marks: 100**
Hours: 36L		**SEE Duration: 3Hrs**

Course Learning Objectives (CLO):

Students are able to:

1. Adequate exposure to learn sampling techniques, random phenomena for analyzing data for solving real world problems.
2. To learn fundamentals of estimation and problems used in various fields of engineering and science.
3. Explore the fundamental principles of statistical inference and tests of hypothesis.
4. Apply the concepts of regression and statistical models to solve the problems of engineering applications.

Unit-I	**07 Hrs**

Sampling Techniques:

Random numbers, Concepts of random sampling from finite and infinite populations, Simple random sampling (with replacement and without replacement). Expectation and standard error of sample mean and proportion.

Unit-II	**07 Hrs**

Estimation:

Point estimation, Estimator and estimate, Criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Method of moment's estimation and maximum likelihood estimation, Properties of maximum likelihood estimator (no proofs), Confidence intervals-population mean (large sample), population proportion.

Unit -III	**07Hrs**

Tests of Hypothesis:

Principles of Statistical Inference, Formulation of the problems with examples, Simple and composite hypothesis, Null and alternative hypothesis, Tests - type I and type II error, Testing of mean and variance of normal population (one sample and two samples), Chi squared test for goodness of fit.

Unit -IV	**07 Hrs**

Linear Statistical Models:

Definition of linear model and types, One way ANOVA and two way ANOVA models-one observation per cell, multiple but equal number of observation per cell.

Unit -V	**08 Hrs**

Linear Regression:

Simple linear regression, Estimation of parameters, Properties of least square estimators, Estimation of error variance, Multivariate data, Multiple linear regressions, Multiple and partial correlation, Autocorrelation-introduction and plausibility of serial dependence, sources of autocorrelation, Durbin-Watson test for auto correlated variables.

Reference Books:

1	Fundamentals of Statistics (Vol. I and Vol. II), A. M. Goon, M. K. Gupta and B. Dasgupta, 3rd Edition, 1968, World Press Private Limited, ISBN-13: 978-8187567806.

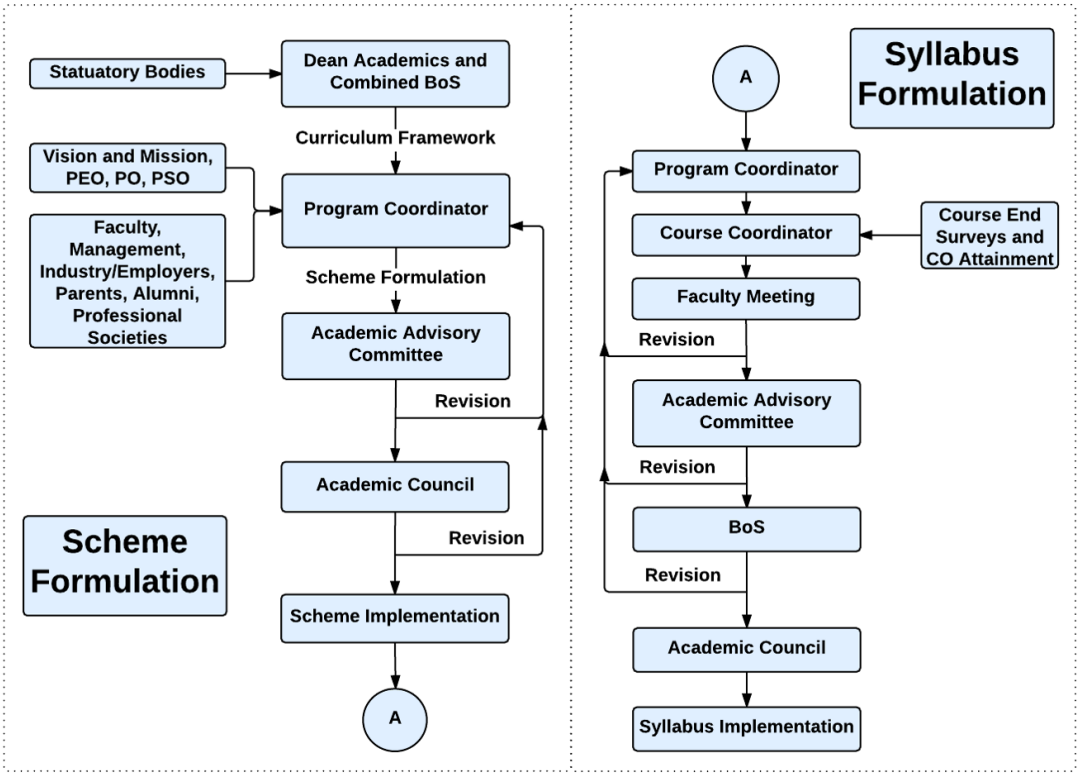
2	Applied Statistics and Probability for Engineers, John Wiley & Sons, Inc., 3rd Edition, 2003, ISBN 0-471-20454-4.
3	S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistic, D. C. Montgomery and G. C. Runger, 10th Edition, 2000, A Modern Approach, S Chand Publications, ISBN 81-7014-791-3.
4	Regression Analysis: Concepts and Applications , F. A. Graybill and H. K. Iyer, Belmont, Calif, 1994, Duxbury Press, ISBN-13: 978-0534198695.

Course outcomes (CO's):
On completion of the course, the student should have acquired the ability to CO1: Identify and interpret the fundamental concepts of sampling techniques, estimates and types, hypothesis, linear statistical models and linear regression arising in various fields engineering. CO2: Apply the knowledge and skills of simple random sampling, estimation, null and alternative hypotheses, errors, one way ANOVA, linear and multiple linear regressions. CO3: Analyze the physical problem to establish statistical/mathematical model and use appropriate statistical methods to solve and optimize the solution. CO4: Distinguish the overall mathematical knowledge gained to demonstrate the problems of sampling techniques, estimation, tests of hypothesis, regression and statistical model arising in many practical situations.

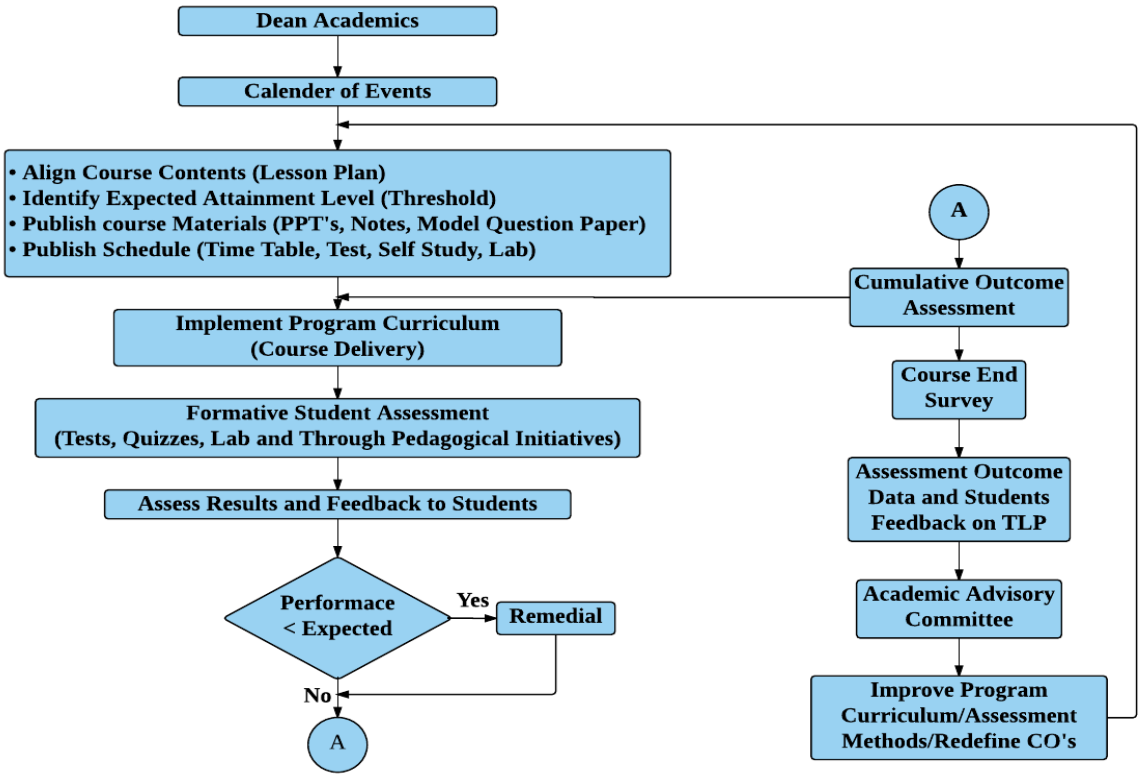
Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks):
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/ field work 4) mini project.
Total CIE is 20+50+30 = 100 marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

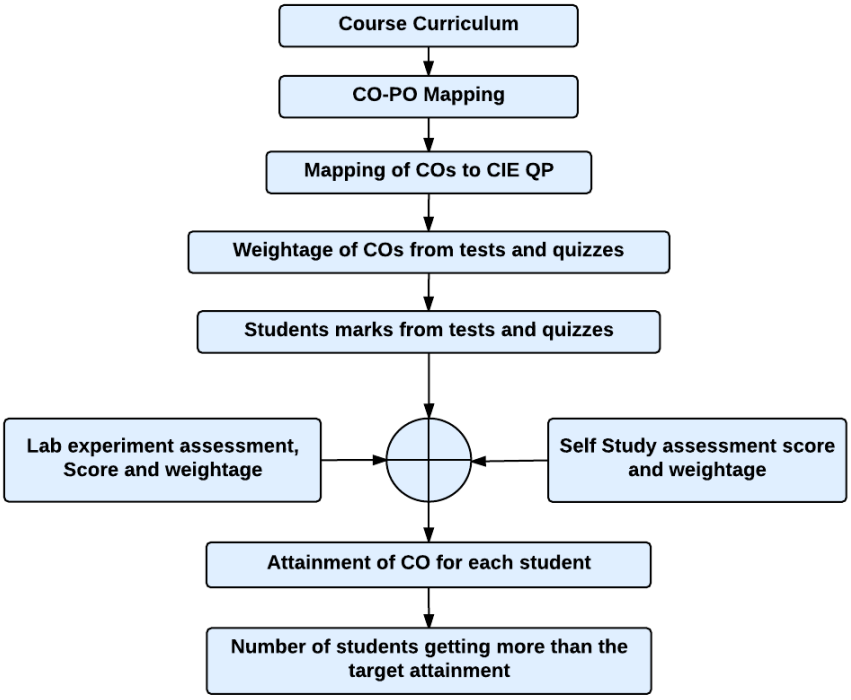
Curriculum Design Process



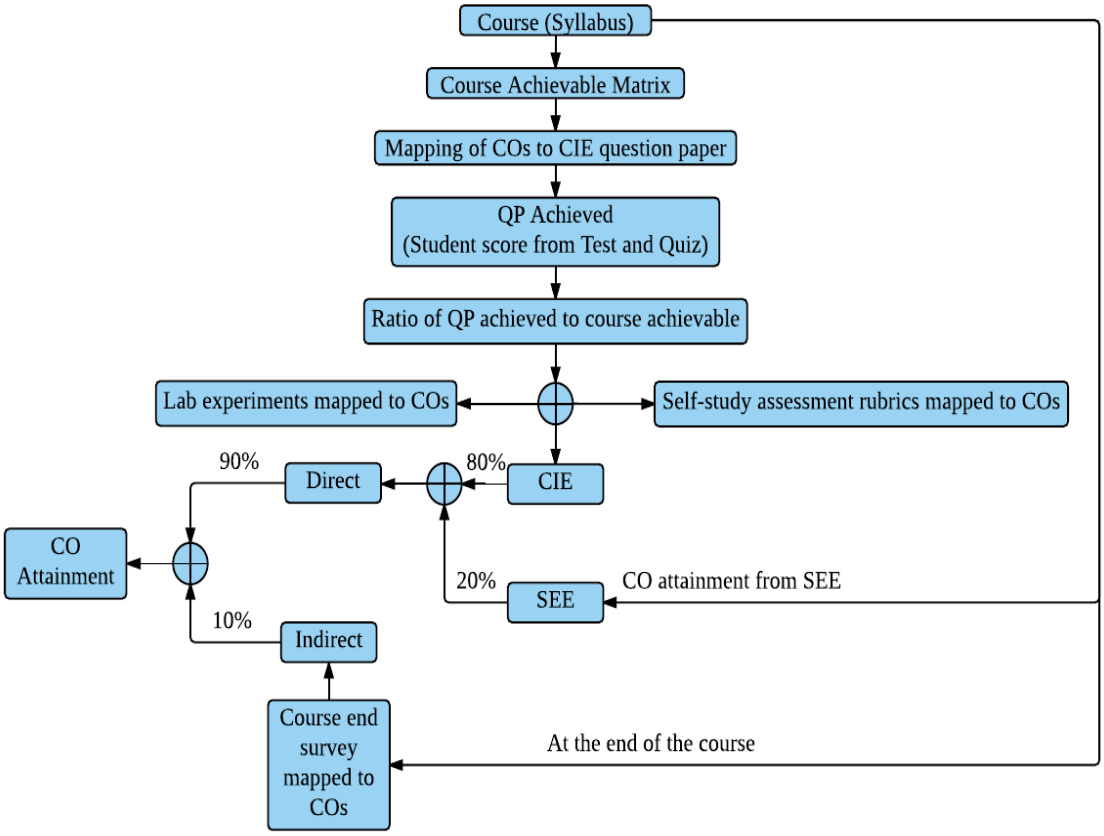
Academic Planning And Implementation



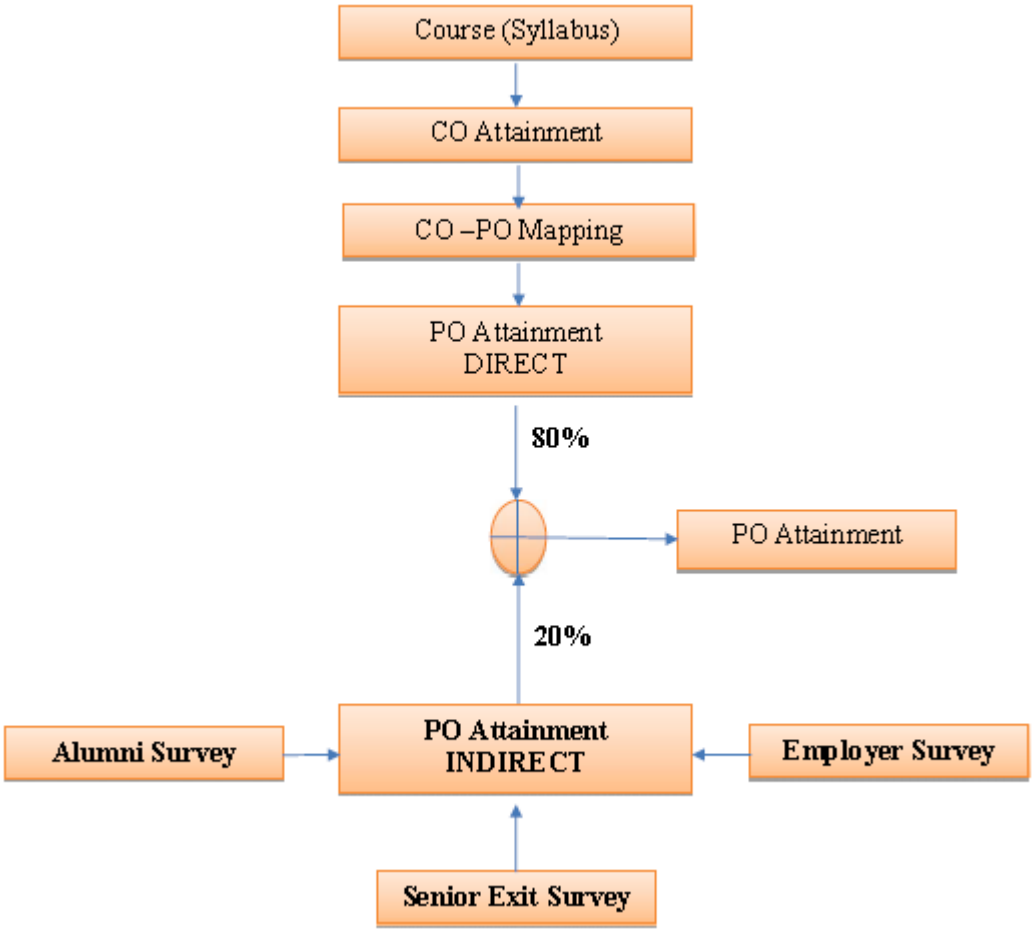
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



PROGRAM OUTCOMES (PO)

PO1:Independently carry out research / investigation and development work to solve practical problems in structural engineering.

PO2:Write and present a substantial technical report/document in the area of structural engineering

PO3:Demonstrate a degree of mastery in use of materials, analysis and design for structural components.

PO4:Use modern tools for analysis and design of structural systems.

PO5:Adopt safety and ethical practices in structural design for sustainable environment.

PO6:Exhibit multidisciplinary and managerial skills, with a commitment to lifelong learning.

RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)
RV Vidyaniketan Post, Mysuru Road
Bengaluru – 560059

Scheme and Syllabus of III & IV Semester

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)
in
STRUCTURAL ENGINEERING

DEPARTMENT OF
CIVIL ENGINEERING

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work and Innovation

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Scheme and Syllabus of III & IV Semester

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Master of Technology (M.Tech)
in
STRUCTURAL ENGINEERING

DEPARTMENT OF
CIVIL ENGINEERING

DEPARTMENT OF
CIVIL ENGINEERING

VISION

Excel in Education, Research and Consultancy in Civil Engineering with Emphasis on Sustainable Development.

MISSION

1. Disseminating and integrating the knowledge of Civil Engineering and Allied Fields
2. Enhancing Industry-Institute Interaction leading to Interdisciplinary Research.
3. Imbibing wide-range of Skills in Cutting-Edge Technology for Sustainable Development.
4. Motivate Entrepreneurship and Professional Ethics to serve the Society.

PROGRAMME OUTCOMES (PO)

M.Tech in Structural Engineering graduates will be able to:

PO1: Independently carry out research / investigation and development work to solve practical problems in Structural Engineering.

PO2: Write and present a substantial technical report/document in the area of Structural Engineering

PO3: Demonstrate a degree of mastery in use of materials, analysis and design for structural components.

PO4: Use modern tools for analysis and design of structural systems.

PO5: Adopt safety and ethical practices in structural design for sustainable environment.

PO6: Exhibit multidisciplinary and managerial skills, with a commitment to lifelong learning.

ABBREVIATIONS

Sl. No.	Abbreviation	Acronym
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics
23.	MCA	Master of Computer Applications
24.	MST	Structural Engineering
25.	MHT	Highway Technology
26.	MPD	Product Design & Manufacturing
27.	MCM	Computer Integrated & Manufacturing
28.	MMD	Machine Design
29.	MPE	Power Electronics
30.	MVE	VLSI Design & Embedded Systems
31.	MCS	Communication Systems
32.	MBS	Bio Medical Signal Processing & Instrumentation
33.	MCH	Chemical Engineering
34.	MCE	Computer Science & Engineering
35.	MCN	Computer Network Engineering
36.	MDC	Digital Communication
37.	MRM	Radio Frequency and Microwave Engineering
38.	MSE	Software Engineering
39.	MIT	Information Technology
40.	MBT	Biotechnology
41.	MBI	Bioinformatics

CONTENTS

RV COLLEGE OF ENGINEERING®, BENGALURU - 560059
(Autonomous Institution Affiliated to VTU, Belagavi)

DEPARTMENT OF CIVIL ENGINEERING

M.Tech Program in STRUCTURAL ENGINEERING

THIRD SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18MST31	Special Construction Materials	CV	4	0	1	**5**
2	18MST32	Internship	CV	0	0	5	**5**
3	18MST33	Major Project: Phase I	CV	0	0	5	**5**
4	18MST3EX	Professional Elective-E	CV	4	0	0	**4**
Total number of Credits				**8**	**0**	**11**	**19**
Total Number of Hours/Week				**8**	**0**	**22**	

SEMESTER : III		
GROUP E: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1	18MST 3E1	Advanced Design of Steel Structures
2	18MST 3E2	Stability of Structures
3	18MST 3E3	Earthquake Resistant Design

FOURTH SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18 MST41	Major Project : Phase-II	CV	0	0	20	**20**
2	18 MST42	Technical Seminar	CV	0	0	2	**2**
Total number of Credits				**0**	**0**	**22**	**22**
Total Number of Hours / Week				**0**	**0**	**44**	

SEMESTER : III						
SPECIAL CONSTRUCTION MATERIALS (Theory and Practice)						
Course Code	**:**	**18MST31**		**CIE Marks**	**:**	**100+50**
Credits L:T:P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 Hrs+3 Hrs**

Unit – I	**11 Hrs**
Review of conventional concrete. Design concrete mix by IS and ACI method, mineral and chemical admixtures, new cementitious materials used for making building materials.	
Unit – II	**10 Hrs**
Geopolymers – Paste, mortar, concrete and masonry units. Concept, advantages, Proportioning, Geopolymer masonry, Applications. Ready Mixed Concrete, Advantages, Components of RMC Plant, Quality aspects of RMC.	
Unit – III	**10 Hrs**
Fibre reinforced concrete, Behaviour in compression and flexure. Types of fibres, Action of fibres, Failure of fibres, Simple Design and Application. Light weight concrete, types, Materials used, Design of light weight concrete, Properties and Applications.	
Unit – IV	**10 Hrs**
Ferro cement- Concept, materials, construction methods, Behaviour in tension, Simple design, Applications. High Density concrete- Necessity, Radiation shielding, materials, methods of placement.	
Unit – V	**11 Hrs**
Nanotechnology and Concrete – Nono-Engineering, Manipulation of materials at nano scale, hydrate-hybridization, nano materials in concrete – Nano SiO_2, NanoTiO_2, Nano Al_2O_3, Nano clay, Carbon nano tubes, nanofibres, Properties and applications.	

Laboratory

1) Proportion concrete mix using BIS and ACI method and compare the properties.
2) Testing of concrete by Schimdt's hammer.
3) Testing of concrete by Pulse velocity method.
4) Location of rebars using profometer
5) Modulus of elasticity of concrete cylinder
6) Flexural strength of concrete.
7) Preparation of alkaline solution and Casting of geopolymer concrete/Masonry block

Course Outcomes

After going through this course the students will be able to:

CO1: Explain the properties of modern construction materials.
CO2: Illustrate the use of construction materials
CO3: Identity suitable materials for specific application.
CO4: Design and conceptualize mixes for structural components.

Reference Books:

1.	Concrete Microstructure, Properties and Materials, P. Kumar Mehta, Paulo J. M. Monteiro McGraw Hill Education India Private Limited, New Delhi, Fourth Edition, 2015. ISBN-13: 978-93-393-0476-1.
2.	Concrete Technology , A R Santhakumar, Oxford University Press, 2012,ISBN-13:978-0-19-567153-7.
3.	Properties of Concrete, Neville. A.M, 4th Edition, Pearson Education, Inc, and Dorling Kindersley Publishing Inc. 1995.
4.	Concrete Technology Theory and Practice, Shetty. M.S, S.Chand & Co Ltd., New Delhi, 2007.

Code Books:	
1	IS 10262 : 2009, Concrete Mix proportioning guidelines, First Revision.2009. ACI Committee 211, Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete, ACI 211.1-91, American Concrete Institute, Farmington Hills, Michigan, 1991

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Continuous Internal Evaluation (CIE); Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER : III						
INTERNSHIP						
Course Code	**:**	**18MST32**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1) The duration of the internship shall be for a period of 8 weeks on full time basis after II semester final exams and before the commencement of III semester.
2) The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.
3) Internship must be related to the field of specialization of the respective PG programme in which the student has enrolled.
4) Students undergoing internship training are advised to report their progress and submit periodic progress reports to their respective guides.
5) Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report. However, interim or periodic reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations.
6) The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.
7) The broad format of the internship final report shall be as follows
    - Cover Page
    - Certificate from College
    - Certificate from Industry / Organization
    - Acknowledgement
    - Synopsis
    - Table of Contents
    - Chapter 1 - Profile of the Organization : Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices,
    - Chapter 2 - Activities of the Department
    - Chapter 3 - Tasks Performed : summaries the tasks performed during 8 week period
    - Chapter 4 – Reflections : Highlight specific technical and soft skills that you acquired during internship
    - References & Annexure

Course Outcomes

After going through the internship the student will be able to:

CO1: Apply engineering and management principles
CO2: Analyze real-time problems and suggest alternate solutions
CO3: Communicate effectively and work in teams
CO4: Imbibe the practice of professional ethics and need for lifelong learning.

Scheme of Continuous Internal Evaluation (CIE):

The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor. The committee shall assess the presentation and the progress reports in two reviews.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Explanation of the application of engineering knowledge in industries, ability to comprehend the functioning of the organization/ departments,	45%
Review-II	Importance of resource management, environment and sustainability presentation skills and report writing	55%

Scheme for Semester End Evaluation (SEE):
The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.

SEMESTER : III						
MAJOR PROJECT : PHASE-I						
Course Code	**:**	**18MST33**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. The Major Project work comprises of Phase-I and Phase-II. Phase-I is to be carried out in third semester and Phase-II in fourth semester.
2. The total duration of the Major project Phase-I shall be for 16 weeks.
3. Major project shall be carried out on individual student basis in his/her respective PG programme specialization. Interdisciplinary projects are also considered.
4. The allocation of the guides shall be preferably in accordance with the expertise of the faculty.
5. The project may be carried out on-campus/industry/organization with prior approval from Internal Guide, Associate Dean and Head of the Department.
6. Students have to complete Major Project Phase-I before starting Major Project Phase-II.
7. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

After going through this course the students will be able to:

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics, societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning

Scheme of Continuous Internal Examination (CIE)

Evaluation shall be carried out in two reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Selection of the topic, Literature Survey, Problem Formulation and Objectives	45%
Review-II	Methodology and Report writing	55%

Scheme for Semester End Evaluation (SEE):

Major Project Phase-I evaluation shall be done by an external examiner (domain expert) and respective guide as per the schedule. Maximum of four candidates per batch shall be allowed to take examination. The batches are to be formed based on specific domain of work.

SEMESTER : III						
ADVANCED DESIGN OF STEEL STRUCTURES (Professional Elective-E1)						
Course Code	**:**	**18MST3E1**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**11 Hrs**
Components of industrial structure, assessment of dead loads, live loads and wind loads on a mill bent frame. Analysis and design of knee brace, column and purlins.	
Unit – II	**10 Hrs**
Analysis and design of gantry girder subjected to single and two wheel loads, Splices for bending moment and shear force.	
Unit – III	**10 Hrs**
Components self supporting steel chimneys, assessment of wind loads, moments at base, assessment of seismic loads. Analysis and Design of self supporting circular steel chimneys.	
Unit – IV	**11 Hrs**
Forms of light guage sections, Effective width computation of unstiffened, stiffened, multiple stiffened compression elements of cold formed light guage sections. Concept of local buckling of thin elements. Limiting width to thickness ratio. Post buckling strength. Design of compression and tension members of cold formed light guage sections, Design of flexural members (Laterally restrained / laterally unrestrained).	
Unit – V	**10 Hrs**
Design of open web flexural structures (triangular and rectangular), Concept of Pre- engineered buildings.	

Course Outcomes

After going through this course the student will be able to:

CO1: Apply the knowledge of various components of different types of steel structures to identify them.

CO2: Analyze the steel components for different loads acting on them.

CO3: Design various types of steel structural components using provisions of standards, codes of practice for ethical design of steel components and develop professional competencies.

CO4: Propose design solution of industrial steel structures at component and system level.

Reference Books:

1.	Bureau of Indian Standards, IS800-2007, IS875-1987, IS-801-1975. Steel Tables, SP 6 (1) – 1984, IS6533(Part 1 and 2),IS1893(part 4):2005.
2.	Design of Steel Structures, N.Subramanian, Oxford University Press,2011, ISBN: 9780198068815.
3.	Design of Steel Structures, Ramchandra and Virendra Gehlot ,Vol 1 and Vol.2, Scientific Publishers, Jodhpur, 2010
4.	Limit State Design of Steel Structures, Duggal S K,TMH publication, New Delhi, ISBN (13):978-0-07-070023-9. 2009

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit

SEMESTER : III						
STABILITY OF STRUCTURES (Professional Elective-E2)						
Course Code	**:**	**18MST3E2**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**11 Hrs**
Buckling of columns: Euler's equation for buckling of elastic column, Buckling of columns with various boundary conditions, Deflection shapes of buckled columns. Energy method, Concepts of stable and unstable equilibrium of systems. Simple column model with a lateral spring, Approximate calculation of critical loads by energy method.	
Unit – II	**10 Hrs**
Inelastic Buckling: Effect of shear force on the critical load of column. Application to buckling of built up columns, Inelastic buckling. Limitations of Euler's theory, Reduced modulus theory and Shenley's tangent modulus theory, comparison with experimental results.	
Unit – III	**10 Hrs**
Buckling of Eccentrically loaded columns: Effect of initial imperfections, Perry Robertson approach to column failure. Influence of eccentricity and secant formula. Multiple column formulas. Multiple column curves of IS code for various imperfection factors. Selection of sections for compression members.	
Unit – IV	**10 Hrs**
Lateral buckling of beams: Lateral buckling of beams in pure bending, Lateral buckling of cantilever beam and narrow rectangular beams. Simply supported beam of I section subjected to central concentrated load. Pure Torsion of thin – walled bars of open cross section. Non – uniform Torsion of thin – walled bars of open cross section.	
Unit – V	**11 Hrs**
Buckling of thin Plates: Simply supported rectangular plate with uniform compression in one direction. Buckling of rectangular plates under the action of shearing stresses. Practical implication in the design of compression members and beams.	

Course Outcomes

After going through this course the student will be able to:

CO1: Explain the principles of strength, stability and phenomenon of buckling

CO2: Apply the principles of stability to calculate buckling load.

CO3: Calculate the buckling load on column, beam – column, frames and plates using classical and approximate methods.

CO4: Develop analytical skills.

Reference Books

1	Theory of Elastic Stability, Stephen P.Timoshenko, James M Gere, 2nd Edition, Tata McGraw Hill, New Delhi,2010, ISBN-10 0-07-070241-1 ISBN-13 978-0-07-070241-7
2	Buckling Strength of Metal structures, F.Bleich, Tata McGraw Hill,1952
3	Guide to Stability Design Criteria for Metal Structures, T.V.Galambos,5th Edition, John Wiley&Sons,Newyork,1998. ISBN 1-4196-5207-9.
4	Strength of Materials, F.R.Shanley, Tata McGraw Hill,1957,ISBN-0-471-46890-8

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: III						
EARTHQUAKE RESISTANT DESIGN (Professional Elective-E3)						
Course Code	**:**	**18MST3E3**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Credits	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit–I	**11 Hrs**
Introduction to engineering seismology: Geological and tectonic features of India, Origin and propagation of seismic waves, characteristics of earthquake and its quantification – Magnitude and Intensity scales, seismic instruments. Earthquake Hazards in India, Earthquake Risk Evaluation and Mitigation. Structural behavior under gravity and seismic loads, Lateral load resisting structural systems, Requirements of efficient earthquake resistant structural system, damping devises, base isolation systems	
Unit–II	**10 Hrs**
The Response history and strong motion characteristics. Response Spectrum – elastic and inelastic response spectra, tripartite (D-V-A) response spectrum, use of response spectrum in earthquake resistant design. Computation of seismic forces in multistoreyed buildings – using procedures (Equivalent lateral force and dynamic analysis) as per IS-1893	
Unit–III	**11 Hrs**
Structural Configuration for earthquake resistant design, Concept of plan irregularities and vertical irregularities, Soft storey, Torsion in buildings. Design provisions for these in IS-1893. Effect of infill masonry walls on frames, modeling concepts of infill masonry walls. Behavior of masonry buildings during earthquakes, failure patterns, strength of masonry in shear and flexure, concepts for earthquake resistant masonry buildings – Codal provisions	
Unit–IV	**10 Hrs**
Design of Reinforced concrete buildings for earthquake resistance-Load combinations, Ductility and energy absorption in buildings. Confinement of concrete for ductility, design of columns and beams for ductility, ductile detailing provisions as per IS-1893. Structural behavior, design and ductile detailing of shear walls.	
Unit–V	**10 Hrs**
Seismic response control concepts – Seismic demand, seismic capacity, Overview of linear and nonlinear procedures of seismic analysis. Performance Based Seismic Engineering methodology, Seismic evaluation and retrofitting of structures	

Course Outcomes

After going through this course the student will be able to:

CO1: Explain the concepts in Engineering Seismology, response spectrum, structural configuration, ductility and seismic analysis.

CO2: Apply and illustrate lateral load resisting structural systems using codal provisions and seismic response control concepts.

CO3: Formulate and design earthquake resistant structures.

CO4: Evaluate the structural response of building under seismic loads

Reference Books:

1	Dynamics of Structures – Theory and Application to Earthquake Engineering- 2nd ed. – Anil K. Chopra, Pearson Education, 2011, ISBN-10: 0132858037; ISBN-13: 978-0132858038
2	Earthquake Resistant Design of Building Structures, Vinod Hosur, WILEY (India), 2013, ISBN 13, : 9788126538591
3	Earthquake resistant design of structures – Pankaj Agarwal, Manish Shrikande - PHI India, 2006, ISBN 10: 8120328922
4	Seismic Design of Reinforced Concrete and Masonry Buildings, T Paulay and M J N Priestley, John Wiley and Sons, 1992, ISBN 0-471-54915-0
5	ISCodes:IS – 1893 (Part I): 2016, IS – 13920: 1993, IS – 4326: 1993, IS-13828: 1993

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: IV						
MAJOR PROJECT: PHASE-II						
Course Code	**:**	**18MST41**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:20**		**SEE Marks**	**:**	**100**
Hours/Week	**:**	**40**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. Major Project Phase-II is continuation of Phase-I.
2. The duration of the Phase-II shall be of 16 weeks.
3. The student needs to complete the project work in terms of methodology, algorithm development, experimentation, testing and analysis of results.
4. It is mandatory for the student to present/publish the work in National/International conferences or Journals
5. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

After going through this course the students will be able to:

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics, societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning.

Scheme of Continuous Internal Examination (CIE)

Evaluation shall be carried out in three reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Review and refinement of Objectives, Methodology and Implementation	20%
Review-II	Design, Implementation and Testing	40%
Review-III	Experimental Result & Analysis, Conclusions and Future Scope of Work, Report Writing and Paper Publication	40%

Scheme for Semester End Evaluation (SEE):

Major Project Phase-II SEE shall be conducted in two stages. This is initiated after fulfilment of submission of project report and CIE marks.

Stage-1 Report Evaluation

Evaluation of Project Report shall be done by guide and an external examiner.

Stage-2 Project Viva-voce

Major Project Viva-voce examination is conducted after receipt of evaluation reports from guide and external examiner.

Both Stage-1 and Stage-2 evaluations shall be completed as per the evaluation formats.

SEE procedure is as follows:

	Internal Guide	**External Examiner**	**TOTAL**	
SEE Report Evaluation	100 marks	100 marks		200 marks
			(A)	(200/2) = 100 marks
Viva-Voce	Jointly evaluated by Internal Guide & External Evaluator		(B)	100 marks
			Total Marks	**[(A)+(B)]/2 = 100**

SEMESTER: IV						
TECHNICAL SEMINAR						
Course Code	**:**	**18MST42**		**CIE Marks**	**:**	**50**
Credits L:T:P	**:**	**0:0:2**		**SEE Marks**	**:**	**50**
Hours/Week	**:**	**4**		**SEE Duration**	**:**	**30 Mins**

GUIDELINES

1) The presentation shall be done by individual students.
2) The seminar topic shall be in the thrust areas of respective PG programs
3) The seminar topic could be complementary to the major project work
4) The student shall bring out the technological developments with sustainability and societal relevance.
5) Each student must submit both hard and soft copies of the presentation along with the report.
6) The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

After going through this course the student will be able to:

CO1: Identify topics that are relevant to the present context of the world
CO2: Perform survey and review relevant information to the field of study.
CO3: Enhance presentation skills and report writing skills.
CO4: Develop alternative solutions which are sustainable.

Scheme of Continuous Internal Evaluation (CIE): Evaluation shall be carried out in two reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Selection of Topic, Review of literature, Technical Relevance, Sustainability and Societal Concerns, Presentation Skills	45%
Review-II	Technological Developments, Key Competitors, Report writing	55%

Scheme for Semester End Evaluation (SEE):

The SEE examination shall be conducted by an external examiner and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.