

23812

M. Tech 2nd Semester Structural Engineering

Examination, May-2026

FEM in Structural Engineering

Paper : 24MTSE22C1

Time allowed : 3 Hours]

[Maximum marks : 100

Note: *Question No. 1 is compulsory. Students have to attempt five questions in total at least one questions from each section. All questions carry equal marks.*

1.
 - (i) Shape Function.
 - (ii) Sub parametric elements?
 - (iii) Constant Strain Triangle (CST).
 - (iv) Eigen value evaluation methods.
 - (v) Inverse Iteration method.
 - (vi) List out the properties of Eigen vectors?

Section-A

2.
 - (i) Explain the procedure for Finite Element Analysis starting from a given differential equation.
 - (ii) Derive the constitutive relation matrices for plane stress and plane strain situations.
3.
 - (i) Explain the principle of minimum potential energy method with an example.
 - (ii) Determine the displacement $u(x)$ using the Rayleigh Ritz method. Assume a displacement field $u(x) = a_0 + a_1x + a_2x^2$. Plot u verses x .

23812-P-4-Q-9 (26)

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Section-B

4. (i) How do you evaluate the shape functions for the Lagrange elements?
 (ii) Find the shape functions of cuboid or brick with 8 nodal points with the help of Lagrange formulae.
5. (i) Explain Hermite shape functions in detail.
 (ii) Find the deflection at the load and the slopes at the ends for the steel shaft shown in Fig. 1. Consider the shaft to be simply supported at bearings A and B. $E = 200 \text{ GPa}$. 12

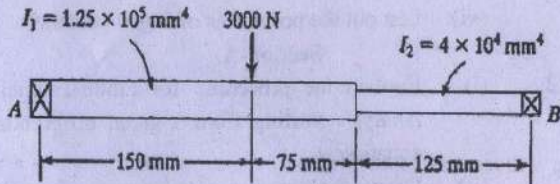


Fig. 1

Section-C

6. (i) What are the isoparametric elements and derive the B matrix for the 4 noded isoparametric quadrilateral element.

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- (ii) For the quadratic, isoparametric triangular element shown in Fig. 2 map the point $\xi = 0.5$ and $\eta = 0.25$ on the parent element to the corresponding point on the distorted element.

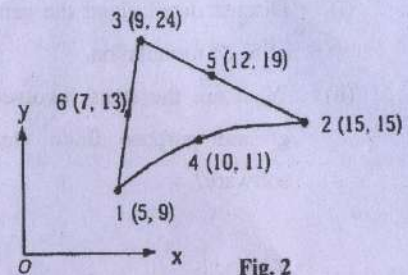


Fig. 2

7. (i) Discuss about Gaussian quadrature in FEM. Explain about interpolation or shape function and polynomial shape function.
 (ii) Explain various axis-symmetric elements. Obtain Generate stiffness matrix for 4 noded Quadrilateral element.

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Section-D

8. Write a short note on the following:

- (i) Plane stress
- (ii) Plate Bending elements
- (iii) Basic theory of plate bending
- (iv) Plane strain analysis

9. (i) Discuss detail about the general procedure of FEM formulation.

- (ii) What are the steps involved and uses of general purpose finite element analysis software?

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M.Tech. (Structural Engineering) 2nd Semester

Examination, May-2026

FEM IN STRUCTURAL ENGINEERING

Paper : 22MTSE22C1

Time allowed : 3 Hours]

[Maximum marks : 100

Note : Attempt five questions in all, selecting one question from each unit. Question No. 1 is compulsory. All questions carry equal marks.

1. Explain the following : 5×4=20
- (a) Potential Energy Principle
 - (b) Direct Stiffness Method
 - (c) Natural coordinate systems
 - (d) Convergence criteria for iso-parametric elements
 - (e) Polynomial Forms

Unit-I

2. Explain the Principle of Minimum Potential Energy and its significance in structural analysis and mechanics of deformable bodies. Discuss how this principle is derived, its physical interpretation and its role in determining equilibrium configurations of elastic systems. 20

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3. Derive the strain-displacement relations for a three-dimensional (3D) elastic body using small deformation theory. Clearly state all assumptions involved. Discuss the physical significance of each term in the strain tensor. 20

Unit-II

4. Explain the concept of the Natural Coordinate System used in finite element methods. Why is it preferred over global coordinates when formulating shape functions and performing numerical integration? Illustrate with a 2D isoparametric quadrilateral element. 20
5. Compare and contrast Lagrange and Serendipity elements used in finite element analysis. Highlight the differences in their shape functions, nodal arrangements, completeness and convergence characteristics. 20

Unit-III

6. Explain the concept of Gaussian Quadrature in numerical integration. Derive the formula for 1D Gauss quadrature with 2-point and 3-point integration. Discuss how the choice of integration points affects the accuracy of the integration. 20

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7. Compute the stiffness matrix for a 1D isoparametric element (linear shape functions). Assume a constant material property E and length L for the element. Use 2-point Gauss quadrature for numerical integration. Show all the steps involved and discuss how the global stiffness matrix is assembled from the element stiffness matrix. 20

Unit-IV

8. Explain the role of the pre-processing and post-processing phase in FEA software. 20
9. Explain the following : 20
- (a) Plane stress and plane strain analysis of rectangular Element.
 - (b) Analysis of framed structures

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M. Tech. Civil (Structural Engineering) 2nd Semester
Examination, May-2026

STRUCTURAL DYNAMICS

Paper : 24MTSE22C2

Time allowed : 3 Hours]

[Maximum marks : 100

Note : Question No. 1 is compulsory. Attempt one question from each section. All questions carry equal marks. Assume missing data, if any, suitably.

8×2.5=20

1. (a) Define damping ratio and its significance in vibration analysis.
- (b) Define the term "Generalized single degree of freedom system".
- (c) Differentiate between model superposition and direct integration methods.
- (d) What is Duhamel's Integral and what type of loading is it used for?
- (e) What is base isolation and how does it improve structural performance?
- (f) Write one advantage and one limitation of the Wilson- θ method.
- (g) State the steps involved in the inverse iteration method for finding natural frequencies.
- (h) Give two examples of machinery that may induce structural vibrations.

23813-P-4-Q-9 (26)

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Section-A

2. (a) What is Fourier analysis? Explain how Fourier series is used to determine the response of an SDOF system subjected to periodic loading. 10
- (b) Discuss the free and forced vibration of an SDOF system with and without damping. Provide governing equations. 10
3. (a) A mass-spring-damper system has a mass of 20 kg, stiffness of 5000 N/m, and a damping coefficient of 50 Ns/m. Determine: 10
- (i) The damping ratio
 - (ii) Natural frequency
 - (iii) Damped natural frequency
 - (iv) Logarithmic decrement
- (b) Write short note on : 10
- (i) Damping
 - (ii) Duhamel's Integral
 - (iii) Natural of Exciting Forces
 - (iv) Mathematical Modeling of Dynamic Systems

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Section-B

4. Describe the Wilson- θ method. Derive the basic expression and explain how this method improves numerical stability for dynamic analysis. 20
5. (a) Explain how the response of a beam with distributed load is computed. 10
- (b) Explain the numerical solution of state-space response using direct integration. 10

Section-C

6. Compare direct integration and modal superposition methods. Highlight the advantages, limitation, and applicability of each method. 20
7. (a) A 2DOF system has masses of 5 kg and 3 kg connected by springs of stiffness 2000 N/m and 800 N/m. formulate the mass and stiffness matrices and calculate the natural frequencies. 10
- (b) Write the general form of an MDOF system. Explain how the mass, damping, and stiffness matrices are constructed and used in time-history analysis. 10

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Section-D

8. (a) Differentiate between elastic and inelastic response spectra. How are they generated, and what is their importance in seismic design? 10
- (b) Write a detailed note on dynamic effects caused by wind loading and moving loads. 10
9. What is base isolation? Explain the working principle of base-isolated structures and how it reduces seismic forces. 20

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M.Tech. 2nd Semester Civil (Structural Engineering)

Examination, May-2026

SOIL STRUCTURE INTERACTION

Paper : 24MTSE22D1

Time allowed : 3 Hours]

[Maximum marks : 100

Note : *Question No. 1 is compulsory. Attempt one question from each section. All questions carry equal marks. Assume missing data, if any, suitably.*

- 1.** (a) Define the limitations of conventional foundation design methods.
- (b) What is relaxation in soil-structure interaction?
- (c) Mention one condition under which non-linear analysis is preferred.
- (d) What is the theory of subgrade reaction?
- (e) What is a raft foundation?
- (f) Define negative skin friction.

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- (g) How is pullout resistance determined?
- (h) Differentiate between single pile and pile group behavior. $8 \times 2.5 = 20$

Section-A

2. (a) Explain the effect of water table on bearing capacity of soil. 10
- (b) Explain the design criterion of foundation is settlement. 10
3. (a) Outline the basic steps in FEM for analyzing foundation behavior. 10
- (b) Discuss the complexities involved in soil-structure interaction analysis. 10

Section-B

4. (a) Describe the significance of stress-strain behavior in stratified soils. 10
- (b) Differentiate between linear and non-linear soil behavior with examples. 10
5. Provide a step-by-step SSI analysis approach for a building on stratified natural deposits. 20

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Section-C

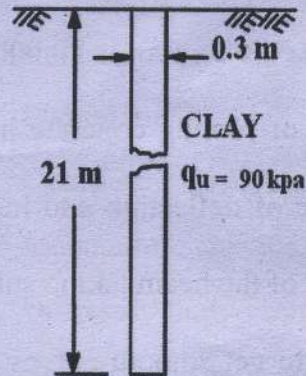
6. (a) A rectangular footing of length 4.0 m, width 2.0 m and depth 400 mm carries a concentrated load of 800KN at centre. The modulus of subgrade reaction of the soil underneath the footing is $20,000 \text{ KN/m}^3$, and the grade of footing concrete is M20. Draw the profile of deflection and moments along the length of the beam taking suitable number of points to get smooth curves. Treat it as a beam on elastic foundation problem. 10
- (b) What are the essential components of a design-oriented foundation analysis program? 10
7. Discuss the preparation and use of software tools for interactive foundation analysis. 20

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[P.T.O.]

Section-D

8. (a) A round pile 30 cm diameter is driven to a depth of 21 m in a deep deposit of clay having an unconfined strength of 90 kN per sq.m. as shown in Figure below. What is the design carrying capacity? 10



- (b) Which type of pile will have the lowest deformation for a particular load? Indicate method of installation and pile type. 10

9. Write short note on : 20

- (i) Anchor Piles
- (ii) Lateral capacity of piles
- (iii) Negative Skin Friction
- (iv) Types of pile foundation

Roll No.

22707

**Foundation Elective 2nd Semester
Examination – May, 2026**

BUILDING MATERIALS

Paper : 22MTSE22F1

Time : Three hours]

[Maximum Marks : 40

Before answering the questions, candidates should ensure that they have been supplied the correct and complete question paper. No complaint in this regard, will be entertained after examination.

Note : Attempt *five* questions in all, selecting *one* question from each Section. Question No. 1 is *compulsory*. All questions carry equal marks.

1. Explain the following terms (any *four*) : $4 \times 2 = 8$
- (i) What is meant by infrastructure development ?
 - (ii) Define lime.
 - (iii) List types of bricks based on quality.
 - (iv) Principle of Water proofing
 - (v) Varnish

SECTION - A

2. Define Civil Engineering. Explain its scope and importance in modern society. 8
3. Define cement. What are the main constituents of cement. List different types of cement. 8

SECTION - B

4. Define stone as a building material. What are the properties of a good building stone ? What is dressing of stone ? 8
5. What are tiles ? Define terracotta. List uses of terracotta. 8

SECTION - C

6. Classify timber into hardwood and softwood. What are defects in timber ? 8
7. Define varnish. What are the uses of varnish ? List types of paints. Compare paint and varnish. 8

SECTION - D

8. What is fire resistance ? Define fireproofing of structures. What are fire-resistant materials ? 8
 9. Explain how dampness affects durability of buildings. Compare damp-proofing and waterproofing. 8
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Roll No.

22709

**Open Elective 2nd Semester
Examination – May, 2026**

STABILIZATION OF SOIL

Paper : 22MTSE22O1

Time : Three hours]

[Maximum Marks : 80

Before answering the questions, candidates should ensure that they have been supplied the correct and complete question paper. No complaint in this regard, will be entertained after examination.

Note : Attempt *five* questions in all, selecting *one* question from each Section. Question No. 1 is *compulsory*. All questions carry equal marks.

1. Describe the following :

- (a) Sand drains and granular piles
- (b) Uses of admixtures
- (c) Necessity of earth reinforcement
- (d) Components of ground anchors

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P. T. O.

SECTION – A

2. (a) What are the objectives of soil stabilization? Explain briefly the selection criteria for the best soil stabilization technique.
- (b) What are the different methods of mechanical stabilization? Describe briefly the Vibro-floatation method in detail.
3. (a) What are the different techniques? Briefly describe ant two techniques in detail.
- (b) Describe the following :
 - (i) Differentiate dynamic compaction and dynamic consolidation
 - (ii) Applications of stone column

SECTION – B

4. (a) What is the necessity of dewatering? Explain in detail the vacuum method of dewatering.
- (b) With the neat sketches, explain the working of "Deep well drainage" method of dewatering.
5. (a) Explain different stages of well point system with neat sketches? Also explain its advantages.

22709-100-(P-4)(Q-9)(26) (2)

- (b) Briefly describe Electrical and thermal methods for dewatering.

SECTION – C

6. (a) What are the granular and chemical admixtures? Describe in detail the chemical stabilization and grouting.
- (b) What is Bituminous stabilization? Explain its advantages.
7. Write a short note on the following :
 - (a) Uses of admixtures
 - (b) Lime column
 - (c) Tar and asphalt used in stabilization
 - (d) Criteria for cement stabilization

SECTION – D

8. (a) What are the types of grouting? Describe in detail the grouting procedure and grout monitoring.
- (b) Explain in detail the construction sequence and methods of installation of soil nailing.

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P. T. O.

9. (a) What are the types and components ground anchors ? Describe its applications.

(b) Describe in detail the reinforced earth and its uses in soil stabilization.

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**M.Tech. 2nd Semester Civil Engg.
(Specialization in Structural Engg.) (Elective-II)**

Examination, May-2026

PRE-STRESSED CONCRETE

Paper : CE-618

Time allowed : 3 Hours]

[Maximum marks : 100

Note : Attempt any five questions. All questions carry equal marks. Assume suitable data if required and state assumptions clearly. Use relevant IS codes where applicable.

1. (a) Explain the different systems of prestressing with neat sketches. 10
(b) Explain the concept of partial prestressing and compare it with full prestressing. 10
2. A post-tensioned bonded prestressed concrete beam of rectangular cross section. 400 mm wide by 500 mm deep, is subjected to a service-load bending moment of 176 kN m, torsional moment of 46.6 kN m and shear force of 76.6 kN. The section has an effective prestressing force determined from service load requirements, of magnitude 500 kN at an eccentricity of 120 mm, provide 5 numbers of 12.5 mm stress-relieved strands of cross-sectional area 467 mm^2 with an ultimate tensile strength of 1820 N/mm^2 . If the cube strength of concrete is 40 N/mm^2 , design suitable longitudinal and transverse reinforcement in the beam using IS:1343-1980. 20

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3. A precast pre-tensioned beam of rectangular section has a breadth of 100 mm and a depth of 200 mm. The beam with an effective span of 5 m, is prestressed by tendons with their centroids coinciding with the bottom kern. The initial force in the tendons is 150 kN. The loss of prestress may be assumed to be 15 percent. The beam is incorporated in a composite T beam by casting a top flange of breadth 400 mm and thickness 40 mm. If the composite beam supports a live load of 8 kN/m^2 , calculate the resultant stresses developed in the composite beam.

20

4. A continuous prestressed concrete beam ABC (AB = BC = 10 m) has a uniform rectangular cross section with a width of 100 mm and depth of 300 mm. The cable carrying an effective prestressing force of 360 kN is parallel to the axis of the beam and located at 100 mm from the soffit.

- Determine the secondary and resultant moment at the central support B.
- If the beam supports an imposed load of 1.5 kN/m , calculate the resultant stress at top and bottom of the beam at B. Assume density of concrete as 24 kN/m^3 .

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- Compare the design method of compressive members using British and IS code. 10
 - Explain the design considerations for shear and torsion in prestressed concrete members. 10

6. Design a non-cylinder prestressed concrete pipe of 600 mm internal diameter to withstand a working hydrostatic pressure of 1.05 N/mm^2 , using a 2.5 mm high tensile wire stressed to 1000 N/mm^2 at transfer. Permissible maximum and minimum stresses in concrete at transfer and service loads are 14 and 0.7 N/mm^2 . The loss ratio is 0.8. Calculate also the test pressure required to produce a tensile stress of 0.7 N/mm^2 in concrete when applied immediately after tensioning and also the winding stress in steel if $E_s = 210 \text{ kN/mm}^2$ and $E_c = 35 \text{ kN/mm}^2$.

20

- Write a short notes on :

- Cable profiles 5
- Jacques Muller's theorem 5
- Analysis of Railway sleepers 5
- Uncracked and cracked prestressed members 5

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[P.T.O.]

8. (a) Explain Guyon's method for end block design. 8

(b) The cross section of a prestressed concrete beam used over a span of 6 m is 100 mm wide and 300 mm deep. The initial stress in the tendons located at a constant eccentricity of 50 mm is 1000 N/mm^2 . The sectional area of the tendons is 100 mm^2 . Find the percentage increase in stress in the wires when the beam supports a live load of 4 kN/m . The density of concrete is 24 kN/m^3 . 12