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Question Paper Code : 40839

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Sixth/Seventh Semester

Mechanical Engineering

ME 8692 — FINITE ELEMENT ANALYSIS

(Common to : Automobile Engineering/Manufacturing Engineering/Mechanical Engineering (Sandwich)/Mechanical and Automation Engineering/Production Engineering)

(Regulations 2017)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Mention the steps involved in preprocessing phase in FEA.

2. What is the use of Eigen value problem?

3. Draw the variation of field variable in a higher order bar element.

4. Define mode shape in a structural dynamics problem of bar subjected to Lateral deflection.

5. How do we use area coordinates interaction technique while deriving equations for a LST element?

6. How does torsion of a non-circular shaft differ from torsion of a circular shaft?

7. Can a thin plate loaded only along two axes in a plane without any constraint for deflection be considered as plane stress condition?

8. Mention any one application of axi-symmetric elements.

9. What are Serendipity elements?

10. Justify whether Jacobian matrix is a key matrix in isoparametric formulation.

PART B — (5 × 13 = 65 marks)

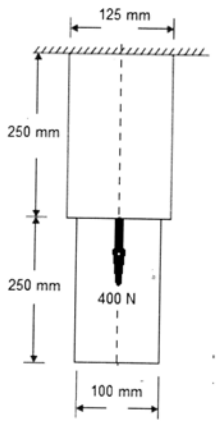
11. (a) (i) Write about historial development of FE method. (5)

(ii) Write note on variational formulation of Boundary value problem with an one dimensional problem of your own. (7)

Or

(b) Solve the following differential equation $\frac{d^2y}{dx^2} + 300x^2 + 20x = 0$, $0 \le x \le 1$, $y(0) = 0$, $y(1) = 0$ by Galerkin method and plot the variation of y as a graph at 0.25 unit intervals from $x = 0$ to $x = 1.0$ unit interval.(13)

12. (a) A stepped thin plate of uniform thickness 20 mm is loaded as shown in the figure. Considering self weight find the displacement at mid span and free end of the plate. Also find the stresses at the two sections of the plate. Take Young's modulus E = 2×10^5 N/mm^2, weight density $\rho = 0.8 \times 10^{-4}$ N/mm^3. (13)

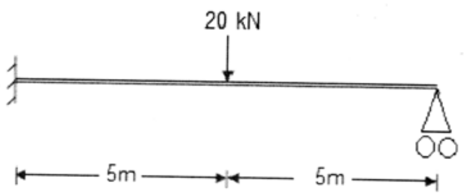


Or

(b) A beam of length 10 m, fixed at one end and supported by roller at the other end carries a 20 kN concentrated load at the certre of the span. By taking Modulus of elasticity of the material as 200 GPa and moment of inertia as 24×10^{-6} m^4 and assuming two elements determine the following (13)

(i) Deflection at the centre of the span.

(ii) Reaction at the supports.

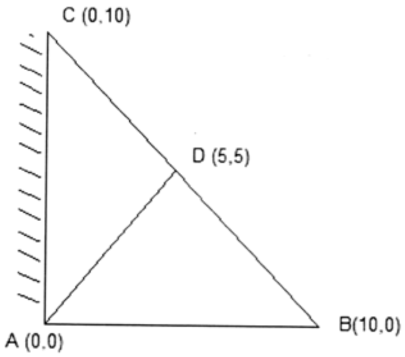


13. (a) Derive the shape functions of a LST element and prove that at any point inside the element the summation of the shape functions is unity. (13)

Or

(b) A shaft has square cross section with 50 mm sides. The rigidity modulus of the shaft is 80 GPa. Shaft length is 1 m. The shaft is fixed at one end and is subjected to a torques of 50 Nm clockwise (viewed from free end) at 0.5 m from fixed end and another torque of 100 Nm counter clockwise (viewed from free end) at the free end. Determine the total angle of twist at the mid span and free end. (13)

14. (a) A steel plate with uniform thickness of 3 mm has coordinates as shown in figure. The end AC is fixed and the corners B and D undergo deflection under plane stress condition. The corner B undergoes deflection of 2 mm to the right 1 mm downward; the corner D undergoes a deflection of 1 mm to the right and 0.25 mm downward. Find the stress and strain in the plate by discretizing into two CST elements. Take $E = 2 \times 10^5$ N/mm^2. (13)



Or

(b) Derive the stress strain relation matrix for an axi-symmetric CST element. (13)

15. (a) A iso-parametric quadrilateral element has it coordinates as follows

A(1,5), B(5,10) C(6,15) and D(0,20).

Determine the Jacobian Matrix at the point Q (2,2). (13)

Or

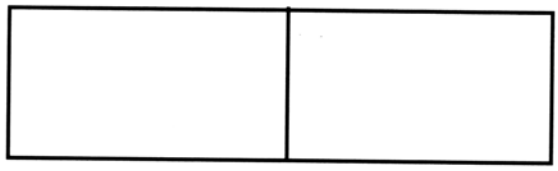
(b) Solve the integral by numerical integration technique using 3 point as well as 2 point formula. Find their error percentages with actual solution

$\int_1^4 \sqrt{x} + 3x dx$. (13)

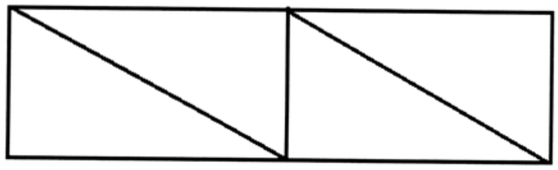
PART C — (1 × 15 = 15 marks)

16. (a) In an engineering application, it is required to analyze a rectangular plate stressed in plane stress condition. It is decided to analyze the plate either by discretizing it into two rectangular elements or as four CST elements as shown in figure.

Which method of discretization will give you a better accuracy of result? Which method will give you computational easiness? Justify your answer with appropriate equations for displacement, strain and stress. (15)



Discretized into two rectangular elements



Discretized into four CST elements

Or

(b) A pressure storage container for a liquid hydrogen storage system is to be analyzed. Compare the relative easiness and difficulties of analyzing it by using a 3D element and a shell element. Also suggest type of FE analysis to be adopted with valid justification. (15)