MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

(Autonomous)

(Autonomous Institution under APJ Abdul Kalam Technological University)

Curriculum

structure for

Master of Technology (M.Tech) in Engineering – Ver 1.0

(Year of Introduction: 2026)

Mar Ivanios Vidyanagar
Nalanchira, Thiruvananthapuram,
Kerala, India. Pin: 695015

www.mbcet.ac.in

PROGRAM OUTCOMES - PO

Program outcomes are the attributes that are expected to be demonstrated by a graduate after completing the course.

PO1: An ability to independently carry out research/ investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tool to model, analyze and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development related to the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects

PO7: An ability to develop cognitive load management skills related to project management and finance which focus on Entrepreneurship and Industry relevance.

The departments conducting the M. Tech course shall define their own PSOs if required, and assessment shall also be done for the same.

CONTENTS

	Page No.
Program Outcomes – PO	2
1. Semester-wise Distribution of the Courses	4
a) Semester I	4
b) Semester II	4
c) Semester III	4
d) Semester IV	5
2. Syllabi for various courses	5
a) Programme core courses	8
b) Programme elective courses	21
c) Industry elective courses	61
d) Research methodology & IPR	74
e) Laboratory course	77
3. Assessment Pattern	83
a) Program Core Course/ Program Core Course with Practical component	84
b) Program Elective Course/ Program Elective Course with Practical component	84
c) Audit Course (Research Methodology and IPR)	85
d) Internship	85
e) Laboratory Courses	90
f) Industry Elective Course	90
g) Skill/ Ability Enhancement Course	91
h) Mini Project	92
i) Project	93

1. Semester-wise Distribution of the Courses

f) Semester I (M1)

Slot	Course Code	Course Type	Course	Marks		Hours	Credits
				CIA	ESE	L - T - P	
A	26CE161A	PCC	**Advanced Numerical Methods and Optimization**	50	50	4 – 0 - 0	4
B	26CE161B	PCC	**Advanced Solid Mechanics**	50	50	4 – 0 - 0	4
C	26CE161C	PCC	**Advanced Theory and Design of RCC Structures**	50	50	4 – 0 - 0	4
D	26CE162X	PEC	Program Elective 1	50	50	3 – 0 - 0	3
E	26CE162X	PEC	Program Elective 2	50	50	3 – 0 - 0	3
S	26AC061A	AC	Research Methodology and IPR	50	50	2 – 0 - 0	0
T	26CE169A	LBC	**Structural Engineering and Design Lab**	100	-	0 – 0 - 3	2
Total				**400**	**300**	**23**	**20**

Teaching Assistance: 6 hours

g) Semester II (M2)

Slot	Course Code	Course Type	Course	Marks		Hours	Credits
				CIA	ESE	L - T - P	
A	26CE161D	PCC	**Structural Dynamics**	50	50	4 – 0 - 0	4
B	26CE062A	PEC	Program Elective 3	50	50	3 – 0 - 0	3
C	26CE162X	PEC	Program Elective 4	50	50	3 – 0 - 0	3
D	26CE166X/ 26CE064X	IEC/ SAEC*	Industry Elective / (Skill/Ability Enhancement Course)	50	50	3 – 0 - 0	3
S	26CE167A	PR	Mini project	100	-	0 – 0 - 6	3
T	26CE169B	LBC	**Structural Dynamics and FEM Lab**	100	-	0 – 0 - 3	2
Total				**400**	**200**	**22**	**18**

Teaching Assistance: 6 hours

***Marks / GPA earned in this SAEC will be used for awarding GPA for this**

h) Semester III (M3)

Slot	Course Code	Course Type	Course	Marks		Hours L - T - P	Credits
				CIA	ESE		
A	26CE074X	SAEC**	Skill/ Ability Enhancement Course	To be successfully completed		-	3
D	26CE178X	PR	Project (Phase I)/ Project/ Internship	100 100 100	- 100 -	0 – 0 – 24 0 – 0 – 24 Industry norms	16
Total				**100**	**-/ 100/ -**	**24**	**19**

Teaching Assistance: 6 hours

* MOOC can be carried out at any time from M1 to M3, and credited in M3.

i) Semester IV (M4)

Slot	Course Code	Course Type	Course	Marks		Hours L - T - P	Credits
				CIA	ESE		
D	26CE178X	PR	Project (Phase II)/ Internship/ Project	100 100 100	100 - 100	0 – 0 – 24 Industry norms 0 – 0 – 24	16
Total				**100**	**100/-/100**	**24/ Industry norms**	**16**

Teaching Assistance: 5 hours

ELECTIVE BASKET

Category Code	Course Code	Course Name	L	T	P	Credit
PEC	26CE162A	Finite Element Methods in Engineering	3	0	0	3
	26CE062A	Data Science and ML in Civil Engineering	3	0	0	3
	26CE162B	Earthquake Resistant Design of Structures	3	0	0	3
	26CE162C	Theory and Analysis of Plates and Shells	3	0	0	3
	26CE162D	Design of Bridges	3	0	0	3

	26CE162E	Advanced Design of Steel Structures	3	0	0	3
	26CE162F	Mechanics of Composite Materials	3	0	0	3
	26CE162G	Advanced Prestressed Concrete Design	3	0	0	3
	26CE162H	Stability of Structures	3	0	0	3
	26CE162I	Tall Structures	3	0	0	3
	26CE162J	Fracture Mechanics	3	0	0	3
	26CE162K	Design of Offshore structures	3	0	0	3
	26CE162L	Behaviour of Structural Materials and Instrumentation	3	0	0	3
	26CE162M	Soil Structure Interaction	3	0	0	3
	26CE162N	Structural Reliability	3	0	0	3
	26CE162O	Random Vibration	3	0	0	3
	26CE162P	Structural Health Monitoring	3	0	0	3
	26CE162Q	Forensic Engineering and Rehabilitation	3	0	0	3

INDUSTRY ELECTIVE COURSES

Slot	Category Code	Course Code	Course Name	L	T	P	Credit
E	IEC	26CE166A	Wind Analysis on Structures, Cladding and Glazing Components	3	0	0	3
		26CE166B	Soil Investigation and Design of Substructures	3	0	0	3
		26CE166C	Design of Infrastructure services	3	0	0	3
		26CE166D	Advanced Finite Element Methods	3	0	0	3

DETAILED SYLLABI

STRUCTURAL ENGINEERING

PROGRAMME CORE COURSES (PCC)

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE161A	Advanced Numerical Methods and Optimization	PCC	4	0	0	4	2026

i) COURSE OBJECTIVES:

The goal of this course is to expose the students to different numerical solutions and to impart the ability to apply mathematics and optimizing techniques for finding solutions to real time problems.

ii) COURSE OUTCOMES:

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

CO1	Solve a system of linear and non-linear algebraic equations.	Apply
CO2	Apply interpolation and data smoothening techniques.	Analyse
CO3	Solve ordinary differential equations of boundary value type and partial differential equations.	Apply
CO4	Illustrate the framework of structural optimization problems.	Analyse
CO5	Apply linear and non-linear programming methods for structural optimisation.	Apply

iii) SYLLABUS

Introduction to numerical methods- errors in numerical methods; System of linear algebraic equations, Systems of non-linear equations - Newton-Raphson method.
Lagrangian interpolation, Quadratic and Cubic splines, Correlation,Multiple linear regression; Numerical integration, Ordinary differential equations of the boundary value type - Finite difference solution; Partial differential equations Introduction to structural optimisation; Linear Programming, Duality of linear programming, Non- Linear Programming problems, Formulation of geometric programming.

iv) TEXT BOOKS

1) Gerald and Wheatly, Applied Numerical Analysis, Pearson Education, 7th edition, 2007, ISBN-13: 978-8131717400.
2) Chapra S. C. and Canale R. P., Numerical Methods for Engineers, Mc Graw Hill, 7th edition, 2016, ISBN-13: 978-9352602131.

3) Grewal B. S., Numerical Methods in Engineering and Science, Khanna Publishers, 11th edition, 2017, ISBN-13: 978-8174092489.
4) Rajasekharan S., Numerical Methods in Science and Engineering, S Chand & company, 2nd edition, 2003, ISBN-13: 978-8121923125.

v) REFERENCES

1) Akai, T. J., *Applied Numerical Methods for Engineers*, Wiley publishers, 1994

2) Smith G. D., Numerical solutions for Differential Equations, Mc Graw Hill, 3rd Edition, 1986, ISBN-13: 978-0198596509.

3) Ketter R. L. and Prawel S., Modern Methods for Engineering Computations, Mc Graw Hill, 1969, ISBN-13: 978-0070344235.

4) Rajasekharan S., Numerical Methods for Initial and Boundary Value Problems, Khanna Publishers, 1989.

5) Rao S. S., *Engineering Optimisation – Theory and Practice*, 4th edition, John Wiley & Sons, Inc., 2013, ISBN-13: 978-8126540440.

6) Deb, K., *Optimisation for Engineering Design – Algorithms and examples*, 2nd edition, Prentice Hall, 2013, ISBN-13: 978-8120346789.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to numerical methods**: Errors in numerical methods; System of linear algebraic equations- Ill conditioned systems-Symmetric and banded systems. Gauss Elimination, factorization and Gauss Seidel iteration; Systems of non-linear equations - Newton-Raphson method. Eigen Value problems- power method;	**12**
II	**Interpolation:** Lagrangian interpolation, Spline Interpolation- Quadratic and Cubic splines,Linear regression and correlation, method of least squares, normal regression analysis, normal correlation analysis, correlation coefficient, Non-polynomial models like exponential model and power equation; Multiple linear regression, Principal components (brief overview only); Numerical integration- Newton – Cotes open quadrature, Gauss quadrature	**13**

III	**Ordinary differential equations**: Boundary value type - Finite difference solution; Partial differential equations - Parabolic equations - Explicit finite difference method, Crank-Nicholson implicit method; Ellipse equations.	12
IV	**Introduction to structural optimization**: Unconstrained and constrained optimization problems - Problem formulation with examples; Linear Programming - Simplex method, Twophase solution, Duality of linear programming.	12
V	**Non-Linear Programming problems**: Unconstrained optimisation Techniques-Direct search method, Random search, Uni-variate pattern search, Descent methods. Formulation of geometric programming	11
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE161B	Advanced Solid Mechanics	PCC	4	0	0	4	2026

i) COURSE OBJECTIVES:

This course is intended to expand on the basic principles established in Solid Mechanics and familiarise the students with basic equations of elasticity in 3D. The students are exposed to two dimensional problems in Cartesian and Polar coordinates and different failure criteria which enhances their skill and capability in analysing and solving problems in Civil Engineering.

ii) COURSE OUTCOMES:

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

CO1	Apply the concepts, principles and governing equations of elasticity and plasticity to analyze stress–strain behavior of materials and structural members	Apply
CO2	Analyse the transformation of stresses and strains in 3D	Analyse
CO3	Apply the concept of elastic behaviour of solids in solving plane stress and plane strain problems using polar coordinates and cartesian coordinates system	Apply
CO4	Predict the structural response of standard cross section of isotropic materials due to applied torsion	Apply

iii) SYLLABUS

Analysis of stress in 3D - Analysis of strain in 3D - Stress Strain relations -Two dimensional problems in Rectangular coordinates - Two dimensional problems in polar coordinates- Torsion of prismatic bars-Introduction to Plasticity

iv) REFERENCES

1) Timeshanko, S. P. and Goodier, J. N., *Theory of Elasticity*, McGraw Hill Education Private Ltd., 3rd edition, 2010.
2) Boreis, A. P., Schmidt, R. J.,*Advanced Mechanics of Materials*, John Wiley & Sons, 6th edition, 2002.
3) Srinath, L. S., *Advanced Mechanics of Solids*, Tata McGra-Hill, 3rd edition, 2009.
4) Cook, R.D., Young, W.C., *Advanced Mechanics of Materials*, Prentice Hall, 2nd edition, 1999.
5) Sadd, M. H., *Elasticity: Theory, Applications and Numerics*, Academic Press, 3rd edition, 2014.

6) Ameen, M., *Computational Elasticity*, Narosa Publishing House, 2009.

7) Sitharam, T.G. and Govindaraju, L., *Applied Elasticity*, Interline Publishing Pvt. Ltd., 2008.

8) Singh, S., *Experimental Stress Analysis*, Khanna Publisher, 4th edition, 2017.

9) Volterra, E. and Gaines, J. H., *Advanced Strength of Materials*, Prentice Hall Publication, New York, USA, 2000.

10) Wang, C. T., *Applied Elasticity*, McGraw Hill Publication, NY, USA, 2000.

11) Singh, S., *Theory of Elasticity*, Khanna Publisher, 4th edition, 2013.

12) J. Chakrabarty, Theory of Plasticity, Elsevier, London, 3rd edition, 2006.

v) COURSE PLAN

Module	Contents	No. of hours
1	Analysis of stress and strain in 3D: Introduction to stress and strain tensor Components, Stress on Oblique Plane through a point, Equilibrium Equations, Strain displacement relation, Compatibility conditions, Transformation of stress and strain at a point, Principal stresses and principal strains, invariants of stress and strain, hydrostatic and deviatoric stress, spherical and deviatoric strains. (no derivations required)	**12**
2	**Stress Strain relations**: General Hooke's law and its reduction for isotropic and orthotropic materials, Boundary value problems of elasticity – Displacement, Traction and Mixed types. Navier's Equations, Beltrami-Michell's Equations (no derivation required) **Two dimensional problems in Rectangular coordinates**: Plane stress and plane strain problems - Airy's stress function -Solution by polynomials – Bending of cantilever loaded at free end, Bending of simply supported beam with udl	**13**
3	**Two dimensional problems in polar coordinates**: General equations - Equilibrium equations, Strain displacement relations and Stress strain relations, compatibility relations (no derivation required). Biharmonic equations and Airy's stress functions- Pure bending of curved beams Problems of axisymmetric stress distributions - Thick cylinders - Stress concentration due to circular hole in plates (Kirsch's problem)	**12**
4	**Torsion of prismatic bars**: Saint Venant's Semi inverse and Prandtl's stress function approach – Torsion of Straight bars – Elliptic and Equilateral triangular cross section. Membrane Analogy - Torsion of thin walled open and closed tubes, Numerical examples	**12**

5	Introduction to Plasticity: One-dimensional elastic-plastic relations, isotropic and kinematic hardening, flow rule, hardening rule, incremental stress-strain relationship, Yield criteria – Simple applications –Elasto– plastic analysis for bending	**11**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE161C	Advanced Theory and Design of RCC Structures	PCC	4	0	0	4	2026

i) COURSE OBJECTIVES:

Goal of this course is to expose the students to the basic concepts of design and ductile detailing of reinforced concrete structures. It introduces the design and detailing of special RCC structures. It also provides an introduction to strut and tie model of design. This course also deals with the beam-column joints and the design using suitable software.

ii) COURSE OUTCOMES:

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

CO1	Analyse the strength and behaviour of RCC Flexural and Compression members	Analyse
CO2	Design of special RCC members such as lat slab, ribbed slab, shear wall and plain concrete walls	Apply
CO3	Apply the concept of strut and tie model in the design of , deep beams, corbels, pile cap and beam-column joints	Analyse
CO4	Design GFRP reinforced Beams and Columns	Apply
CO5	EvaluateRCC buildings using any relevant software	Evaluate

iii) SYLLABUS

Basic theory and design philosophies- Design concepts-Limit state method-Estimation of deflection and control of cracking, -Design of special RC member, Strut and Tie Models-evelopment, Design of GFRP reinforces beams and columns

iv) REFERENCES:

1) Nilson, A. H., Darwin, D. and Dolan, C. W., *Design of Concrete Structures*, Tata Mc-Graw Hill Book Co., New York, 2016.
2) Park, R. and Paulay, T., *Reinforced Concrete Structures*, John Wiley & Sons, New York, 1975.
3) DevadasMenon and UnnikrishnaPillai, S. Reinforced Concrete Design, Tata McGraw Hill Pvt. Ltd., New Delhi, 2017.
4) Jain, A. K., *Reinforced Concrete: Limit State Design*, Nem Chand and Brothers, Roorkee, 2012.
5) Thomas, T. C., *Unified Theory of Reinforced Concrete*, CRC Press, London, 2015.

6) Varghese, P. C, *Advanced of Reinforced Concrete Design*, Prentice Hall of India Pvt Ltd, 2010.
7) ACI 440.11-22 Requirements for Structural Concrete Reinforced with Glass Fiber-Reinforced Polymer (GFRP) Bars.
8) IS 456 : 2000 (Reaffirmed 2005), *Plain and Reinforced Concrete Code of Practice*, Bureau of Indian Standards, New Delhi, 2005.
9) SP 16 : 1980, *Design Aids for Reinforced Concrete to IS 456:2000,* Bureau of Indian Standards, New Delhi, 1999
10) IS 13920 : 2016, *Ductile Design and Detailing of Reinforced Concrete Structures subjected to Seismic Forces - Code of Practice*, Bureau of Indian Standards, New Delhi, 2016.
11) BS 8110:1997, *Structural use of concrete — Part 1: Code of practice for design and construction,* British Standard, 1997
12) ACI 318:1995, *Building Code Requirements for Structural Concrete*, American Concrete Institute, MI, 1995
13) GFRP- Reinforced Concrete Design Handbook
14) EN 1992-1-1 2004: *Design of concrete structures - Part 1-1: General rules and rules for buildings*, Eurocode 2, 2004.
15) ECP 203:2007, *Egyptian Code for Design and Construction of Concrete Structures,* Arab Republic of Eygpt, 2007.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Basic theory and design philosophies:** Advanced theory in stress-strain characteristics of concrete under uniaxial and multi axial states of stress, confined concrete, Effect of cyclic loading on concrete and reinforcing steel, Stress block parameters. **Design and Ductile detailing of structural members**: General principles of ductile detailing, factors that increase ductility, specifications of materials for ductility, design and ductile detailing of flexural and compression members.	**12**
II	**Deflection of reinforced concrete flexural members**: Introduction, Short-term and long-term deflection of flexural members due to imposed loads. **Cracking in concrete members:** Introduction, factors affecting crack width in beams, mechanisms of flexural cracking, calculation of crack width, estimation of crack width in beams as per IS 456:2000, BS 8110:1997, ACI 318:1995, BS EN 1992-1-1 2004, ECP 203:2007.	**12**

III	**Design of special RCC members**: Design of flat slab, ribbed slab, shear wall and plain concrete walls Concept of design of concrete members for fire resistance	**12**
IV	**Strut and Tie model and design:** Strut-tie model, identify the regions in various structural components, flow of forces, identify locations and details of reinforcement based on strut and tie models, apply strut and tie model to the design of deep beams, Corbels, Pile cap and beam-column joints.	**12**
V	**GFRP Reinforced Concrete Design:** Mechanical, thermal and long-term properties of FRP materials, benefits and use, design of beams, one way and two-way slabs, and column using ACI 440.11-22 **Software in design of RCC buildings:** Design of building frames using any relevant design software.	**12**
	Total hours	**60**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE161D	Structural Dynamics	PCC	4	0	0	4	2026

1. COURSE OBJECTIVES:

This course deals with free and forced vibration characteristics of single degrees of freedom and multi degree of freedom systems. It also deals with the frequencies and mode shapes of the beam with different end conditions (distributed mass system).

2. COURSE OUTCOMES:

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

CO 1	Explain the basic terms and principles associated with structural dynamics	Understand
CO 2	Develop mathematical models and responses for SDOF systems and MDOF shear building of simple structural systems under dynamic loads.	Apply
CO 3	Analyse the dynamic response of structural systems for various dynamic inputs.	Analyse
CO4	Explain the dynamic behaviour of continuous parameter systems.	Apply

3. SYLLABUS:

Importance of vibration studies. Systems with single degree of freedom - Free and forced vibration with and without damping - Response to support motion. Multi-degree of freedom systems (Lumped mass) - Evaluation of natural frequencies and mode shapes - Coordinate coupling - Orthogonality of normal modes - Forced vibration analysis of multi- degree of freedom systems - Mode superposition method. Vibration isolation- Distributed mass (continuous) systems - Axial vibration of rods - Flexural vibration of single span beams - Evaluation of frequencies and mode shapes.

4. REFERENCES:

1. Anil K. Chopra, Dynamics of Structures, 5th edition, Pearson Education, 2020.
2. Mario Paz and William Leigh, Structural Dynamics: Theory and Computation, 6th edition, Springer, 2019.
3. Madhujit Mukhopadhyay, Structural Dynamics: Vibrations and Systems, 7th edition, Springer,

2021.

3. Madhujit Mukhopadhyay, Structural Dynamics: Vibrations and Systems, 7th edition, Springer, 2021.
4. Clough R.W. and J. Penzien, Dynamics of Structures, 2nd edition, CBC Press, 2015.
5. J.W. Smith, Vibration of Structures, Chapman and Hall London, 1988.
6. Alphose Zingoni, Vibration Analysis and Structural Dynamics for Civil Engineers: Essentials and Group-Theoretic Formulations, CBC Press, 2018

5. COURSE PLAN:

Module	Contents	No. of hours
I	Vibration studies and its importance to structural engineering applications – Types of dynamic loading – Systems with single degree of freedom – Elements of a vibratory system – Mathematical model for single degree of freedom systems - Equation of motion. Undamped and damped free vibration of single degree of freedom system. Measurement of damping from free vibration response - Logarithmic decrement	**9**
II	Response of single degree of freedom systems to harmonic loading, Impulse response function, Response of single degree of freedom systems subjected to impulse, periodic and general loading- Duhamel integral. Single degree freedom subjected to support motion. Vibration isolation –Transmissibility. Free vibration response of damped MDOF systems, concept of modal damping.	**14**
III	Multi-degree of freedom systems – Equation of motion. Shear building concept and models for dynamic analysis – Evaluation of natural frequencies and mode shapes by solution of characteristic equation. Co-ordinate coupling -Orthogonality of normal modes. Maximum modal responses and modal combination using SRSS rule.	**13**

IV	Forced vibration analysis of multi-degree of freedom systems - Mode superposition method of analysis. Response of multi degree of freedom systems to support motion. Vibration measuring instruments - Methods of vibration control - Tuned mass damper	**12**
V	Distributed mass systems - Axial vibration of rods - Flexural vibration of single span beams - simply supported beam, cantilever beam and fixed beam - Evaluation of frequencies and mode shapes –Variational formulation of the equation of motion – Lagrange’s equation. Effect of seismic, wind, blast, wave loading and other dynamic forces on structure, Dynamic analysis of structure using any FEM softwares.	**12**
	Total hours	**60**

PROGRAM ELECTIVE COURSES (PEC)

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162A	Finite Element Methods in Engineering	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

This course imparts an understanding of fundamental knowledge and technique of FEM. This course enables the students to develop tools to analyse engineering problems using FEM and typical commercial FEA packages.

ii) COURSE OUTCOMES:

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

CO1	Apply the fundamental concept of theory of elasticity and finite element method in developing the equilibrium equations and finding stresses and strains	Apply
CO2	Analyse the structural members using energy principles	Analyse
CO3	Develop the shape functions of different elements	Apply
CO4	Analyse the stiffness matrix and Nodal load vector for bar beam and CST elements	Analyse
CO5	Apply the finite elemnt formulation to determine the stresses of different elements	Apply

iii) SYLLABUS

Fundamentals of theory of elasticity- Equations of equilibrium, Strain-displacement relation, compatibility conditions, constitutive relation; Energy principles- Introduction to weighted residual methods; Evolution of FEM, Review of direct stiffness method, Outline of the FE procedure; Element properties, convergence requirements, equilibrium and compatibility in the solution; Types of finite elements; Shape functions; Development of stiffness matrix and nodal load vector for bar, beam and CST elements, Concept of iso parametric formulation; Computer Implementation of FEM procedure.

iv) REFERENCES

1. Cook, R. D., Malkus, D. S., Plesha, M. E. and Witt, R. J., *Concepts and Applications of Finite Element Analysis*, John Wiley & Sons, 4th Edition, 2001.

2. Krishnamoorthy, C. S., *Finite Element Analysis: Theory and Programming*, Tata McGraw Hill, 2nd edition, 2007.

3. Bathe, K. J., *Finite Element Procedures in Engineering Analysis*, Prentice Hall, 2nd edition, 2009.
4. Zienkiewicz, O. C. and Taylor, R. W., *Finite Element Method*, Elsevier Butterworth Heinemann, 5th edition, 2005.
5. Chandrupatla, T. R. and Belegundu, A. D., *Introduction to Finite Elements in Engineering*, Pearson Education, 4th edition, 2012.
6. Hutton, D. V., *Fundamentals of Finite Element Analysis*, Tata McGraw Hill, 1st edition, 2004.
7. Mukhopadhyay, M. and Abdul Hamid Sheikh, *Matrix and Finite Element Analyses of Structures*, Ane Books, 1st edition, 2015.
8. Timeshenko, S. P. and Goodier, J. N., *Theory of Elasticity*, Mc-Graw Hill Education Private Ltd., 3rd edition, 2010.
9) Srinath, L. S., *Advanced mechanics of Solids*, Tata McGraw-Hill, 3rd edition, 2010.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Fundamentals of theory of elasticity**- Concept of Stress and Strain, Stress tensor, Stain tensor, Equations of equilibrium, Strain-displacement relation, Compatibility conditions, Constitutive relation **Energy principles**- Principle of virtual work, Principle of stationary potential energy; Variational formulation Rayleigh-Ritz method	10
II	**Introduction to FEM**- Evolution of FEM, Review of direct stiffness method, Outline of the FE procedure; Element properties- Displacement functions, convergence requirements, equilibrium and compatibility in the solution, Development of equilibrium equation	8
III	**Types of finite elements**- Development of shape functions for bar and beam, CST, LST; Lagrange and Serendipity elements; Plane stress and plane strain problems. Introduction to axisymmetric elements; Types of 3D elements	8
IV	Development of stiffness matrix- bar, beam and CST elements Development of consistent nodal load vector- bar, beam and CST elements	10
V	Concept of isoparametric formulation- Line element and Plane bilinear element; Gauss quadrature technique Introduction to plate bending – Kirchoff and Mindlin plate theories, FE formulations for Kirchoff and Mindlin Plate	9

	elements, finite element formulation of plate elements (overview) Computer Implementation of FEM procedure- Pre Processing, Solution, Post-Processing, Use of Commercial FEA Software	
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of introduction
26CE062A	Data Science and ML in Civil Engineering	PEC	3	0	0	3	2026

i) COURSE OVERVIEW

Goal of this course is to introduce the applications of Artificial Intelligence (AI) in Civil Engineering by covering foundational concepts of artificial intelligence and machine learning techniques, with a focus on real-world applications, while the project component enhances practical skills to solve domain-specific challenges using AI, and to obtain comprehensive knowledge of various tools and techniques for data transformation and visualization, to learn probability and probabilistic models of data science, and to learn basic statistics and hypothesis testing for specific problems.

ii) COURSE OUTCOMES

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

CO1	Apply exploratory data analysis and create insightful visualisations to identify patterns	Apply
CO2	Make use of statistical foundations of data science and analyse the degree of certainty of predictions using statistical test and models	Analyse
CO3	Apply the basic probability principles and techniques in data science	Apply
CO4	Apply Machine learning techniques in solving problems in Civil Engineering.	Apply

iii) SYLLABUS

Data Science process, Memorization methods, Unsupervised models, Univariate data exploration, Data visualisation, Prediction and filtering, Probability theory and Statistics, Machine Learning Basics.

iv) a) TEXTBOOKS

1. Russell, S., & Norvig, P. Artificial Intelligence: A Modern Approach, 4th Edition, Pearson Education, 2022.
2. Alpaydin, E. Introduction to Machine Learning, 4th Edition, MIT Press, 2020.

b) REFERENCES

1. Mandal, U. K., & Saha, S. AI and Data Analytics in Civil Engineering, 1st edition, CRC Press,

2023.
2. Nathan Yau, "Visualize This: The Flowing Data Guide to Design, Visualization and Statistics", Wiley, 2011
3. Nina Zumel, John Mount "Practical Data Science with R”. Manning Publications. 2014

v) COURSE PLAN

Module	Contents	No. of hours
I	**Data Science process**- Roles and stages in a data science project, working with files and databases, Exploring and managing data. Exploratory Data Analysis. Exploring Univariate Data - Histograms - Stem-and Leaf Quantile Based Plots - Continuous Distributions - Quantile Plots- QQ Plot- Box Plots	9
II	**Probability Concepts** -Axioms of Probability - Conditional Probability and Independence - Bayes Theorem - Expectation - Mean and Variance Skewness Kurtosis; Common Distributions-Binomial, Poisson, Uniform, Normal, Exponential.	9
III	**Introduction to Statistics** - Sampling, Sample Means and Sample variance sample moments, covariance, correlation, Sampling Distributions - Parameter Estimation Bias - Mean Squared Error - Relative Efficiency - Standard Error - Maximum Likelihood Estimation. Comparing Two Samples - A/B Testing - ANOVA.	9
IV	**Introduction to Machine Learning**: Basics of Machine Learning (ML)- types of Machine Learning Systems and Challenges. **Supervised learning**- Regression techniques- Linear Regression, Logistic regression, Multiple linear regression; Polynomial Regression (concept only), Decision Tree Regression (concept only). Classification techniques (Basic concept only)- Support Vector Machines. Application in prediction.	9
V	**Unsupervised learning-**Dimensionality Reduction – Need, Principal Component Analysis, Clustering: Basic concepts, Types of Clustering, similarity/dissimilarity measures. Clustering Algorithm-K-means algorithm, Hierarchical clustering (concepts only), Density-based clustering (concept only). Performance Evaluation Measures – clustering. Relevant Case studies.	9
	Total	**45 hours**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162B	Earthquake Resistant Design of Structures	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

This course imparts the basic concept about seismology and seismic design of structures. This course also deals with different methods for the seismic analysis of buildings.

ii) COURSE OUTCOMES:

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

CO1	Apply the basic concept of seismology in developing the response spectra	Apply
CO2	Determine the seismic response of framed RCC structures using different static and dynamic methods	Apply
CO3	Design various beam-column joints as per ductility requirements.	Apply
CO4	Evaluate the seismic response of structure using finite element software package	Evaluate

iii) SYLLABUS

Elements of earthquake engineering;Seismic performance of structures and structural components during earthquakes; Response spectrum, design spectrum; Seismic Design Philosophy; Seismic analysis of RCC buildings- Equivalent static analysis, response spectrum analysis, mode superposition method, Time history analysis, Push over analysis;Seismic protection of structures; Seismic Design of masonry buildings;Analysis and design of building systems to Earthquake Loads (Hands on session using packages like ETABS).

iv) REFERENCES:

1) Duggal, S. K., *Earthquake Resistant Design of Structures*, Oxford University Press, 2nd edition, 2007.
2) Mario Paz, Structural Dynamics - *Theory and Computations*, CBS Publishers, 6th edition, 2018.
3) PankajAgarwal and Manish Shrikhande, *Earthquake Resistant Design of Structures*, Prentice Hall, 5th edition, 2009.
4) Jai Krishna, A. R., Chandrasekharan, A. R. and Brijesh Chandra, *Elements of Earthquake Engineering*, South Asian Publishers, 2nd edition, 2001.
5) Anil, K. Chopra, *Dynamics of Structures*, Pearson Education, 5th edition, 2007.

6) Clough and Penzien, *Dynamics of Structures*, McGraw Hill, 4th edition, 2008.
7) IS 1893 (Part 1) : 2025, *Criteria for Earthquake Resistant Design of Structures*, Bureau of Indian Standards, New Delhi, 2016.
8) IS 4326: 2013, *Earthquake Resistant Design and Construction of Buildings - Code of Practice*, Bureau of Indian Standards, New Delhi, 2013.
9) IS 13920: 2016, *Ductile design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces- Code of Practice*, Bureau of Indian Standards, New Delhi, 2016

v) COURSE PLAN

Module	Contents	No. of hours
I	**Earthquake seismology** – Causes of earthquake, Plate tectonics, Earthquake fault sources, Seismic waves, Elastic rebound theory, Quantification of earthquake, Intensity and magnitudes, Earthquake source models.	**7**
II	**Basic Concepts**: Seismic performance of structures and structural components during earthquakes; Ground motion parameters; Response spectrum, design spectrum; Seismic design philosophy, capacity design	**9**
III	**Seismic Analysis of RCC Buildings**: Equivalent static analysis, response spectrum analysis, mode superposition method; Time history analysis. Push over analysis - Introduction - Modern concepts **Seismic Protection of Structures**: Basic elements of seismic isolation; Seismic dampers - Types of Dampers	**10**
IV	**Design of Beam Column Junctions:** Elastic and Inelastic deformations of structures – ductility of the composite system - design of axial and flexural members – beam column junction detailing – strong column - weak beam effects	**9**
V	**Computer Aided Analysis and Design** Computer Analysis and design of Building systems to Earthquake Loads – Hands on session using packages like ETABS.	**10**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162C	Theory and Analysis of Plates and Shells	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES

The goal of this course is to impart an understanding of basic concepts, classification, and stress-strain relationships of plates and shells suitable for various structural systems. The course aims in developing an ability to study the behaviour of the plates and shells with variable geometry under the action of different types of loads and to apply these concepts in structural applications.

ii) COURSE OUTCOMES

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

CO1	Analyse the deformations developed in different plates subjected to various loading and support conditions.	Analyse
CO2	Analyse the deformations developed in different shells subjected to various loading conditions.	Analyse
CO3	Analyse special forms of plates and shells	Analyse

iii) SYLLABUS

Introduction to plates, Theory of thin plates, Pure bending of plates, Deflections of laterally loaded plates, Simply supported rectangular plates, Theory of thick plates, Circular plates, Annular plates, Introduction to shells, General theories of cylindrical shells, Theory of folded plates, Special forms of shells

iv) REFERENCES

1) Timoshenko, S.P. and Krieger, S. W., *Theory of Plates and Shells*, Tata McGraw Hill, 2nd edition, 2017.
2) Chandrashekhara, K., *Theory of Shells*, Universities (India) Press Ltd., 2009.
3) Ramaswamy, G. S., *Design and Construction of Concrete Shell Roofs*, CBS Publishers, 2nd edition, 2018.
4) Kelkar, V. S. and Sewell, R.T., *Fundamentals of the Analysis and Design of Shell Structures*, Prentice Hall Inc., 2014.
5) Varadan, T. K. and Bhaskar, K., *Analysis of Plates – Theory and Problems*, Narosa Publishing Co., 2016.
6) Reddy, J. N., *Theory and Analysis of Plates and Shells*, Taylor and Francis, 2nd edition, 2012.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to plates:** Classification of plates – thin, thick plates; Theory of thin plates (Classical Plate theory) - Differential equation to bending of long rectangular plates to a cylindrical surface. **Pure bending of plates:** Relation between slope and curvature, bending moments and curvature; Particular cases of pure bending.	**9**
II	**Deflections of laterally loaded plates:** Differential equation for small deflections in laterally loaded plates **Simply supported rectangular plates:** Solution by Navier's method and Levy's method **Special forms of plates:** Isotropic, anisotropic plates, orthotropic plates, functionally graded plates; Thick plates (Mindlin's plate theory).	**9**
III	**Circular plates:** Differential equations for symmetrical bending of circular plates - uniformly loaded circular plates - simply supported and fixed edges. **Annular plates:** Plates subjected to uniform moments and shear forces along the boundaries.	**9**
IV	**Introduction to shells:** Classifications, Membrane theory of shells, Structural application of various forms of shells - spherical, conical and cylindrical shells; Deformation of shells without bending - definitions and notations. **Analysis of Plates/Shells:** Finite element software to model and analyze plate/shell structures, applications of plates and shells in modern infrastructure.	**9**
V	**Theory of folded plates**: Concepts, Classification of folded plates, Features of reinforced concrete folded plates. **Special forms of shells:** Hyperbolic shells, hyperbolic paraboloid shells and Conoids; Structural applications (concepts only).	**9**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162D	Design of Bridges	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

This course is to expose the students to the fundamentals of design of bridges by imparting knowledge on the various methods of analysis of loads acting on different types of bridge structures using IRC codes.

ii) COURSE OUTCOMES:

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

CO1	Designe general arrangement requirements of bridges	Apply
CO2	Apply various loads on bridge and methods of structural analysis of bridges.	Apply
CO3	Design culverts and common bridge superstructures such as RCC Solid slab and T-beam & slab and its reinforcement detailing	Analyse
CO4	Design prestressed concrete bridges.	Analyse
CO5	Analyse the behaviour of substructure, foundation and bearings of bridges.	Analyse

iii) SYLLABUS:

Introduction to Bridge Engineering: types of bridges, forces and design criteria, IRC loads, Bridge Deck Analysis- Design of RCC deck slab, T-beam and slab, box girder, Analysis and design of Prestressed concrete bridge, Design of substructure and foundation, bearings , Overview of FEM based analysis software and Bridge Information Modelling

iv) REFERENCES:

1) Johnson Victor D, “Essentials of Bridge Engineering”, 7th Edition, Oxford, IBH publishing Co. Ltd, 2006.
2) Rajagopalan N., “Bridge Superstructure”, Narosa Publishing House, 2006
3) Krishna Raju N., “Design of Bridges”, Oxford & IBH Publishing Co. Pvt. Ltd., 2012.
4) Praveen Nagarajan, “Design of Concrete Bridges”, Wiley
5) Jagadeesh T.R. & Jayaram M.A., “Design of Bridge Structures”, Prentice-Hall of India Pvt. Ltd., 2009.

Standard Specifications and Code of Practice for Road Bridges, IRC, New Delhi

6) IRC:5-2015, *General Features of Design*, Indian Roads Congress, New Delhi, 2015.
7) IRC:6-2017, *Loads and Load Combinations*, Indian Roads Congress, New Delhi, 2017.
8) IRC:112-2020, *Code of Practice for Concrete Bridges*, Indian Roads Congress, New Delhi, 2020.

9) IRC:78-2014, *Foundations and Substructure*, Indian Roads Congress, New Delhi, 2014.

10) IRC:83 (Part-1: 2015, Part-2: 2018, Part-3: 2018, Part-4: 2015), *Bearings*, Indian Roads Congress, New Delhi.

11) IRC:SP:105-2015, *Explanatory Handbook to IRC:112*, Indian Roads Congress, New Delhi, 2015.

12) IRS, *Concrete Bridge Code*, Research Designs and Standards Organisation (RDSO), Lucknow.

13) IRS, *Substructure and Foundation Code*, Research Designs and Standards Organisation (RDSO), Lucknow.

v) COURSE PLAN

Module	Contents	No. of hours
I	**General Arrangement Design**: Classification of Bridges - Codes of practices for Highway and Railway bridges (IRC & IRS) - Types and functions of Bridge Elements - Site selection and planning of bridge alignment with approaches. Considerations for width of bridges - Hydraulic Design - Geotechnical considerations - Considerations for Span Arrangement - Bridge Aesthetics - Preparation of General Arrangement Drawing.	**9**
II	**Structural Analysis of Bridges**: Types of Structural forms and actions - Solid slab – Voided slab -T beam and slab –- Box girder – Bow string girder –- Cable stayed bridge - Suspension bridge. (Concept only) Loads on bridges as per codal provisions - Vehicle Load with impact and braking effect Wind load - Shrinkage and temperature effect - Earth pressure - Water current force - Seismic effect.(Concept only) Analysis methods for longitudinal and transverse actions -– Pigeauds method - Courbon’s method – Guyon-Massonet method using Morice and Littile charts –	**9**
III	**Design of RCC Superstructures**: Limit State Design concepts as per IRC: 112 - Design for flexure, shear and torsion of Box culverts - RCC Solid Slab – T beam and slab -Detailing of primary reinforcements as per on IRC: 112.	**9**
IV	**Pre-stressed Concrete Bridges**: Design of single span bridges- Introduction to various forms - Slab bridges-girder bridges- box girder	**9**
V	**Design of Substructures and Foundation**: Types and functions of Bearings as per IRC: 84 - metallic bearings - Elastomeric bearing - Pot bearing - Spherical bearing. Design considerations for Substructures as per IRC: 78 - Stability analysis and design of Abutment - Pier. Design considerations for	**9**

	Foundations as per IRC: 78 - Stability analysis and design of open and well foundations **Overview of FEM based analysis software and Bridge Information Modelling**	
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162E	Advanced Design of Steel Structures	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

To help the students develop an ability to perform analysis and design of steel members and their connections. It enables students to identify steel structural members based on their behaviour. An expertise to professional and contemporary issues in advanced steel design is also acquired.

ii) COURSE OUTCOMES:

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

CO1	Design various types of connections in steel structures	Analyse
CO2	Analyse the structural behaviour of steel industrial buildings, including moment-resisting frames.	Analyse
CO3	Design light gauge steel structures	Analyse
CO4	Apply steel–concrete composite behaviour and gantry girder design principles in steel structural systems.	Apply

iii) SYLLABUS:

Design Philosophies, Connections, Beam to column connections, Splices, Industrial buildings and gantry girders, Steel-Concrete Composite structures, Light gauge steel structures.

iv) REFERENCES:

1) Dayaratnam, P., *Design of Steel Structures*, S. Chand Publishing, 1stedition, 2015.
2) Subramanian, N., *Design of Steel Structures*, Oxford University Press, 2015.
3) Ramchandra, Gehlot, V.,*Design of Steel Structures 2*, Scientific publishers, 19th edition, 2016.
4) Duggal, S.K., *Design of Steel Structures*, McGraw Hill Education; 3rd edition, 2017.
5) Wie-Wen, Y., *Cold-Formed Steel Structures*, John Wiley & Sons, 4thedition, 2019.
6) Johnson, R.P., *Composite Structures in Steel and Concrete*, Blackwell Scientific Publications, UK, 2nd edition, 2008.
7) Chen, W.F., and Toma, S., Advanced Analysis of Steel Frames, CRC Press.
8) IS 800: 2007, *General Construction in Steel – Code of Practice*, Bureau of Indian Standards, New Delhi, Third Revision, 2007.
9) IS 801 : 1975 (Reaffirmed 2010), *Code of Practice for use of Cold formed Light gauge Steel Structural members in General Building Construction*, Bureau of Indian Standards, New Delhi, First Revision, 2010.
10) IS 811 : 1987 (Reaffirmed 2004), *Specification for Cold Formed Light Gauge Structural Steel Sections*, Bureau of Indian Standards, New Delhi, Second Revision, 2004.

COURSE PLAN

Module	Contents	No. of hours
I	**Design Philosophies:** Existing methods, Introduction to Limit State Design. **Connections:** - Classification (Simple, Rigid, semi rigid), Beam to Column and Beam to Beam connections, web angle and end plate connections; defects in connections	**9**
II	**Beam to column connections:** Seat angle, stiffened beam seat connection; lug angles and shear lag. **Splices:** Need for splices, Beam and column splices, bolted and welded splices; Prying force.	**9**
III	**Column Bases:** Design of slab base and gusseted base; eccentrically loaded base plate **Special connections:** Connections from column base to footings - anchor bolts and shear connectors	**9**
IV	**Design of industrial buildings**: Design of members subjected to lateral loads and axial loads - Sway and non-sway frames, bracings and bents - Rigid frame joints - Rigid joints in multi-storey buildings - Special steel moment resisting frames – Basic capacity design approach – Beams, columns and connection panel design – P-Delta stability of moment resisting frames Design of crane and gantry girders [design concepts only]	**9**
V	**Light gauge steel structures:** Introduction – Types of cross sections – Materials - Local and post buckling of thin elements - Stiffened and multiple stiffened compression elements - Tension members - Beams and deflection of beams **Steel-Concrete Composite structures:** Composite behaviour, Connections for composite action, composite sections under positive and negative bending (concepts only)	**9**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162F	Mechanics of Composite Materials	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

Goal of this course is to expose the students to the concepts of composite materials that are finding immense application in the field of aerospace, automobile and civil engineering presently due to its outstanding material capability. It deals with the fundamentals of composite materials for designing composite structures in various fields.

ii) COURSE OUTCOMES:

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

CO1	Choose different composites based on their application and manufacturing processes	Apply
CO2	Examine the models, failure and stress/strain criteria of different types of lamina	Apply
CO3	Examine the micro mechanical behaviour of composite laminates	Apply
CO4	Examine the strength and failure analysis of laminates	Apply
CO5	Deduce the governing equations to solve the deflection of composite beams and plates	Analyse

iii) SYLLABUS

Introduction to composites, Composite Fundamentals, Structural applications of Composite Materials, Manufacturing Processes. Mechanics of Composite Lamina, Failure theories. Micro Mechanical Behaviour of Composite Laminates - Classical Lamination Theory, stress-strain variation, In-plane forces, bending and twisting moments, special cases of laminate stiffness. Laminate strength analysis procedure, Failure envelopes, Free-Edge Inter laminar Effects, Analysis of free edge inter-laminar stresses, Effects of stacking sequence- Bending and Buckling of Laminated Beams and Plates.

iv) REFERENCES:

1) Reddy, J. N, *Mechanics of Laminated Composite Plates: Theory and Analysis*, CRC Press, 2nd edition, 2003.
2) Ronald F. Gibson, *Principles of Composite Material Mechanics* ,CRC Press, 4th edition, 2016.

3) Jones M. Roberts, *Mechanics of Composite Materials*, Taylor and Francis, 2nd edition, 1999.
4) Calcote, L. R., *Analysis of Laminated Composite Structures*, Van Nostrand, 1st edition, 1969.
5) Vinson, J. R. And Chou, T. W., *Composite materials and their use in Structures*, Applied Science Publications Ltd., London, 1975.
6) Agarwal,B. D. And Broutman, L. J., *Analysis and performance of Fibre composites*, Wiley, 3rd edition, 1990.
7) Ever J. Barbero, *Introduction to Composite Materials Design*, CRC Press, 2nd edition, 2014.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Composite Fundamentals:** Definition of composites - constituents- Classification of composites –Structural applications of Composite Materials – Manufacturing Processes. Review of Basic Mechanics of Materials Equations and Linear Elasticity in 3D and 2-D plane stress and plane strain	**8**
II	**Lamina Stress-Strain Relationships:** Number of elastic constants and reduction from 81 to 2 for different materials. Stress-Strain relations for a uni-directional and orthotropic lamina Effective Moduli of a continuous fibre-reinforced lamina: Models based on mechanics of materials and theory of elasticity - Failure of Continuous Fibre-reinforced orthotropic Lamina - Maximum stress/strain criteria, Tsai-Hill and Tsai-Wu criterion.	**8**
III	**Micro-mechanical behaviour of composite laminates:** Classical Lamination Theory, stress-strain variation, In- plane forces, bending and twisting moments, special cases of laminate stiffness.	**9**
IV	**Analysis of Laminates:** Laminate strength analysis procedure –Failure envelopes – Progressive failure Analysis. Free-Edge Inter laminar Effects – Analysis of free edge inter laminar stresses-Effects of stacking sequence-Hygro-thermal effects on material properties in laminates.	**10**
V	**Bending of Laminated Beams and Plates:** Governing equations and boundary conditions - Solution techniques - deflection of composite beams and plates under transverse loads for different boundary conditions	**10**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162G	Advanced Prestressed Concrete Design	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

Goal of this course is to make students familiar with the concepts and design of typical pre-stressed concrete structural elements and to have knowledge about the provisions in the code of practice.

ii) COURSE OUTCOMES:

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

CO1	Analyse determinate and indeterminate prestressed concrete section	Analyse
CO2	Examine the loss of pretensioning	Apply
CO3	Design the prestressed concrete members for flexure, shear, torsion by the concept of limit state method	Analyse
CO4	Calculate the short term and long term deflection of prestressed concrete members as per IS code	Apply
CO5	Design prestressed compression members and post tensioned slabs	Analyse

iii) SYLLABUS

Basic concept and principles of pre-stressed concrete systems, Analysis for flexure, Loss of pre-stress, Design philosophy and design for flexure, shear and torsion, Codal provisions, Calculation of deflection (short & long term), Design of PSC slabs, Design of compression members, prestressing of statically indeterminate structures, design of post-tensioned slabs.

iv) REFERENCES:

1) Dayaratnam, P., *Prestressed Concrete Structures*, Oxford & IBH Publishing Co., 7thedition, 2017.
2) Krishna, R.N., *Prestressed Concrete*, Tata McGraw Hill Publishing Company Ltd., New Delhi, 6thedition ,2018.
3) Lin, T.Y. and Ned H.B., *Design of Prestressed Concrete Structures*, John Wiley and sons, New York, 3rdedition, 2010.
4) Praveen, N., *Prestressed Concrete Design*, Pearson Education India, Delhi, 1stedition, 2013.

5) IS 1343 – 2012 (Reaffirmed 2012), *Pre-stressed Concrete Code of Practice*, Bureau of Indian Standards, 2012.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction:** Principles – advantages – materials for prestressed concrete - definition of Type I, Type II and Type III structures – requirements. **Methods of prestressing**– pre-tensioning and post- tensioning – anchorage systems. **Analysis**: Assumptions – Analysis of Prestress – Resultant Stresses at a section – Thrust Line – Concept of load balancing – Stresses in tendons – Cracking Moment. **Loss of Prestress**- Stages of losses, Types of losses in pre- tensioning and post-tensioning due to Elastic shortening, Shrinkage, Creep, Relaxation, Anchorage Slip, Friction - Concept of reduction factor.	**10**
II	**Design for flexure**: Philosophy - limit states - concepts - collapse and serviceability - service load - basic requirements - stress range approach - Lin's approach - Magnel's approach - cable layouts. **Design for shear:** Shear and principal stresses - limit state shearing resistance of cracked and uncracked sections - design of shear reinforcement by limit state approach. **Design for torsion:** Behaviour under torsion - modes of failure - design for combined torsion, shear and bending as per IS 1343: 2012.	**10**
III	**Deflection:** Deflection - short- and long-term deflection of uncracked and cracked members as per IS 1343: 2012 Design and analysis of post and pre-tensioned PSC slabs. **Prestressing of statically indeterminate structures:** Advantages, Effect, Method of achieving continuity, Primary, Secondary and Resultant moments, Pressure line, Concept of Linear transformation, Guyon's theorem, Concordant cable profile.	**8**
IV	**Design of Compression members**: - Design of compression members with and without flexure, its application in the design of Piles, Flag masts and similar structures.	**7**
V	**Design of post-tensioned slabs** Introduction to post-tensioned slabs; Analysis and design considerations of post-tensioned slabs; Factors influencing in choosing slab thickness; Corrosion protection of unbonded tendons; load balancing; Distribution of tendons in Two-way slabs.Equivalent frame method; Stress checks and control of cracking; Considerations for Edge and Corner panels.Flexural capacity of PT slabs; Shear design of PT slabs; Calculation of deflections of slabs; Example on the design of post-tensioned Flat Plate.	**10**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162H	Stability of Structures	PEC	3	0	0	3	2026

i) COURSEOBJECTIVES:

The goal of this course is to expose the students to the buckling phenomenon that occurs in the structures like columns, beam-columns, frames, plates and shells which helps them to understand the stability of various structures.

ii) COURSEOUTCOMES:

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

CO1	Examine the stability of columns using deformation theories.	Apply
CO2	Examine the behaviour of imperfect columns.	Apply
CO3	Apply energy methods for calculating the critical load of columns and plates	Apply
CO4	Examine the buckling of built-up columns, beams, beam-columns and frames.	Apply
CO5	Determine the torsional buckling of columns and the lateral buckling of beams	Apply

iii) SYLLABUS

Buckling of Columns- Methods of Neutral Equilibrium, Large Deformation Theory for Columns, Energy method for calculating critical loads, Buckling of Beam Columns, Torsional Buckling, Buckling of Frames, Stability of a frame by Matrix Analysis, Buckling of Plates, Instability of shells.

iv) REFERENCES:

1) Timoshenko, S. P. And Gere, J. M., *Theory of Elastic Stability,* Dover Publications, 2nd edition, 2009.
2) Chajes, A., *Principles of Structural Stability Theory*, Prentice Hall Inc., 1974.
3) Iyenger, N. G. R., *Structural Stability of columns and plates*, Affiliated East West Press Pvt. Ltd., 1990.
4) Allen, H. G. And Bulson, P. S., *Background to Buckling*, Mc-Graw Hill Book Co., 1980.
5) Galambos, T. V., *Structural Members and Frames*, Dover Publications Inc., 1st edition, 2016.
6) Galambos, T. V. And Surovek, A. E., *Structural Stability of Steel: Concepts and Applications for Structural Engineers*, Wiley, 1st edition, 2008.

v) COURSEPLAN

Module	Contents	No. of hours
I	**Buckling of Columns**: Introduction-Concepts of Stability-Methods of Neutral Equilibrium - Euler Column - Eigen Value Problem – Axially Loaded Column - Effective Length Concept and Design Curve. Large Deformation Theory for Columns. Nonlinear buckling analysis and geometric nonlinearity.	**10**
II	**Behaviour of Imperfect Columns**: Initially bent column-Eccentrically Loaded Column. **Inelastic buckling**: Reduced modulus and modern load-deflection approaches. **Approximate methods**: Finite difference and finite element basics for stability (with software like ANSYS/MATLAB intro). **Energy methods**: Rayleigh-Ritz with modern applications.	**8**
III	**Buckling of Built-up Columns:** Non-prismatic members-Effect of shear on critical Loads. **Beams and Beam Columns:** Introduction - Beam Column with Concentrated and Distributed Loads - Effect of Axial Load on Bending Stiffness. Design of Beam Columns-Interaction Formula. Stability of composite beams and GFRP-reinforced beam-columns.	**9**
IV	**Buckling of Frames:** Introduction-Modes of Buckling-Critical Load using Neutral Equilibrium Methods. Stability of a frame by Matrix Analysis. **Torsional Buckling:** Torsional and Torsional-Flexural Buckling of Columns, Lateral Buckling of Beams. Continuous beams with axial load. Buckling-resistant design per recent codes	**9**
V	**Buckling of Plates:** Differential Equation of Plate Buckling-Critical Load of a plate uniformly compressed in one direction. Post-buckling strength and design of compressed plates. Vibration-stability interactions and dynamic buckling (intro).	**9**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162I	Tall Structures	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES

The goal of this course is to impart knowledge in the design philosophy adopted for tall structures and latest concepts in the structural systems suitable for tall structures. It also deals with various techniques in the analysis and design of tall structures subjected to wind.

ii) COURSE OUTCOMES

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

CO1	Analyse and design tall structures subjected to various loading conditions.	Analyse
CO2	Design foundations of RCC chimney as per the standards.	Analyse
CO3	Apply the concept of wind loads to estimate its effects on tall structures.	Apply
CO4	Evaluate the performance of tall structures designed using relevant software.	Evaluate

iii) SYLLABUS

Tall structures, Structural systems, design considerations of Transmission tower, Cooling towers, RCC Chimney and its foundations, effects of wind on tall structures, application of software in analysis and design of high rise structures.

iv) REFERENCES:

1) Bryan, S. and Alex, C., *Tall Building Structures*, Wiley, 1stedition, 1991.
2) Manohar, S. N., *Tall Chimneys-Design and Construction*, Tata McGraw-Hill, 1st edition, 2008.
3) Murthy, S. S. and Santhakumar, A. R., *Transmission Line Structures*, McGraw-Hill, 3rd edition, 2010.
4) Relevant IS codes (IS 4998 (Part 1): 1992 (Reaffirmed 2012), IS 6533 (Part 2): 1989 (Reaffirmed 2003), IS 6533 (Part 2): 1989 (Reaffirmed 2003)), Bureau of Indian Standards, New Delhi.
5) Raju, K. N., *Advanced Reinforced Concrete Design*, University Press, 4th edition, 2007.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Tall Buildings:** Structural Concept, Configurations, Design aspects for tall buildings - loading conditions (gravity, earthquake, blast etc). **Structural systems:** Various structural systems - Rigid frame Structures, Braced frames, Infilled frames, Shear walls, Coupled shear walls, Wall frame structures, Tubular structures, core structures, outrigger braced structures, Structural applications of these systems.	**9**
II	**Transmission towers:** Configuration of transmission towers, bracing system, Design aspects of a tower including foundations, conductors etc (concept only).	**9**
III	**Cooling towers:** Types, components, requirements, need, design forces, analysis and design aspects of a typical cooling tower (concept only).	**9**
IV	**RCC Chimney and its foundation:** Types of chimneys, elastic design and limit state design concepts, design of RCC chimney based on these concepts, foundations for chimneys, design of raft and pile foundations.	**9**
V	**Wind on tall structures:** Static and dynamic effects of wind, wind load analysis, structural design considerations, analysis of wind on tall structures. **Analysis of frames:** Overall buckling analysis of frames, wall – frames – Translational - torsional instability, out of plumb effects.	**9**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162J	Fracture Mechanics	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

Goal of this course is to expose the students to Significance of fracture mechanics and enhance their problem-solving skills. It introduces Linear Elastic Fracture Mechanics, Elastic Plastic Fracture Mechanics, Experimental and Modelling tools and Numerical Simulation of plain concrete fracture experiments.

ii) COURSE OUTCOMES:

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

CO 1	Solve fracture parameters by applying the concepts of linear elastic fracture mechanics	Analyse
CO 2	Solve fracture parameters by applying the concepts of elastic plastic fracture mechanics	Analyse
CO 3	Identify the experimental and modelling tools associated with fracture processes of concrete and non-metals	Apply
CO 4	Examine crack propagation using Computational Fracture Mechanics	Apply

iii) SYLLABUS

Significance of fracture mechanics, Griffith energy balance approach, Irwin's modification to the Griffith theory, Stress intensity approach, Cack tip plasticity, Fracture toughness, sub-critical crack growth, Linear Elastic Fracture Mechanics (LEFM), Cack Tip Plasticity, LEFM Testing, Plane strain and plane stress fracture toughness testing, Elastic Plastic Fracture Mechanics (EPFM), Fatigue Cack Growth, Sustained Load Fracture, Experimental and Modelling tools, Numerical Simulation of plain concrete fracture experiments.

iv) (a) TEXT BOOKS

1) Anderson, T.L, *Fracture Mechanics Fundamentals and Applications*, CRC Press, 4th edition, 2017.
2) Broek, D., *Elementary Engineering Fracture Mechanics*, MartinusNijhoff Publishers, 2nd edition, 1986.
3) Mier, J. G. M., *Fracture Processes of ConcreteAssessment of Material Parameters for Fracture Models*, CRC Press, 1st edition, 2017.

b) REFERENCES:

1) Janssen, M., Zuidema, J. and Wanhill, R., *Fracture Mechanics*, CRC Press, 2nd edition, 2004.
2) Broek, D. The Practical Use of Fracture Mechanics – Kluwer Academic Publishers, 1989.
3) Hellan, D., *Introduction to Fracture Mechanics*, McGraw-Hill Inc. US, 1984.
4) Kumar, P., *Elements of Fracture Mechanics*, McGraw-Hill Education Private Limited, 2014.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction**, Significance of fracture mechanics, Griffith energy balance approach, Relations for practical use, Irwin's modification to the Griffith theory, Stress intensity approach, Fracture toughness, sub-critical crack growth, Influence of material behaviour, I, II & III modes, Mixed mode problems.	**10**
II	**Linear Elastic Fracture Mechanics (LEFM),** Elastic stress field approach, Mode I elastic stress field equations, Stress intensity factors (SIF),Energy Release Rate **Crack Tip Plasticity,** Irwin plastic zone size, Shape of plastic zone, State of stress in the crack tip region, Influence of stress state on fracture behaviour, Slow stable crack growth and R-curve concept, Description of crack resistance. Determination of R-curves, , Practical use of fracture toughness and R-curve data.	**9**
III	**Elastic Plastic Fracture Mechanics (EPFM),** Development of EPFM, J-integral, Crack opening displacement (COD) approach, COD design curve, Relation between J and COD, Tearing modulus concept, Fatigue Crack Growth: - Description of fatigue crack growth using stress intensity factor, Effects of stress ratio and crack tip plasticity – crack closure,	**9**
IV	**Fracture Processes of Concrete:** Cracking in concrete and concrete structures, Mechanical behaviour of Concrete in compression. tension, shear and multiaxial state of stress **Experimental and Modelling tools,** Load- versus displacement-controlled testing. Importance of boundary Conditions, Specimen selection, Need for standard testing, Fictitious crack model, Lattice model **Fracture mechanics for structural analysis**, Analysis of bond-slip between steel and concrete, Analysis of anchor pull-out, Evaluation of brittleness of structures	**10**
V	**Computational Fracture Mechanics** The Finite Element Method. The Boundary Integral Equation Method. Mesh Design. Linear Elastic Convergence Study, Analysis of Growing Cracks Conventional Finite Elements, Special Crack Tip Elements, Quarter Point Eight Node Isoparametric Elements. **Fracture Mechanisms in Nonmetals** Fracture Toughness of Fiber Reinforced Brittle Matrix Composites Crack	**7**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162K	Design of Offshore Structures	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

Goal of this course is to make students familiar with the concepts and design of offshore structures and to have knowledge about the provisions in the code of practice.

ii) COURSE OUTCOMES:

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

CO 1	Examine the basic tasks regarding dimensioning and structural design of offshore structures.	Apply
CO 2	Estimate the maximum forces on an offshore structure due to operational loads and conduct static and dynamic analyses of fixed platforms.	Apply
CO 3	Design jacket platforms, tubular joints and concrete gravity platforms.	Analyse
CO 4	Estimate the resistance of platforms against fatigue and accidental loads.	Apply
CO 5	Examine the corrosion mechanism and its preventive methods	Apply

iii) SYLLABUS

Offshore structures – types-conceptual development - Basics of wave motion-wave theories-wave kinematics-random waves-wave spectrum-wave breaking - Loads on offshore structures- operational Loads - environmental loads – Morison equation- Wave forces on large structures-Linear diffraction theory - materials-allowable stresses-design methods and code provisions of API and, DNV- Principles of static and dynamic analysis of jacket platforms- Analytical modeling of jacket platforms- Design principles of Concrete offshore platforms-Jack up platforms -Compliant platforms- Tension Leg Platforms and Spar platforms- -Design of tubular members and joints – simple design problems- Fatigue analysis- Submarine pipelines-design procedure-thickness calculations.

iv) REFERENCES:

1) Chakrabarti S.K., *Hydrodynamics of Offshore Structures*, WIT Press Publications, 2001.
2) Chandrasekaran, S., *Dynamic Analysis and Design of Ocean Structures*, Springer, 2019.
3) DNV-RP-C203- *Fatigue Design of Offshore Steel Structures*, 2019.
4) DNV-RP-C204- *Design Against Accidental Loads,* 2019.
5) DNV-RP-B101-*Corrosion Protection of Floating Protection and Storage Units*, 2015.
6) API RP 2A. *Planning, Designing and Constructing Fixed Offshore Platforms*, API. 2014.
7) Gerwick, B.C., Jr.,*Construction of Marine and Offshore Structures*, CRC Press, Florida, 2007.
8) Clauss, G, Lehmann, E.andOstergaard, C., *Offshore Structures*, Vol. 1 & 2, Springer-Verlag, 1994.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Types of offshore structures and their conceptual development**- Fixed, Compliant and Floating systems **–** Behaviour under static and dynamic Loads-Analytical models for offshore structures- Materials used in offshore construction - construction and installation of jacket and gravity platforms **Statutory regulations**- Allowable stresses and introduction to limit state concepts- Design methods and Code Provisions- Design specification of API, DNV, Lloyd's and other Classification Societies.	**8**
II	**Environmental loads**- Wind, wave, current and ice loads- Calculation of forces based on maximum base shear and overturning moments- Design wave height and spectral definition- Morison's Equation-Maximum wave force on offshore structure-Concept of return period waves- Principles of static and dynamic analyses of fixed offshore platforms **Use of approximate methods**- Principles of working stress design (WSD) and Load and Resistance factor design (LRFD)- Allowable stresses and partial safety factors- Design of offshore structural elements.	**11**
III	**Introduction to tubular members**- Slenderness effect- Column buckling- **I** Tubular joints- Possible modes of failure, Eccentric and offset Connections-Cylindrical and rectangular structural members- In plane and multi plane connections- Parameters governing in-plane tubular joints- Kuang's formulae. **S** **Elastic stress distribution**- Punching shear stress- Overlapping braces- Stress concentration- Chord collapse and ring stiffener spacing- Stiffened tubes- External hydrostatic pressure - Fatigue of tubular joints- Fatigue behaviour- S-N curves- Palmgren-Miner cumulative damage rule- Design of tubular joints as per API Code.	**11**
IV	**Design against accidental loads-** Fire, Blast and Collision-- Behaviour of steel at elevated temperature -Fire rating requirements for Hydrocarbon fires- Design of offstructures for high temperature exposure- Blast Mitigation measures -Blast walls and protective systems - Collision of service vessels and boats - energy absorption mechanisms and structural response.	**8**
V	**Corrosion**- Corrosion mechanism- Types of corrosion- Offshore structure corrosion zones- Biological corrosion- Preventive measures of corrosion- Principles of cathode protection systems- Sacrificial anode method and impressed current method- Online corrosion monitoring- Corrosion fatigue in offshore structural components.	**7**
	Total hours.	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162L	Behaviour of Structural Materials and Instrumentation	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

Goal of this course is to familiarize the students regarding the estimation of properties of the materials used in concrete. The course also aims to expose the students to different types of concrete, their mix design and evaluation of strength of concrete by destructive and non-destructive methods.

ii) COURSE OUTCOMES:

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

CO 1	Examine the suitability of materials used for preparing RCC	Apply
CO 2	Examine the different types of concretes and their properties	Apply
CO 3	Apply the codal provisions to design concrete mix	Apply
CO 4	Apply different NDT techniques to determine the quality of concrete.	Apply
CO 5	Examine the load, strain and displacement using different instrumentation systems	Apply

iii) SYLLABUS

Components of concrete, special concrete, mix design of various types of concrete, properties of hardened concrete, durability test, non-destructive testing, instrumentation and testing of reinforced concrete members.

iv) REFERENCES:

1) Nevile, A. M., *Properties of Concrete*, Pearson, 5th edition, 2011.
2) Mehta, P. K. and Monteiro, P. J. M., *Concrete: Microstructure, Properties and Materials,* McGraw Hill, 4th edition, 2006.
3) Santhakumar, A. R., *Concrete Technology*, Oxford University Press, 2nd edition, 2018.
4) Zongjin, L., *Advanced Concrete Technology,* John Wiley and Sons, Inc., Hoboken, New Jersey, 2011.
5) Krishnaraju, N., *Design of Concrete Mixes*, CBS Publishers, 4th edition, 2010.
6) Prasad, J., Nair, C. G. K., *Non-Destructive Test and Evaluation of Materials*, Mc-Graw Hill, 2nd edition, 2011.
7) Jan, G .M. V. M., *Fracture Processes of Concrete: Assessment of Material Parameters for Fracture Models,* CRP Press, 1997.
8) IS 10262: 2019, *Concrete Mix Proportioning – Guidelines*, Bureau of Indian Standards, New Delhi, India, 2019.
9) IS 1489 (Part 1): 2015, *Specification for Portland Pozzolana Cement*, Bureau of Indian Standards,

New Delhi, 2015.

10) IS 383: 2016, *Specification for Coarse and Fine Aggregates from Natural Sources for Concrete (Third revision)*, Bureau of Indian Standards, New Delhi,2016.
11) IS 2386 (Part III) : 1963, *Methods of Test for Aggregates for Concrete - Specific Gravity, Density, Voids, Absorption and Bulking,* Bureau of Indian Standards, New Delhi,1963.
12) IS 516 – 1959, *Method of Tests for Strength of Concrete*, Bureau of Indian Standards, New Delhi,1959.
13) IS 456: 2000 (Reaffirmed 2005), *Plain and Reinforced Concrete Code of Practice*, Bureau of Indian Standards, New Delhi, 2005.
14) IS 2770 (Part I) : 1967 (Reaffirmed 2007), *Methods of Testing Bond in Reinforced Concrete*, Bureau of Indian Standards, New Delhi,1967.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Concrete Components**: Cement – Bogue's Compounds, Hydration Process, Types of Cement, Low-carbon binders, Secondary Cementitious Materials (SCMs). Aggregates – Gradation Charts, effects on properties of concrete, Combined Aggregate, Alkali Silica Reaction. Interface between aggregates and cement matrix, Interface properties: strength and fracture energy, Recycled Aggregates. Admixtures – Chemical and Mineral Admixtures. Fresh Concrete - Segregation and bleeding. **Properties of hardened concrete:** Microstructure of hardened concrete – Aggregate phase, hydrated cement paste. Interfacial Transition Zone (ITZ) - ITZ improvement through mineral admixtures. Strength of concrete, behaviour of concrete under various stress states, stress strain behaviour – cyclic load, Dimensional stability of concrete – Elastic behaviour, shrinkage and creep. Test on bond strength between steel and concrete	**11**
II	**Strength of concrete:** Behaviour of concrete under various stress states, stress strain behaviour – cyclic load, Dimensional stability of concrete – Elastic behaviour, shrinkage and creep. Test on bond strength between steel and concrete **Durability of concrete**: Durability concept, service life design, factors affecting, reinforcement corrosion, fire resistance, frost damage, sulphate attack, alkali silica reaction, concrete in sea water, statistical quality control, Durability acceptance criteria as per BIS code.	**9**
III	**Special concrete** – Fibre reinforced concrete, High strength concrete, High performance concrete, Ultra High performance concrete, Self-compacting concrete, Alkali-activated and Geopolymer concrete, Lightweight concrete, **Proportioning of concrete mixtures:** Mix design objectives and performance criteria, Factors considered in the design of mix, IS 10262:2019	**8**

	guidelines and method of mix design, Mix design of special concrete - Field Quality Assurance - Batching tolerance, slump control, yield monitoring.	
IV	**Non-destructive testing of concrete**: Surface Hardness, Ultrasonic pulse velocity, Penetration resistance, Pull-out test, chemical testing for chloride and carbonation- core cutting - measuring reinforcement cover. **Advanced Characterization:** Scanning Electron Microscopy, X-Ray Microanalysis of Concretes, Interpretation of concrete deterioration from SEM/EDXA, Techniques for Corrosion Investigation in Reinforced Concrete	**9**
V	**Instrumentation for measurement:** Measurement of Strain - Strain gauge types, Characteristics, circuits - Strain Gauge rosettes. Force transducers - Load cells - tension, compression, shear, bending. Displacement measurement - Linear variable differential transformer, Laser/optical sensors **Modern Sensors and Data systems:** Fibre Optic sensors, MEMS sensors, wireless data acquisition. Basics of signal conditioning and structural health monitoring.	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162M	Soil Structure Interaction	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

The goal of this course is to render the effects of soil flexibility in the response of the structure. It introduces the analysis of the structure with soil structure interaction effects to obtain the realistic response

ii) COURSE OUTCOMES:

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

CO 1	Analyse the beams founded on elastic foundation using the basic concepts of soil-structure interaction	Analyse
CO 2	Analyse the plates founded on elastic foundation using the basic concepts of soil-structure interaction	Analyse
CO 3	Analyse single pile and pile group	Analyse
CO 4	Determine the load deflection behaviour for laterally loaded piles	Apply

iii) SYLLABUS

Soil-Foundation Interaction - Soil response model - Elasto-plastic behaviour, Beams on Elastic Foundations- Analysis of beams of finite and infinite length -Time dependent behaviour, Plates on Elastic medium-thin and thick plates, Elastic analysis of piles- Analysis of pile groups, Interaction analysis, Load deflection prediction for laterally loaded piles.

iv) REFERENCES

1) Selvadurai, A. P. S., *Elastic Analysis of Soil-Foundation Interaction*, Elsevier, 1st edition, 2015.
2) Poulos, H. G. and Davis, E. H., *Pile Foundation Analysis and Design*, John Wiley, 1980.
3) Reese, L.C., *Single Piles and Pile Groups under Lateral Loading*, Taylor & Francis, 2nd edition, 2011.
4) Kurian, N. P., *Design of Foundation System – Principles & Practices*, Narosa Publishing House, 4th edition, 2019
5) ACI 336.2R-88 (Reapproved 2002), Suggested Analysis and Design Procedures for combined footings and Mats, American Concrete Institute.
6) Swami Saran, *Analysis & Design of Substructures*, Oxford & IBH Publishing Co. Pvt. Ltd., 2nd Edition, 2019.

v) COURSE PLAN

Module	Contents	No. of hours
I	**General soil-structure interaction problems:** Contact pressures and soil-structure interaction for shallow foundations, concept of sub grade modulus, effects/parameters influencing subgrade modulus. Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Types of interaction problems	**9**
II	**Beam on Elastic Foundation:** Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness, Time-dependent response.	**8**
III	**Plate on Elastic Medium:** Thin and thick plates, Analysis of finite plates, Numerical modelling, experimental and field investigations, prediction of failure mechanism, economic considerations.	**9**
IV	**Elastic Analysis of Pile:** Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis.	**10**
V	**Laterally Loaded Pile:** Load deflection prediction for laterally loaded piles, Sub-grade reaction and elastic analysis, Interaction analysis.	**9**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162N	Structural Reliability	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

This course aims to introduce the basics of the structural reliability analysis procedures and to familiarize students with the applications of probability analysis and reliability techniques in structural engineering.

ii) COURSE OUTCOMES

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

CO 1	Apply probability theories, random variables, and random processes for quantifying uncertainties mathematically.	Apply
CO 2	Apply probabilistic analysis and properties of material to determine allowable stresses based on specified reliability	Apply
CO 3	Apply Monte Carlo simulations for reliability analysis of structural elements	Apply
CO 4	Analyse structural systems using reliability methods and codal provisions	Analyse

iii) SYLLABUS

Fundamentals of probability theory, resistance distributions and parameters, probabilistic analysis for loads, basic structural reliability, level 2 reliability methods, Monte Carlo study of structural safety, reliability of structural system, reliability-based design.

iv) REFERENCES

1) Nowak, A. S. and Collins, K. R., *Reliability of Structures*, CRC Press, London, 2nd edition,2019.
2) Melchers, R. E., *Structural Reliability Analysis and Prediction*, John Wiley and Sons, 3rd edition, 2018.
3) R. Ranganathan, *Reliability Analysis and Design of Structures*, Tata McGraw Hill, 2006.
4) Ang, A. H. S. and Tang, W. H., *Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering*, John Wiley and Sons, New York, 2nd edition, 2016.
5) Benjamin, J. R. & Cornell, C. A., *Probability, Statistics, and Decision for Civil Engineers*, reprint ed., Courier Corporation / Dover, 2014.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Fundamentals of Probability theory:** Concepts of Structural safety, design method, basic statistics and probability data reductions. Histograms, sample correlation, Random variables, functions of random variables, moments and expectation, discrete and continuous variables, common probability distributions.	9
II	**Resistance distributions and parameters:** Introduction, Statistics of properties of concrete, steel and other building materials, statistics of dimensional variations, characterization of variables, allowable stresses based on specified reliability. **Probabilistic analysis** for live load, gravity load and wind load.	9
III	**Basic structural reliability:** Introduction, computation of structural reliability, reliability analysis of simple elements. **Level 2 Reliability methods:** Introduction, basic variables and failure surface, first order second moment methods (FOSM).	9
IV	**Monte Carlo study of structural safety:** General, Monte Carlo method, applications. **Reliability of Structural system:** Introduction, system reliability, reliability analysis of frames.	9
V	**Reliability based design:** Introduction, resistance factors of design, safety checking formats and code calibrations, IS Code provisions, Calibration of partial safety factors, Uncertainty models for load and resistance, Reliability Based Optimization. Introduction to the stochastic process.	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162O	Random Vibration	PEC	3	0	0	3	2026

i) COURSE OBJECTIVE:

This course aims to introduce students the statistical concepts in vibration analysis and understand the behaviour of systems subjected to random vibrations.

ii) COURSE OUTCOMES

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

CO 1	Apply the concept of probability theory and random process to solve random vibration problems.	Apply
CO 2	Analyse the solution of random vibration through spectral and stochastic functions.	Analyse
CO 3	Analyse linear SDOF and MDOF system subjected to random vibration	Analyse
CO 4	Analyse the response of linear continuous system of random vibration.	Analyse
CO 5	Apply the concept of nonlinear random vibration for practical application.	Apply

iii) SYLLABUS

Basic concepts in Probability Theory, Random process, spectral density functions, Properties of various random processes, Random vibration, response of linear SDOF, MDOF and continuous systems, Basics of nonlinear random vibration.

iv) REFERENCES

1) Newland, D. E., *An Introduction to Random Vibrations, Spectral & Wavelet Analysis*, Dover Publications, 2012
2) Preumont, A., *Random Vibration and Spectral Analysis*, Springer Netherlands, 2013
3) Lin, Y. K., *Probabilistic Structural Dynamics Advanced Theory and Applications*, McGrawHill, 2004
4) Cho, T. W. S., *Nonlinear Random Vibration*, Taylor and Francis, 2014
5) Lalanne, C., *Random Vibration*, CRC Press. 2020.
6) Wirsching, P. H, Paez, T. L. and Ortiz, H., *Random Vibration*, Dover Publications.2006
7) Ibrahim, R. A., *Parametric Random Vibration*, Dover Publications, 2008

v) COURSE PLAN

Module	Contents	No. of hours
I	**Probability Theory** - Random variables, Probability distribution and density functions - Expected value mean, variance, conditional probability, characteristic functions, Chebyshev inequality, functions of random variable **Random process** - concepts of stationary and ergodicity–non stationary process - auto and cross correlation and covariance functions - Mean square limit, differentiability and integrability	**9**
II	**Spectral Analysis -**Wiener Khintchine relation. Properties of Guassian, Poisson and Markov process. Broad band and narrow band random process - white noise.	**9**
III	**Stochastic response of linear SDOF Systems**- Level crossing, Peak,first passage time and other characteristics of the response of the SDOF systems.	**9**
IV	**Stochastic response of MDOF systems** to stationary and non-stationary random excitation. Response of continuous systems - normal mode method.	**9**
V	**Response of Non-linear systems to Random Excitation** - Markov vector – equivalent linearization and perturbation methods - Level crossing, peak and envelope statistics - First excursion and fatigue failures - Applications.	**9**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162P	Structural Health Monitoring	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

Goal of this course is to make students familiar with the concepts and design of typical pre-stressed concrete structural elements and to have knowledge about the provisions in the code of practice.

ii) COURSE OUTCOMES:

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

CO 1	Examine the finite element and structural modelling for assessing failure of structures	Apply
CO 2	Compare the different systems and sensors for health monitoring of structures	Analyse
CO 3	Apply different techniques for health monitoring of structures	Apply
CO 4	Analyse and interpret health monitoring data	Analyse
CO 5	Evaluate the structural health through case studies.	Evaluate

iii) SYLLABUS

Review of Structural Modelling and Finite Element Models - Review of Signals, Systems and Data Acquisition Systems - Sensors for Health Monitoring Systems - Health Monitoring/Diagnostic Techniques- Health Monitoring/Diagnostic Techniques -Integrated Health Monitoring Systems - Information Technology for Health Monitoring -Project Based Health Monitoring Techniques

iv) REFERENCES:

1) Philip, W., *Industrial sensors and applications for condition monitoring*, Mechanical Engineering Publications, 1994.
2) Armer, G.S.T., *Monitoring and assessment of structures*, CRS Press, 2019.
3) Wu, Z.S., *Structured health monitoring and intelligent infrastructure*, Proceedings of the First International Conference SHMII-01, Tokyo, Japan, 13-15 November 2003 Volumes 1 and 2, CRC Press/Balkema, 2003.
4) Piersol, A.G. and Paez, T. L., *Harris' Shock and Vibration,* Handbook, McGraw-Hill, 2009.
5) Rao, J.S., *Vibratory condition monitoring of machines*, Narosa Publishing House, 2000.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Review of Structural Modelling and Finite Element Models:** Modelling for damage and collapse behaviour of structures, finite element modelling, theoretical prediction of structural failures.	**9**
II	**Review of Signals, Systems and Data Acquisition Systems:** Frequency and time domain representation of systems, Fourier/Laplace transforms, modelling from frequency response measurements, D/A and A/D converters, programming methods for data acquisition systems. **Sensors for Health Monitoring Systems:** Acoustic emission sensors, ultrasonic sensors, piezo-ceramic sensors and actuators, fibre optic sensors and laser shearography techniques, imaging techniques.	**10**
III	**Health Monitoring/Diagnostic Techniques:** Vibration signature analysis, modal analysis, neural network-based classification techniques. **Integrated Health Monitoring Systems:** Intelligent Health Monitoring Techniques, Neural network classification techniques, extraction of features from measurements, training and simulation techniques, connectionist algorithms for anomaly detection, multiple damage detection, and case studies.	**10**
IV	**Information Technology for Health Monitoring:** Information gathering, signal analysis, information storage, archival, retrieval, security; wireless communication, telemetry, real time remote monitoring, network protocols, data analysis and interpretation.	**8**
V	**Project Based Health Monitoring Techniques:** Health monitoring techniques based on case studies, practical aspects of testing large bridges for structural assessment, optimal placement of sensors, structural integrity of aging multi-storey buildings, condition monitoring of other types of structures.	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE162Q	Forensic Engineering and Rehabilitation	PEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

Goal of this course is to equip the students to identify reasons of distress in structures and suggest repair/ remedial measures.

ii) COURSE OUTCOMES:

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

CO 1	Examine the causes of failure of structures	Apply
CO 2	Examine the level of distress of structures	Apply
CO 3	Examine the effect of various environmental problems and natural hazards for the strengthening of structures	Apply
CO 4	Examine the different repair and retrofitting techniques for structures	Apply

iii) SYLLABUS

Failure of Structures, review of the construction theory, performance problems. Causes of deterioration in concrete and steel structures. Diagnosis and Assessment of Distress, Visual inspection, non-destructive tests. Fibre optic method for prediction of structural weakness. Effect of Environmental Problems and Natural Hazards. Methods of repair of concrete and steel structures. Modern Techniques of Retrofitting, Case studies.

iv) REFERENCES:

1) Raikar, R. N., *Learning from Failures – Deficiencies in Design, Construction and Service,* R&D Centre (SDCPL), Raikar Bhavan, 2002.
2) Dovkaminetzky, *Design and Construction Failures*, Galgotia Publication, New Delhi, 2001.
3) Raina, V. K., *Bridge Rehabilitation*, Shroff Publications, New Delhi, 2006.
4) Feld, J. and Carper, K. L., *Construction Failures*, Wiley Europe, 2008.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Failure of Structures**: Review of the construction theory – performance problems – responsibility and accountability – case studies – learning from failures – causes of distress in structural members – design and material deficiencies – over loading. Causes of deterioration in concrete and steel structures. Preventive measures, maintenance.	9
II	**Diagnosis and Assessment of Distress**: Visual inspection – non-destructive tests – ultrasonic pulse velocity method – rebound hammer technique – ASTM classifications – pullout tests – Bremor test – Windsor probe test – crack detection techniques – Fibre optic method for prediction of structural weakness –core sampling and testing. Chemical tests: carbonation and chloride tests – Corrosion potential assessment, cover meter survey, resistivity measurement – Identification and estimation of damage, structural integrity and soundness assessment, interpretation and evaluation of results – consideration for repair strategy – Case studies of RCC buildings subjected to distress– case studies – single and multistorey buildings	9
III	**Environmental Problems and Natural Hazards**: Effect of corrosive, chemical and marine environment – pollution and carbonation problems – durability of RCC structures – damage due to earthquakes, flood and fire - strengthening of buildings – provisions of BIS 1893 and 4326	9
IV	**Modern Techniques of repair, rehabilitation and retrofitting of RCC and steel structures**. Structural first aid after a disaster – guniting - jacketing – use of chemicals in repair Essential parameters for repair materials – Ferrocement and fiber concrete as rehabilitation materials, premixed cement concrete and mortars, polymer modified mortars and concrete, epoxy and epoxy systems, Rust eliminators, polymer concrete system – Repair to active and dormant cracks: grouting, routing and sealing, stitching, slurry injection, gunite, shortcrete, vacuum concrete	9
V	**Repair and strengthening of various damaged structural elements (slab, beam, and columns):** reinforcement replacement, plate bonding technique, ferrocement jacketing, RCC jacketing, internal and external pre-stressing, fiber wrap technique – Underwater repair – Chemical and electrochemical method of repair– Cathodic protection Rust eliminators and polymer coating for rebars - foamed concrete - mortar repair for cracks - shoring and underpinning -strengthening by pre-stressing. Case studies – bridges - water tanks – cooling towers – heritage buildings – high rise buildings.	9
	Total hours	**45**

INDUSTRY ELECTIVE COURSES (IEC)

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE166A	Wind Analysis on Structures, Cladding and Glazing Components	IEC	3	0	0	3	2026

i) COURSE OVERVIEW:

Goal of this course is to familiarise the student with the effects of wind loading in buildings and other structures such as bridges, steel transmission line towers and cooling towers. The concepts learned will help them to analyse the structure for the given wind force condition as per the codal provisions. It also enables the students to undertake sustained learning on wind tunnel testing.

ii) COURSE OUTCOMES

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

CO 1	Explain the characteristics of wind and Bluff body aerodynamics.	Apply
CO 2	Make use of static and dynamic wind effects on structures	Apply
CO 3	Explain the effect of wind on building structures, cladding and glazing.	Apply
CO 4	Analyse the structures, claddings and glazing subjected to wind load	Analyse
CO 5	Explain the role of wind tunnel testing on structures	Apply

iii) SYLLABUS

Nature of wind storm, Design wind speed, Atmospheric boundary layer and Wind turbulence. Basic Bluff body aerodynamics, Wind effects on Low Buildings, Wind effects on Tall Buildings, Design forces on multi-storey buildings, towers, cladding and roof trusses, Wind load calculation on special structures such as cooling towers, rail/road bridges and tall chimneys, Role of Wind Tunnel, Modelling, Tornado effects.

iv) TEXT BOOKS

1) Holmes, J. D., Wind loading of structures, CRC Press, 4th edition, 2022.
2) Sachs, P., Wind Forces in Engineering, Pergamon Press, New York, 2nd edition, 2013.
3) Simiu, Emil; Yeo, DongHun, Wind effects on Structures- Modern Structural Design

for Wind, John Wiley & Sons, 4th Edition, 2019
4) Lawson, T. V., Wind Effects on Buildings, Vols. I and II, Applied Science and Publishers,
London, 1993.
5) Devenport, A. G., Wind Loads on Structures, Division of Building Research, Ottowa, 1990.

REFERENCES

1) Scruton, C. P., An introduction to wind effects on structures (Vol. 3), Oxford University Press, 1981.
2) Sachs, P., Wind forces in engineering, Elsevier, 2013.
3) Dyrbye, C. and Hansen, S. O., Wind loads on structures, John Wiley & Sons, 1996.
4) Simiu E and Miyata T, Design of buildings and bridges for wind: a practical guide for ASCE-
7 standard users and designers of special structures, 1st edition, Wiley, 2006.
5) Simiu, E. and Scanlan, R. H., Wind effects on structures: An Introduction to wind engineering, Wiley, 1996.
6) IS 875 (Part 3): 2015 - Design Loads (Other than Earthquake) for Buildings and Structures Code of Practice - Wind Loads (Third Revision), Bureau of Indian Standards, New Delhi.
7) AS 1288-2006: Glass in buildings- selection and installation, Australian Standard.

v) COURSE PLAN

Module	Contents	No.of hours
I	Introduction: Characteristics of wind, Nature of wind storm, types ofwinds, Extreme wind conditions, Design wind speed, Atmospheric boundary layer and Wind turbulence. Basic Bluff body aerodynamics: Flow around bluff bodies, Pressure & force coefficients flow around flat plates, Walls, Prismatic shapes	9
II	Static wind effects-drag coefficient, lift coefficient. Dynamic wind effects - along wind load, across wind load, flutter, galloping, buffeting. Interference effects (concept only) – Rigid structure – Aeroelastic structure (concept only)	9

III	Effect on typical structures: Wind effects on roof and cladding, Wind effects on Low rise buildings: Low buildings with different roof shapes and multi-span buildings. Wind effects on tall buildings: Along wind effects, Across wind effects and vortex shedding. Wind effect on chimneys, towers, bridges and structural glazing	**9**
IV	Wind load calculations as per IS 875 (Part 3) - Application to design: Design forces on multi-storey buildings, towers, cladding and roof trusses. Wind load calculation on special structures such as cooling towers, rail/road bridges, tall chimneys and structural glazing.	**9**
V	Wind Tunnel: Role of Wind Tunnel-Flow simulation, Modelling, Flow measurement, Pressure measurement, Deformation measurement. Basic considerations, Tornado effects.	**9**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE166B	Soil Investigation and Design of Substructures	IEC	3	0	0	3	2026

i) COURSE OVERVIEW

Goal of this course is to expose the students to design of various types of foundation, slope failures and site investigation techniques.

ii) COURSE OUTCOMES

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

CO 1	Develop the design of shallow foundations, deep foundations and subgrade.	Apply
CO 2	Apply the standard procedure to calculate pile capacity.	Apply
CO 3	Apply the concept of slope stability to interpret slope failure.	Apply
CO 4	Examine the soil characteristics to identify suitable ground Improvement techniques.	Analyse
CO 5	identify the various parameters for foundation design from site investigation data.	Apply

iii) SYLLABUS

Introduction to shallow foundation, Limit State Design of reinforced concrete in foundations; design of subgrade using CBR method. Design of Pile foundations. Analysis of slope stability. Selection of Ground Improvement Techniques based on soil characteristics. Interpretation of site investigation data.

iv) REFERENCES

1) Das, B. M., and Sivakugan, N., "Principles of Foundation Engineering", Cengage Learning Inc, 7th Edition, 2019.
2) Terzaghi, K., Theoretical Soil Mechanics, John Wiley & Sons, 1943
3) Moseley, M. P. and K. Krisch, Ground Improvement, Taylor and Francis, 2006.
4) Coduto, D. P., "Foundation Design Principles and Practices", Pearson, Indian edition, 2nd edition, 2012.
5) Hausmann, M. R., "Engineering Principles of Ground Modification", McGraw Hill, 1989.

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to shallow foundation, types; bearing capacity factors - effect of foundation shape, eccentricity and inclination of load, influence of water table; Introduction to Limit State Design of reinforced concrete in foundations; Soil pressure for structural design; structural design of spread footings, isolated footings, combined footings, strap footing and strip footings. Introduction to shallow foundation, types; bearing capacity factors - effect of foundation shape, eccentricity and inclination of load, influence of water table; Design of Raft Foundation. Introduction to Limit State Design of reinforced concrete in foundations; Soil pressure for structural design; structural design of spread footings, isolated footings, combined footings, strap footing and strip footings. Brief introduction to design of subgrade using CBR methods. Determination of soil modulus.	**9**
II	Introduction to Pile foundation, types; Estimation of pile capacity of single pile; Calculation of settlement for single piles by elastic method. Estimation of pile capacity of group piles; Spacing criteria; efficiency of group piles. Stress on underlying soil strata, structural design of pile foundation and its components – pile cap, pile shoes, pile to pile cap connection. Introduction to Under-reamed pile foundation, Piled Raft Foundation – Advantages and necessity Pile Load Test, interpretation of values and field application.	**9**
III	Introduction and types; natural slopes and engineered slopes; slope failure – types, factors; Concept of slope stability, factors to be considered for analysis - site topography, ground water, seismicity, effect of ground water. Infinite slope analysis in dry sand, c-φ soil with seepage; Planar surface analysis, Circular surface analysis – friction circle method, method of slices, Limit equilibrium method Introduction to Geotechnical Forensic Investigation of Slope Failure, measures to prevent slope failure.	**9**

IV	Introduction – need; Types of insitu densification – vibrofloataion, compaction pile, vibro-compaction piles, dynamic compaction Types of drains, design of vertical drains, construction techniques. Grouting techniques, types, desirable characteristics, properties of treated ground; Brief introduction to Soil stabilization on various soil types, geosynthetics and soil reinforcement. Introduction to stone columns and encased stone columns	**9**
V	Exploration and Field Investigation Principles of exploration, planning of investigation programmes, preliminary investigation, methods of exploration, geophysical methods, sampling and samplers; Standard Penetration Test, corrections, Correlation of SPT value with Atterberg's limit, shear strength and relative density. Brief introduction to SCPT, DCPT, Pressure meter and Plate Load Test, Correlations. Laboratory Testing of samples procured from site investigation; Site investigation report writing;	**9**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE166C	Design of Infrastructure Services	IEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

Goal of this course is to expose the students to the analysis and design of retaining structures and bridges.

ii) COURSE OUTCOMES:

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

CO1	Apply IRC standards for the design of retaining walls, culverts, bridges, substructure and foundation.	Apply
CO2	Assess the hydraulic and clearance parameters for bridges.	Evaluate
CO3	Apply 2D frame analysis and grillage analysis for the analysis and design of RCC box culverts and girder bridges.	Apply
CO4	Examine the effect of soil structure interaction, construction sequences and secondary effects on bridges.	Analyze
CO5	Estimate the bearing capacity of shallow and deep foundations resting on different types of soil.	Evaluate
CO6	Develop a program to perform the analysis and design of retaining walls as per IRC provisions.	Apply

Note: CO3 and CO6 may be assessed through project work.

iii) SYLLABUS

Analysis and design of retaining wall, hydraulic calculation for bridges, analysis and design of sub structure, Design of RCC box type structures based on 2D frame analysis, Grillage analysis and design of girder bridges, Introduction to continuous and integral bridges, Seismic design and detailing, safe bearing capacity calculation, design principle of retaining structures.

iv) REFERENCES:

1) Mosley, B., Reinforced concrete design, Red Globe Press, 7th edition, 2012.

2) Surana, C.S. and Agrawal, R., Grillage Analogy in Bridge Deck Analysis, Narosa Publishing House, 2001.
3) Hambly, E. C., Bridge deck behaviour, Taylor and Francis Group, 2nd edition, 2019.
4) Bowles, J. E., Foundation Analysis and Design, McGraw-Hill Education, 5th edition, 2001.
5) IRC:5-2015, Standard Specifications and Code of Practices for Road Bridges – Section-I General Features of Design, Indian Roads Congress, New Delhi, 2015.
6) IRC SP 13:2004, Guidelines for The Design of Small Bridges and Culverts, Indian Roads Congress, New Delhi, 2004.
7) IRC 78:2014, Standard Specifications and Code of Practice for Road Bridges, Section- VII Foundations and Substructures, Indian Roads Congress, New Delhi, 2014.
8) IRC 112:2020, Code of Practice for Concrete Road Bridges, Indian Roads Congress, New Delhi, 2020.
9) IRC 6:2017, Standard Specifications and Code of Practice for Road Bridges, Section-II, Loads and Load Combinations, Indian Roads Congress, New Delhi, 2017.
10) IRC: SP:116-2018, Guidelines for Design and Installation of Gabion Structures, Indian Roads Congress, New Delhi, 2018.
11) IRC: SP: 66-2016, Guidelines for Design of Continuous Bridges, Indian Roads Congress, New Delhi, 2016.
12) IRC: SP: 102-2014, Guidelines for Design and Construction of Reinforced Soil Walls, Indian Roads Congress, New Delhi, 2014
13) IRC: SP:115-2018, Guidelines for Design of Integral Bridges, Indian Roads Congress, New Delhi, 2018
14) Flood reports, Central Water Commission, Government of India.

iv) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to behavior of retaining wall, loads acting on retaining walls as per IRC provisions, analysis and design of retaining wall, stress check and check for crack width as per IRC standards. Developing excel worksheet for the analysis and design of retaining walls.	**9**

II	Hydraulic calculation of bridges as per IRC, discharge calculation using catchment area method, area velocity method, hand synthetic unit hydrograph method; Afflux and scour depth calculation	**9**
III	Analysis and design of RCC box culverts and girder bridges based on 2D frame analysis and grillage using any software package. Soil structure interaction, construction sequences, secondary effects due to creep and shrinkage, temperature effects. Eigen stresses due to non-linear temperature distribution over the section. Introduction to continuous and integral bridges	**9**
IV	Analysis and design of substructure and foundation – abutments, pier, open foundation and pile foundation. Developing excel worksheet for the plotting the interaction curve and determining the moment of resistance of circular and rectangular columns.	**9**
V	Introduction to seismic design and ductile detailing of substructure and foundations. Safe bearing capacity calculation for open foundation resting on sandy soil and clayey soil. Pile capacity calculation – end bearing, friction pile. Design principles for retaining structures such as reinforced earth wall, gabion wall, soil nailing.	**9**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE166D	Advanced Finite Element Methods	IEC	3	0	0	3	2026

i) COURSE OBJECTIVES:

To expose the students to apply Finite Element (FE) Modelling knowledge to real life structural engineering applications, predicting behaviour of structural elements and implementing computational facilities and FE formulation to industry and research.

ii) COURSE OUTCOMES:

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

CO1	Identify advanced FEM and application of such knowledge to real life Structural Engineering applications.	Apply
CO2	Examine behaviour of plates and shells through FE modeling and analysis.	Analyse
CO3	Examine dynamic behaviour of different elements through FE modeling and analysis	Analyse
CO4	Examine buckling behaviour of different elements through FE modeling and analysis	Analyse
CO5	Solve for errors, elemental mapping and its integration, eigen values and vectors in FE modeling.	Apply
CO6	Apply the concept of FEM to non-linear problems and fracture mechanics	Apply

iii) SYLLABUS

Review of Finite Element Method - Two dimensional Finite Element Analysis – introduction, Application of three dimensional equations for two dimensional analysis – Axisymmetric elements and its applications - Finite Element Analysis of Plates and Shells

- Dynamic Analysis using Finite Element Method - Buckling analysis - Error analysis in Finite Element Method - Numerical Integration - Eigenvalue and vectors in FEM - Introduction to non-linear FE Modelling and FEM in fracture mechanics.

iv) REFERENCES:

1. A textbook of finite element analysis formulation and programming by D K Maharaj, Dreamtech Press (1 January 2019)
2. Introduction to finite element method by J N Reddy, McGraw-Hill Education, Fourth edition, 2019
3. Fundamentals Of Finite Element Analysis by David V. Hutton Publisher: Tata Mcgraw Hill Education Private Limited, Paperback, 1st July 2017
4. Finite Element Analysis Theory and Application with ANSYS by Saeed Moaveni Publisher: Pearson, third edition (2011)
5. Finite element analysis: Theory and programming by C Krishnamoorthy, Second edition (2001) Tata McGraw Hill Education

v) COURSE PLAN

Module	Contents	No. of hours
I	Review of Finite Element Method. Two dimensional Finite Element Analysis: Introduction, Application of three dimensional equations for two dimensional analysis. Axisymmetric/solid of revolution elements - Stiffness matrix derivation, Applications of axisymmetric elements - Solution of pressure vessel.	**9**
II	Finite Element Analysis of Plates and Shells: Introduction, Review of plate theories, Kirchhoff plate elements and Mindlin plate elements, Formulation of triangular and rectangular elements for plate bending analysis. Introduction to analysis of shells, General three and four node elements, Curved isoperimetric elements.	**10**
III	Dynamic Analysis using Finite Element Method: Introduction, Governing Equations, Mass matrices - lumped, consistent and coupled damping, Free vibration analysis of spring mass system - a bar and a beam, Modal participation and effective mass computation, Forced vibration - Harmonic response analysis.	**10**
IV	Buckling analysis - Bifurcation buckling, Stress stiffness matrix for a bar and a beam, Calculation of buckling loads. Error analysis in Finite Element Method - Sources of error, Discretisation of error, Mesh Revision Methods	**8**

	Brief description to numerical integration - One and two dimensional integration	
V	Eigen values and eigen vectors - General eigen value problems, Solution algorithms Introduction to non-linear finite element method, Direct substitution method and Newton-Raphson method Finite element method in fracture mechanics.	**8**
	Total hours	**45**

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RESEARCH METHODOLOGY & IPR (MCC)

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26AC061A	Research Methodology & IPR	AC	2	0	0	0	2026

i) COURSE OBJECTIVES:

This course is intended to prepare the M. Tech students to carry out their dissertation/ research project work effectively, with a research bias. The student will be able to formulate a viable research problem, do a critical analysis of publications in the area of research, and identify a research method suitable for the work. The student will achieve the capability to write a technical paper based on his/her dissertation/ research project

ii) COURSE OUTCOMES:

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

CO1	Explain research ethics, Citation, Impact factor and Plagiarism	Apply
CO2	Formulate a research problem, make a suitable research design, and identify the data collection methods	Apply
CO3	Analyse the collected data	Analyse
CO4	Explain the role of IPR and Patent law in fostering research work, leading to creation of improved products, thus supporting economic growth and social benefits	Apply
CO5	Develop a technical paper for publication	Apply

iii) SYLLABUS:

Introduction to Research Methodology- motivation for research, types of research, ethical issues. Identifying a research area and collecting related literature. Research problem- scope-objectives, literature review, identifying research gaps, and formulate the research problem. Research design and methods, data collection and analysis.Copy right – royalty - IPR and patent law.Process of patenting and development, Procedure for grant of patents.Copy left- open access, citation, plagiarism, iImpact factor.Writing a technical paper.

iv) REFERENCES:

1) Stuart Melville and Wayne Goddard, *Research methodology: an introduction for science & engineering students.*
2) Ranjit Kumar, 2nd Edition, *Research Methodology: A Step by Step Guide for beginners*.
3) Ramappa T*., Intellectual Property Rights Under WTO*, S. Chand, 2008.
4) Robert P. Merges, Peter S. Menell, Mark A. Lemley, *Intellectual Property in New Technological Age*, 2016.

5) Mayall, *Industrial Design*, McGraw Hill, 1992. Niebel, "Product Design", McGraw Hill, 1974.

v) Course Plan:

Module	Contents	Hours
I	**Introduction to Research Methodology:** Motivation towards research, Types of research. Professional ethics in research: Ethical issues, ethical committees. Identification of major conferences and important journals in a chosen area of interest. Collection of at least 10 published papers on a research problem in the chosen area.	**6**
II	**Defining and formulating the research problem:** Literature Survey, Analysing the collected papers to understand how the authors haveidentified the research gaps, arrived at their objectives, and formulated their research problem. Understanding how their research work is different from the previous works in the chosen area.	**6**
III	**Research design and methods**: Analyzing the collected papers to understand how the authors have formulated the research methods, both analytical methods and experimental methods. Data Collection and analysis: Analyzing the collected papers to understand the methods of data collection, data processing, analysis strategies, and tools used for analyzing the data.	**6**
IV	**Copy right** - royalty - Intellectual property rights and patent law – Process of Patenting and Development, Procedure for grant of patents. **Reproduction of published material:** Copy left- Open access, Citation and acknowledgement. Plagiarism, Impact factor.	**6**
V	**Technical writing** - Structure and components of a typical technical paper, abstract and conclusion, illustrations and tables, bibliography, referencing and footnotes. Writing a technical paper – based on the identified research problem, and using the collected papers, Literature survey, Problem formulation, and Research design, and a hypothetical result.	**6**
	Total hours	**30**

LABORATORY COURSE (PCC)

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE169A	Structural Engineering and Design Lab	PCC	0	0	3	2	2026

i) COURSE OBJECTIVES:

The goal of this course is to familiarize the students with experimental evaluation of properties of materials used in concrete and to study the behaviour of concrete members, steel reinforcements and GFRP bars. The students will be exposed to the instruments for measurement of strain, deflection, operations of UTM, hydraulic loading systems, force measuring devices etc. The course also aims to familiarize the students with software packages for analysis, design and detailing of reinforced concrete structures.

ii) COURSE OUTCOMES:

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

CO 1	Decide the suitability of materials used for preparing a concrete mix.	Evaluate
CO 2	Apply the IS method of mix design to develop a concrete mix.	Apply
CO 3	Evaluate the hardened properties and quality of the developed concrete mix.	Evaluate
CO 4	Assess the modes of failure and bond strength between concrete and reinforcement bars (steel and GFRP).	Evaluate
CO 5	Assess the failure modes and behaviour of reinforced concrete and prestressed concrete members.	Evaluate
CO 6	Apply software tools in the analysis and design of structural elements and framed structures subjected to gravity loads.	Apply

iii) SYLLABUS:

- Design of concrete mix – 4 sessions
- Hardened property of concrete – 1 session
- Test on reinforcement bars – 1 session
- Bond strength test – 1 session
- Test on RC members – 3 sessions
- Design of RCC elements (software) – 1 session
- Analysis of RCC structures (software) – 4 sessions

iv) REFERENCES:

1) Relevant IS codes (IS 10262: 2019, IS 1489 (Part 1): 2015, IS 383: 2016, IS 2386 (Part III): 1963, IS 516 – 1959, IS 456-2000 (Reaffirmed 2005), IS 2770 (Part I): 1967 (Reaffirmed 2007), Bureau of Indian Standards, New Delhi.

2) ACI Code 440.11-22 Requirements for Structural Concrete Reinforced with Glass Fiber-Reinforced Polymer (GFRP) Bars, An ACI Standard.
3) Reference Manual of the Relevant Software.

v) COURSE PLAN

Module	Contents	No. of hours
I	Develop a concrete mix which is suitable for structural applications a) Test on materials b) Mix design c) Fresh property d) Test for compressive strength	**8**
II	Evaluate the tensile and flexural strength of developed mix and relate it with the compressive strength a) Test for flexural strength b) Test for split tensile strength c) Test for modulus of elasticity	**6**
III	Determine the modes of failure and bond strength between concrete and reinforcement bars a) Test on steel reinforcements b) Test on GFRP bars	**4**
IV	Study the modes of failure and behaviour of reinforced concrete members prepared using the developed mix a) Test on reinforced concrete beam b) Test on prestressed concrete beam c) Test on reinforced concrete column d) Test on reinforced concrete beam for torsion(demo) e) Test on beam-column joint (demo)	**10**
V	Analysis and design of RCC elements with different support conditions using any software package a) Continuous Beams b) Rigid Joint Frames c) Pin Joint Frames	**9**
VI	Analysis and design of multistoreyed buildings using any software package	**8**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26CE169B	Structural Dynamics and FEM Lab	LBC	0	0	3	2	2026

i. COURSE OBJECTIVES:

Goal of this course is to study the dynamic response of structures and to understand the concept of amplification, liquefaction and soil structure interaction of structures. The course is also intended to familiarize the students with the various finite element software packages available for structural applications.

ii. COURSE OUTCOMES:

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

CO 1	Investigate the dynamic response of structures subjected to harmonic and non-harmonic base motion.	Apply
CO 2	Demonstrate the vibration of single and two span beams, vertical vibration effects, vibration of isolation system and vibration absorber.	Understand
CO 3	Analyse the structures using FE tools	Analyse
CO 4	Make use of MATLAB for solving matrix operations	Apply

iii. SYLLABUS

- Dynamics of a single storied building frame with planar asymmetry subjected to harmonic base motion
- Dynamics of a three storied building frame with and without planar asymmetry subjected to periodic (non-harmonic) base motion
- Vibration isolation of a secondary system
- Dynamics of a vibration absorber
- Dynamics of a four storied building frame with and without an open ground floor Dynamics of a single and two span beams
- Earthquake induced waves in rectangular water tanks, Dynamics of freestanding rigid bodies under base motion, Seismic wave amplification, liquefaction and soil structure interaction (Demonstration only)
- Introduction to finite element software packages and Analysis of Truss

- Analysis of Rectangular Plate with Hole
- Analysis of Cantilever Beam
- Analysis of Continuous Beam
- Analysis of Frame
- Natural Frequency of Frame
- Ground Excitation of Structure
- Introduction to MATLAB and study of basic matrix operations using MATLAB

iv. REFERENCES

1. Mario, Paz, *Structural Dynamics – Theory and Computation*, CBS Publishers and Distributors, 2004.
2. Mukhopadhyay, M., *Structural Dynamics - Vibrations and Systems*, Ane Books, 2nd edition, 2008.
3. Anil, K. Chopra, *Dynamics of Structures- Theory and Application to Earthquake Engineering*, Pearson Education, 1st edition, 2001.
4. IS 1893 (Part 1): 2016, *Criteria for Earthquake Resistant Design of Structures*, Bureau of Indian Standards, New Delhi, 2016.
5. Reference manual of the relevant software.

v. COURSE PLAN

Module	Contents	No. of hours
I	Dynamics of a single storied building frame with planar asymmetry subjected to harmonic base motion	**3**
II	Dynamics of a three storied building frame with and without planar asymmetry subjected to periodic (non-harmonic) base motion	**3**
III	Vibration isolation of a secondary system (Demonstration only)	**3**
IV	Dynamics of a vibration absorber (Demonstration only)	**3**
V	Dynamics of a four storied building frame with and without an open ground floor	**3**
VI	Dynamics of a single and two span beams (Demonstration only)	**3**

VII	• Earthquake induced waves in rectangular water tanks (Demonstration only) • Dynamics of free standing rigid bodies under base motion (Demonstration only). • Seismic wave amplification, liquefaction and soil structure interaction (Demonstration only)	**3**
VIII	Introduction to finite element software packages and Analysis of Truss	**3**
IX	Analysis of Cantilever Beam	**3**
X	Analysis of Continuous Beam	**3**
XI	Analysis of Frame	**3**
XII	Natural Frequency of Frame	**3**
XIII	Analysis of Rectangular Plate and Rectangular Plate with a Hole	**3**
XIV	Ground Excitation of Structure	**3**
XV	Introduction to MATLAB and study of basic matrix operations using MATLAB	**3**
	Total hours	**45**

ASSESSMENT PATTERN
(2026 SCHEME)

Assessment Pattern

a) Program Core Course/ Program Core Course with practical component

A PCC/ PCCP is evaluated out of 100 marks; 50 marks for Continuous internal assessment (CIA) and 50 marks for End semester evaluation (ESE).
Evaluation shall include application, analysis, and design based questions for both CIA and ESE.

Continuous Internal Assessment (CIA): 50 marks

Micro project/Laboratory/ Course based project: 30 marks

Course based task/ Seminar/Quiz: 10 marks

Continuous Assessment Test (CAT), 1 No: 10 marks
(CAT shall include minimum 60% of the syllabus)

Micro project/ Course based project shall be done individually. Group projects are not permitted.

End Semester Examination (ESE): 50 marks

ESE will be conducted by the Controller of Examinations (CoE). Duration of the examination shall be 180 minutes.

The question paper will contain 7 questions with minimum one question from each module, having 10 marks for each question. A question can have sub parts. Students shall answer any five questions.

The questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, overall achievement and maturity of the students in a course, through questions relating to theoretical/ practical knowledge, derivations, problem solving and quantitative evaluation.

b) Program Elective Course/ Program Elective Course with practical component

A Program Elective Course conducted as a theory course along with its related laboratory experiments comes under the course type PECP. A PEC/ PECP is evaluated out of 100 marks; 50 marks for CIA and 50 marks for ESE.
Evaluation shall include application, analysis, and design based questions for both CIA and ESE.

Continuous Internal Assessment: 50 marks

Preparing a review article based on peer reviewed original publications
(Minimum 10 publications shall be referred)/ Micro project/Laboratory : 30 marks

Course based task/ Seminar/ Data collection and interpretation: 10 marks

Continuous Assessment Test (CAT), 1 No: 10 marks
(CAT shall include minimum 60% of the syllabus)

End Semester Examination: 50 marks
The ESE will be conducted by the CoE. Duration of the examination shall be 180 minutes.

The question paper will contain 7 questions with minimum one question from each module, having 10 marks for each question. A question can have two or more sub parts. Students shall answer any five questions.

The questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, testing of overall achievement and maturity of the students in a course, through questions relating to theoretical/ practical knowledge, derivations, problem solving and quantitative evaluation.

c) Audit Course (Research Methodology and IPR)

An audit course is evaluated out of 100 marks; 50 marks for CIA and 50 marks for ESE.

Continuous Internal Evaluation: 50 marks

Course based task:	20 marks
Seminar/Quiz:	20 marks
Continuous assessment Test (CAT), 1 No:	10 marks

(CAT shall include minimum 60% of the syllabus)

End Semester Examination: 50 marks
The ESE will be conducted by the CoE. Duration of the examination shall be 180 minutes.

The question paper will contain 7 questions with minimum one question from each module, having 10 marks for each question. Students shall answer any five questions.

d) Internship

Internships are educational and career development opportunities, providing practical experience in a field or discipline. They are structured, short-term, supervised placements often focused around particular tasks or projects with defined timescales. A student has the opportunity to do internship for one semester either in M3 or in M4. Such students will carry out a Project work in the other semester.

A student shall carry out the Internship at an Industry/ Research Organization or at another institute of higher learning and repute (Academia). The students must select the organization for doing Internship on their own, with prior approval from the respective PG Programme coordinator. Every student shall be assigned a Faculty supervisor at the beginning of his/her Internship. The training shall be related to their specialization. The internship must be carried out for duration of four to five months, during the third semester or fourth semester. On completion of the Internship course, the student is expected to be able to develop skills in facing and solving the problems experienced in the related field.

Types of Internships

- Industry Internship with/ without Stipend
- Government / PSU Internship (BARC/ Railway/ ISRO etc.)
- Internship with prominent education/ Research Institutes
- Internship with Incubation centers/ Start-ups

Guidelines

- The duration of internship must be for a minimum of four months and a maximum of five months.
- Students can take mini projects, assignments, case studies by discussing it with concerned authority from industry and can work on it during internship.
- All students should compulsorily follow the rules and regulations of the industry.
- Every student should take prior permissions from concerned industrial authority if they want to use any drawings, photographs or any other document from industry.
- Student should follow all ethical practices and Standard Operating Procedure (SOP) of the industry.
- Students must take necessary health and safety precautions as laid by the industry.
- Student should contact his /her Guide/Supervisor from the College on a weekly basis to communicate the progress.
- Each student has to maintain a diary/log book
- After completion of internship, students are required to submit
  - ✓ Report of work done
  - ✓ Copy of Internship certificate
  - ✓ Feedback from internship mentor in the place of internship
  - ✓ Proof of stipend (in case of paid internship).

Evaluation of Internship

Internship will be evaluated out of 100 marks for CIA.

Student's diary/ Daily Log:	25 Marks
Evaluation done by the Industry:	25 Marks
Internship Report:	25 Marks
Comprehensive Viva Voce:	25 Marks

Student's Diary/ Daily Log:

The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches and drawings related to the observations made by the students. Student's diary must be signed each day by the supervisor/ in charge of the section where the student has been working.

Format of Student's Diary

Name of the Organization/Section:

Name and Address of the Section Head:

Name and Address of the Supervisor:

Name and address of the student:

Internship Duration: From .... To ....

Brief description about the nature of internship:

Day	Brief write up about the Activities carried out: Such as design, sketches, result observed, issues identified, data recorded, etc.
1	
2	
3	

Signature of Industry supervisor   Signature of Head/ HR Manager

Office Seal

Format of Attendance Sheet

Name of the Organization/ Section:

Name and Address of the Section Head:

Name and Address of the Supervisor:

Name and address of the student:

Internship Duration: From .... To ....

Month & Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	…

Month & Year																			
Month & Year																			

Signature of Industry supervisor Signature of Head/ HR Manager

Office Seal

Note:

- Student's Diary shall be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.
- Attendance Sheet should remain affixed in daily training diary. Do not remove or tear it off.
- Student shall sign in the attendance column. Do not mark 'P'.
- Holidays should be marked in red ink in the attendance column. An absence should be marked as 'A' in red ink.

Student's diary will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary
- Adequacy and quality of information recorded
- Drawings, design, sketches and data recorded
- Thought process and recording techniques used
- Organization of the information.

Format for Evaluation of Intern by industry

Student Name : Date:

Supervisor Name : Designation:

Company/ Organization :

Internship Address:

Dates of Internship: From___________________ To__________________________

Please evaluate intern by indicating the frequency with which you observed the following

parameters:

Parameters/ Marks	Needs improvement (0 – 0.25 marks)	Satisfactory (0.25 – 0.5 marks)	Good (0.75 marks)	Excellent (1 mark)
Behavior				
Performs in a dependable manner				
Cooperates with coworkers and supervisor				
Shows interest in work				
Learns quickly				
Shows initiative				
Produces high quality work				
Accepts responsibility				
Accepts criticism				
Demonstrates organizational skills				
Uses technical knowledge and expertise				
Shows good judgment				
Demonstrates creativity/ originality				
Analyzes problems effectively				
Is self reliant				
Communicates well				
Writes effectively				
Has a professional attitude				
Gives professional appearance				
Is punctual				
Uses time effectively				

Overall performance of student Intern (Please Tick one):

Needs improvement (0.50 marks)
Satisfactory (1.0 mark)
Good (1.5 marks)

Excellent (2.0 marks)

Additional comments, if any (2 marks):

Signature of Industry Supervisor *Signature of Section Head/HR Manager*

Office Seal

Internship Report:

After completion of the internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period and should be submitted to the faculty Supervisor. The student should prepare the final report on the assigned topics. Diary/ daily log will also help to a great extent in writing the report since much of the information has already been incorporated by the student into the diary. The training report should be signed by the Internship supervisor, PG Programme Coordinator and Faculty mentor.

The Internship report will be evaluated on the basis of following criteria:

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.
- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taught in the course

Comprehensive Viva Voce:

Viva Voce will be done by a committee comprising Faculty Supervisor, PG Programme Coordinator, and one faculty member from a sister department. This committee shall evaluate the internship report also.

e) Laboratory Courses

Laboratory courses will have only continuous internal assessment and carries 100 marks. Final assessment shall be done by two examiners; one examiner will be a senior faculty from the same department.

Continuous internal assessment: 100 marks

Performance in regular laboratory experiments: 70 marks

Final assessment/ laboratory test: 30 marks

f) Industry Elective Course

Engineering students frequently aspire to work in areas and domains that are key topics in the industry. There are concerns by recruiters that skill sets of engineering students do not match with the Industry requirements, especially in the field of latest topics.

Industry knowledge aids in the bridge building process between academic institutions and industry. It also aids students in expanding their knowledge and innovating by allowing them to create something new. Core engineering courses provide students with a strong foundation. Evolving technology necessitates new methods and approaches to progress, prosperity, and the inculcation of problem-solving techniques. Industry knowledge will enable the students to deal with any scenario more effectively, thus fulfilling the current industry demands.

Rapid technological advancements have resulted in a massive revival in the way engineering works in the industry. Projects necessitate the integration of knowledge and abilities from a diverse variety of engineering specialties, with the barriers between them becoming increasingly blurred.

Students can choose courses offered by Industries that cover a wide range of highly relevant topics such as artificial intelligence, internet of things, big data, automation, and other relatable courses.

IEC will be evaluated out of 100 marks; 50 marks for CIA and 50 marks for ESE.

Continuous internal assessment: 50 marks

The continuous internal evaluation will be done by the expert in the Industry handling the course, and the coordinator from the college.

Micro project/ Course based project:	30 marks
Course based task/Seminar/Quiz:	10 marks
Continuous assessment Test (CAT), 1 No:	10 marks

(CAT shall include minimum 60% of the syllabus)

End Semester Examination: 50 marks

ESE will be conducted by the CoE using the question paper provided by the industry. Duration of the examination shall be 180 minutes.

The question paper will contain 7 questions with minimum one question from each module, having 10 marks for each question. Students shall answer any five questions. Evaluation of the answer scripts will be done by the expert in the Industry handling the course or the coordinator from the college under the expert’s guidance.

g) Skill/ Ability Enhancement Course

SAEC are online MOOC of 12 weeks duration and shall be considered only if it is conducted by the agencies namely AICTE/ NPTEL/ SWAYAM/ NITTTR. The course should have a proctored/ offline end semester examination. Students can do the SAEC credited in M2 according to their convenience from their first semester, but shall complete it by their second semester. Students can do the SAEC credited in M3 according to their convenience from their first semester, but shall complete it by their third semester. The list of MOOC must be those approved by the concerned Board of studies, from which the students can choose their courses. A course may be approved

only if at least 70% of the course content matches with the area/ stream of study. The course shall not be considered if its content has more than 50% of overlap with a core/ elective course in the concerned discipline or with an open elective.
A credit of 3 and a grade point of 10 will be awarded to all students whoever successfully completes the SAEC credited in M3. Marks/ GPA awarded to the other SAEC shall be used for SGPA/CGPA computation.

h) Mini Project

Mini project helps to strengthen the understanding of the fundamentals through application of theoretical concepts, and to boost their skills and widen the horizon of thinking. The ultimate aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects enhances problem solving skills. The Mini project ensures preparedness of students to undertake their project work in M3 and M4. Students should identify a topic of interest in consultation with his/her PG Programme Coordinator. They should demonstrate the novelty of the project through the results and outputs. This mini project work is assessed in three evaluations, two interim evaluations and a final evaluation. The evaluations will be done by a committee comprising of Project Coordinator, Two senior faculty members in the department, and the student's Project Supervisor

Final evaluation will be conducted only if the Interim project report approved by the student's supervisor is submitted. The Plagiarism level in the report should be ≤ 25%, assessed based on the overall similarity index given by Turnitin licensed to the College.
Mini Project will be evaluated out of 100 marks under CIA, and has no ESE.

a) First evaluation:

Evaluation committee: 20 marks

- Literature Survey: 7 marks
- Objectives and Methodology: 7 marks
- Clarity of presentation: 6 marks

b) Second evaluation:

Evaluation committee: 20 marks

- Design: 7 marks
- Implementation plan: 5 marks
- Expected results: 8 marks

c) Final evaluation: 60 marks

a) Supervisor/ Guide: 10 marks

- Log book and Regularity: 5 marks
- Overall evaluation of the project work: 5 marks

b) Evaluation committee: 50 marks

Demonstration of functionality/ specifications:	20 marks
Level of completion:	5 marks
Clarity of presentation:	5 marks
Knowledge on the project work:	5 marks
Interim project report:	
Technical content:	5 marks
Adequacy of references:	5 marks
Templates followed:	5 marks

i) Project

The students must carry out the project work either in the college or in any CSIR/ industrial R&D organization/ any other reputed Institute which have facilities to carry out project work in the proposed area.

Project work outside the College:

For doing project work outside the college, the following conditions are to be met:

- They have successfully completed the course work prescribed in the approved curriculum up to the second semester.
- The student has to get prior approval from the DLAC.
- Students availing this facility should continue as regular students of the College.
- Facilities required for doing the project work shall be available in the Organization/ Industry. A certificate stating the time period for which the facilities shall be made available to the student, issued by a competent authority from the Organization/ Industry shall be submitted by the student along with the application.
- The student should have an external as well as an internal supervisor. The internal supervisor should belong to the college and the external supervisor shall be a Scientist or Engineer from the Institution/ Industry/ R&D organization with which the student proposes to do his project work. The external supervisor shall be with a minimum Post graduate degree in the related area.
- The MOOC must be completed as per the curriculum requirements:
- The student has to furnish his/her monthly progress as well as attendance report signed by the external supervisor and submit the same to the concerned internal supervisor.
- The external supervisor is to be preferably present during all the stages of evaluation of the project.

Internship leading to Project:

Students who complete their internship in M3 at some reputed organization are allowed to continue their work as project in their fourth semester, after getting approval from the DLAC. Such students shall make a brief presentation regarding the work they propose to carry out before the DLAC for a detailed scrutiny and to resolve its suitability for accepting it as an M.Tech project. Once accepted, they will be permitted to complete their project in that organization (where they have successfully completed their internship) during their fourth semester.

Project as part of Employment:
Students may be permitted to discontinue the programme and take up a job, provided they have completed all the courses till the second semester (FE status students are not permitted) prescribed in the approved curriculum. The project work can be done during a later period either in the organization where they work if it has R & D facility, or in the College. Such students shall submit an application with details (copy of employment offer, and the plan of completion of their project) to the Dean (PGSR) through the HoD. When the student plans to do the project work in the organization with R & D facility where they are employed, they shall submit a separate application with the following details:

- Name of R & D Organization/Industry
- Name and designation of an external supervisor from the proposed organization/ industry (a scientist or engineer with a minimum post graduate degree in the related area), along with his profile, and consent letter.
- Name and designation of a faculty member of the College as internal supervisor, and his/her consent letter.
- Letter from the competent authority from the Organization/ Industry granting permission to do the project work.
- Details of the proposed project work along with the work plan for completion of the project.

DLAC will scrutinize the proposal and forward to CLAC for approval.
When a student does his project work along with the job in the organization (with R & D facility) where they are employed, the project work shall be completed in four semesters (two semesters of dissertation work along with the job may be considered as equivalent to one semester of dissertation work at the college). He should complete the M. Tech programme within four years from the date of admission as per the regulation. Extensions may be granted based on requests from the student and recommendation of the supervisors. Method of assessment of the project will be the same as in the case of regular students.

Evaluation of Project (Phase I) in M3
Project (Phase I) will be evaluated out of 100 marks under CIA, and has no ESE. There will be two evaluations (first evaluation and final evaluation). The assessment shall be done by the student's Project Supervisor, and a committee comprising of Project Coordinator, two senior faculty members in the department, and the student's Project Supervisor. Project Coordinator shall enter the marks in the CoE portal.
Final evaluation will be conducted only if the student has submitted the Interim project report approved by the Supervisor, and Plagiarism level in the Interim project report is ≤25%.

1) **First evaluation: 30 marks**

Project Supervisor: 10 marks

i. Progress of work: 5 marks
(Literature Survey, Objectives, Methodology)

ii. Log book and Regularity: 5 marks

Evaluation committee: 20 marks

i. Topic, Objectives: 5 marks

ii. Methodology and Implementation plan
for the work in M3: 10 marks

iii. Clarity in presentation: 5 marks

2) **Final evaluation: 70 marks**

Project Supervisor: 25 marks

i. Progress of work: 15 marks

ii. Log book and Regularity: 5 marks

iii. Interim project report: 5 marks

Evaluation committee: 45 marks

i. Demonstration of work completed: 15 marks

ii. Presentation and Viva voce: 10 marks

iii. Implementation plan of work in M4: 5 marks

iv. Interim project report: 15 marks
Technical content: 10 marks
Adequacy of references and
Templates followed: 5 marks

Evaluation of Project (Phase II) in M4/ Project in M3 or M4

The evaluation of Project (Phase II) has CIA for 100 marks, and ESE for 100 marks. The continuous internal assessment is done under two evaluations (first evaluation and final evaluation), by the student's Project Supervisor, and a committee comprising of Project Coordinator, two senior faculty members in the department, and the student's Project Supervisor. Project Coordinator shall enter the marks in the CoE portal.

Final evaluation will be conducted only if the student has submitted the project report approved by the Supervisor, and Plagiarism level in the project report is ≤25%.

Continuous internal assessment: 100 marks

1) **First evaluation: 40 marks**

Project Supervisor: 15 marks

i. Progress of work: 10 marks
(Experimentation and results)

ii. Log book and Regularity: 5 marks

Evaluation committee: 25 marks

i. Demonstration of work completed: 15 marks

ii. Presentation and Viva: 10 marks

2) Final evaluation: 60 marks

Project Supervisor: 15 marks

i. Progress of work: 10 marks
(Quality and quantum of work)

ii. Project report: 5 marks

Evaluation committee: 45 marks

i. Demonstration of work completed: 10 marks

ii. Presentation and viva: 10 marks

iii. Project report: 10 marks
Technical content: 5 marks
Adequacy of references: 5 marks

iv. Paper publication: 15 marks
(Published/accepted for publication in a journal/conference)

End semester examination (Viva-voce examination): 100 marks

The ESE will be done by a committee that comprises of the Project Coordinator, an external expert (from industry or research/academic institute), and the student's Project Supervisor

Each department must submit a panel of external experts to Dean (PGSR), as per the academic calendar. The minimum qualification requirement for an external examiner is M.Tech. The number of experts to be submitted is one more than number of students divided by 6 (rounded to the next integer). Honorarium for the external expert will be as fixed by the College.

The Project coordinator will enter the ESE marks in the CoE portal.

Marks Distribution for Viva-voce examination

i. Innovation & originality: 15 marks
(Introduction, Recent and related literature, Scope of the work, Objectives)

ii. Implementation and execution: 20 marks
(Methodology and work plan, Results and discussions, Quality of work done)

iii. Project Documentation: 20 marks

(Introduction, Problem Statement , Literature review, Methodology, Results and discussions, Conclusions, Future work, References)

iv. Presentation and Defense: 40 marks

(Clarity and effectiveness of presentation, Ability to explain the project objectives, Methodology and Findings, Handling questions and providing satisfactory answers)

v. Publication: 5 marks

(Published/accepted for publication in a jour