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B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Sixth Semester

Mechanical Engineering

ME 2353/ME 63/10122 ME 605 — FINITE ELEMENT ANALYSIS

(Common to Automobile Engineering)

(Regulation 2008/2010)

Time : Three hours | Maximum : 100 marks

Any missing data may be suitably assumed.

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Distinguish between the Rayleigh-Ritz method and finite element method.
2. What do you understand by the term "piecewise continuous function"?
3. Illustrate element connectivity information considering beam elements.
4. Mention two advantages of quadratic spar element over linear spar element.
5. What is the salient feature of an isoparametric element? Give an example.
6. Define Jacobian.
7. What is the principle of mode superposition technique?
8. Specify the consistent mass matrix for a beam element.
9. Distinguish between homogenous and non-homogenous boundary conditions.
10. Define the stream function for a one-dimensional incompressible flow.

PART B — (5 × 16 = 80 marks)

11. (a) Develop the weak form and determine the displacement field for a cantilever beam subjected to a uniformly distributed load and a point load acting at the free end.

Or

(b) Consider a plane wall with a uniformly distributed heat source. Obtain the finite element formulation for the above case based on the stationarity of a functional.

12. (a) Derive the stiffness matrix and body force vector for a quadratic spar element.

Or

(b) Analyze the beam shown in Fig. 1 using finite element technique. Determine the rotations at the supports. Given E = 200GPa and $I = 4 \times 10^6$ mm^4.

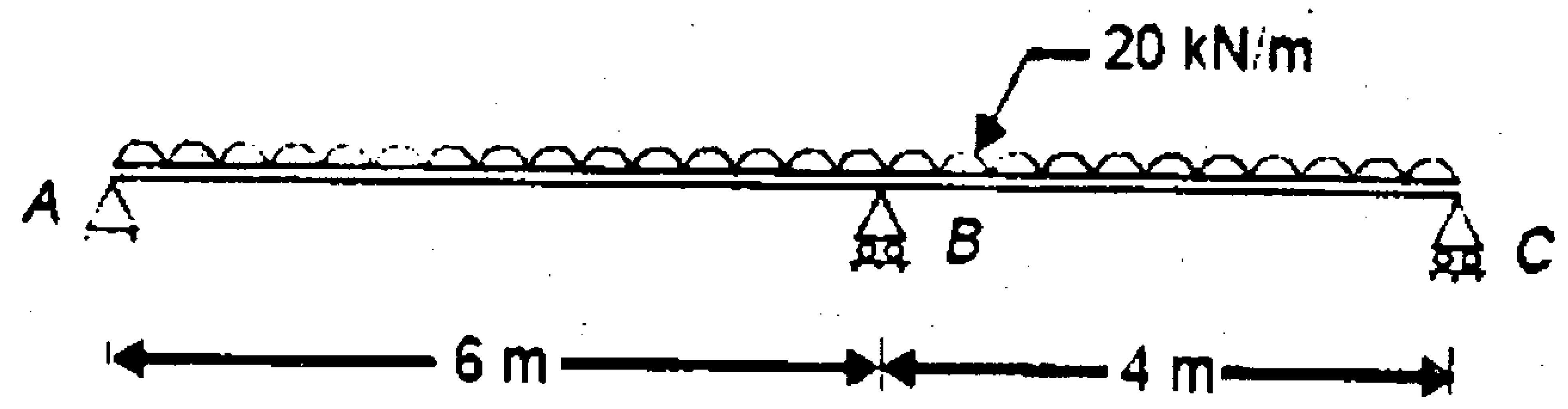

Fig. 1

13. (a) Establish the body force and traction force (uniformly distributed) vector for a lower order quadrilateral element.

Or

(b) (i) Derive the expression for nodal vector in a CST element subjected to pressures P_{x1}, P_{y1} on side 1, P_{x2}, P_{y2} on side 2 and P_{x3}, P_{y3} on side 3 as shown in Fig. 2. (10)

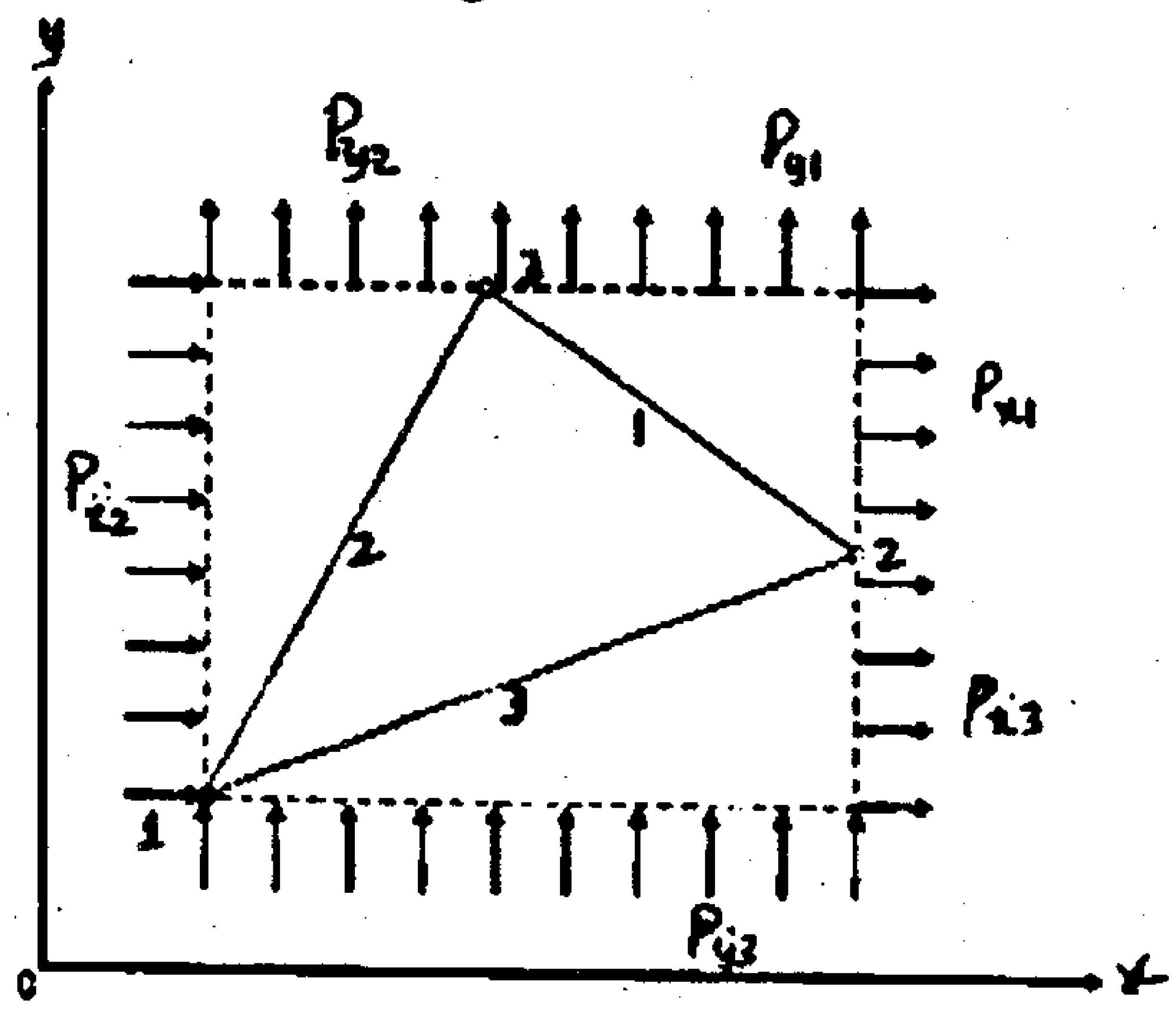

Fig. 2

(ii) Establish any two shape functions corresponding to one corner node and one mid-node for an eight node quadrilateral element. (6)

14. (a) A vertical plate of thickness 40 mm is tapered with widths of 0.15m and 0.075m at top and bottom ends respectively. The plate is fixed at the top end. The length of the plate is 0.8m. Take Young's modulus as 200 GPa and density as 7800 kg/m^3. Model the plate with two spar elements. Determine the natural frequencies of longitudinal vibration and the mode shapes.

Or

(b) Explain the direct integration method using central difference scheme for predicting the transient dynamic response of a structure.

15. (a) Consider a brick wall of thickness 0.3 m, k = 0.7 W/m °C. The inner surface is at 28°C and the outer surface is exposed to cold air at -15°C. The heat transfer coefficient associated with the outside surface is 40 W/m^2 °C. Determine the steady state temperature distribution within the wall and also the heat flux through the wall. Use two 1D elements and obtain the solution.

Or

(b) Establish the finite element equations including force matrices for the analysis of two dimensional steady-state fluid flow through a porous medium using triangular element.