Please check that this question paper contains 8 questions and 2 printed pages within first ten minutes.

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Program: M.Tech. Structural Engineering
Name of Subject: Finite Element Method in Structural Engineering
Subject Code: MST-102
Paper ID: 16126
Scientific calculator is Allowed

Time Allowed: 03 Hours Maximum Marks: 100

NOTE:
1) Attempt all questions
2) Any missing data may be assumed appropriately

Part-A (4 @ 5 = 20 Marks)

Q1. Give complete steps of Finite Element Analysis applied to stress analysis problem.

Q2. How discretisation of a structure should be done to get acceptable results and with minimum requirements of the resources?

Q3. What are the numerical integration techniques used in the Finite Element Method?

Q4. How Finite Element Analysis software is evaluated to use in a design office by a Structural Engineer?

Part-B (4 @ 20 = 80 Marks)

Q5. Derive stiffness matrix for a truss element of length "L", which makes an angle with x-axis, having "A" area of X-section and "E" is young's modulus of elasticity.

Or

Analysis the 3 member truss ABC which forms an equilateral triangle, using Finite Element Method. Member BC is horizontal, B is pinned support while C is having roller support. Joint A is above BC, and is subjected to horizontal load of P in the right direction. All three members have length "L", "A" area of X-section and "E" is young's modulus of elasticity

Q6. Assume you have conducted a Finite Element Analysis using a commercial FEA software for a structural component. Describe the post-processing steps involved in extracting meaningful information from the results. Discuss how to interpret stress contours, displacement plots, and other relevant output data. Highlight the significance of convergence checks and sensitivity analyses in the post-processing stage. Provide insights into how the results obtained can be utilised for design decisions.

Or

P.T.O.

Discuss the isoparametric formulation of a quadrilateral element in the context of solid mechanics. Explain the advantages of using isoparametric elements and the concept of mapping in isoparametric coordinates. Derive the shape functions and explain how they are used in the computation of strains and stresses.

Q7. Analyse a 2-D structural frame for nodal displacements using matrix stiffness method. Portal frame is having height of 4 m, and bay length of 5m. Take moment of inertia of horizontal member of 2 times that of moment of inertia of vertical members. The supports A and D (at foundation level) are considered as fixed. The upper B joint of left column AB and beam BC has horizontal force of 150 kN acting towards right.

Or

Demonstrate the process of modelling and analysing the beam within the Finite Element Method with the help of a simply supported beam subjected to a uniform distributed load. Include the establishment of boundary conditions, solution for nodal displacements. Discuss the interpretation of results and the accuracy of the method in with respect to beam behaviour.

Q8. Explain the importance of interpolation functions in the Finite Element Method. Discuss the requirements for compatibility and completeness of interpolation functions. Provide examples of interpolation functions commonly used in structural analysis, and explain how they ensure accurate representation of the physical behavior of structures.

Or

Discuss the role of polynomial forms in the Method of Weighted Residuals. Explain how the choice of polynomial forms affects the accuracy and convergence of the solution. Provide insights into the advantages and limitations of using higher-order polynomial forms in the context of the Galerkin method.

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