16/05/19

B.E / B.TECH (FULL TIME) DEGREE END SEMESTER EXAMINATIONS, APR-MAY 2019
VI SEMESTER (REGULATION 2012)
(COMMON TO MECH, MANUF)
ME 8752 – FINITE ELEMENT ANALYSIS

Time: 3 Hours | Max. Marks: 100

PART-A (10 x 2 = 20 Marks)

1. List the various Weighted Residual methods and explain the concept behind these techniques
2. What are shape functions? List their properties
3. Differentiate between Essential and Natural Boundary conditions with suitable examples
4. Derive M_{33} term of the mass matrix for a beam element
5. What does $\iint N_i\, dx\, dy$ yield for a constant strain triangular element?.
6. Derive the shape function for the corner node of a quadratic quadrilateral Lagrangean element.
7. Derive the constitutive matrix for plane strain element.
8. Give the B (Strain displacement) matrix for a linear quadrilateral element.
9. What are natural coordinate systems? What are the advantages of the same?
10. Derive the shape functions of an ID linear iso parametric element.

PART-B (5 x 16 = 80 Marks)

11. For the tapered steel bar shown in Fig 11, subjected to its own self weight, determine the deflection at the free end using any weighted residual technique or the Ritz technique. Assume E=200GPa and γ=77kN/m^2

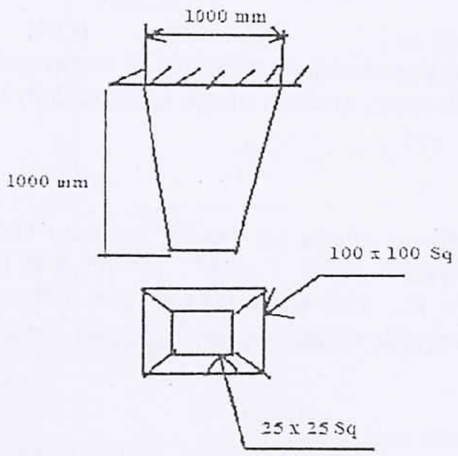


Fig 11

12. a) Determine using any numerical technique, the temperature distribution along a circular fin of length 8cm and radius 2cm. The fin is attached to a boiler whose wall temperature is 200 °C and the free end is insulated. Assume convection coefficient h=10 W/cm2 °C, Conduction coefficient K= 70 W/cm°C and T∞ = 40°C. Calculate the temperatures at every 2cm from the left end.

Fig 12a

(OR)

12. b) Determine the first two natural frequencies of longitudinal vibration of the steel stepped bar shown in Fig .12b and plot the mode shapes. All dimensions are in mm.

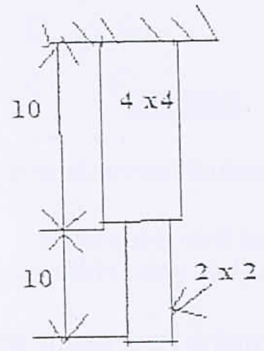
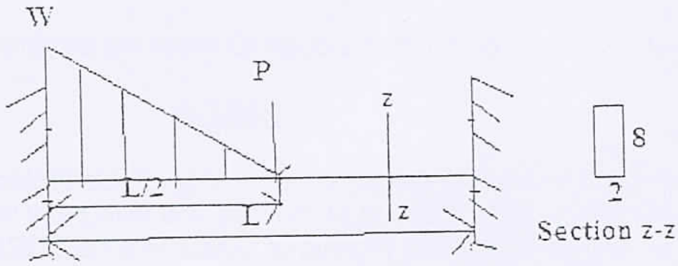


Fig 12b

13. a) Determine the max deflection and reaction in the fixed fixed beam shown in Fig 13a. How will you compute the maximum stress? W=2kN; P=10kN; L=200cm.



(OR)

13. b) Determine the stresses in a member of rectangular cross section subjected to torsion. The cross section of the shaft is 2cm by 2cm and the governing equation is $\nabla^2\phi = -2700$

14. a) (i)Determine three points on the 56° contour line for a rectangular element shown in Fig 14a T_1=40° , T_2=65° , T_3=60° and T_4=52°(10 Marks)
(ii) Derive the K_{11} and K_{32} terms of the stiffness matrix for a four noded bilinear rectangular element used in scalar variablei problem (6 marks)

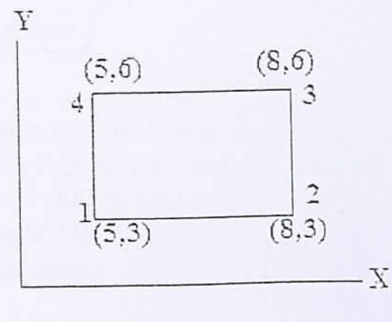


Fig 14a

(OR)

14. b) (i)Determine the strain displacement matrix, Constitutive matrix and nodal force vector for the element as shown in fig 14b. How is the stiffness matrix derived (12 Marks)

(ii) Derive the stiffness matrix for a one dimensional axial element using strain energy approach (4 Marks)

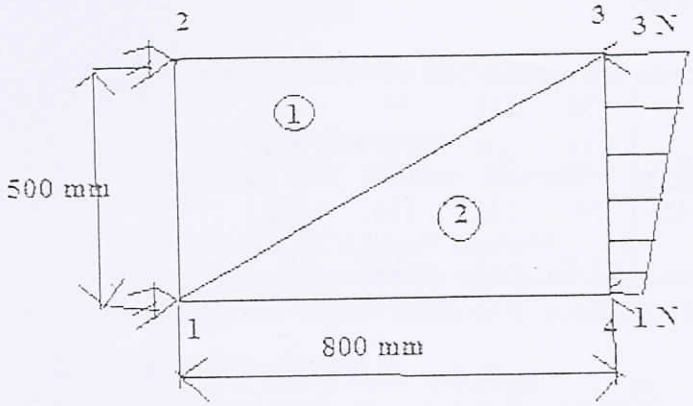


Fig 14b

15.a) (i)For the four noded element shown in Fig 15a determine the Jacobian and evaluate its value at the point (1/4, 1/4) (8 Marks)

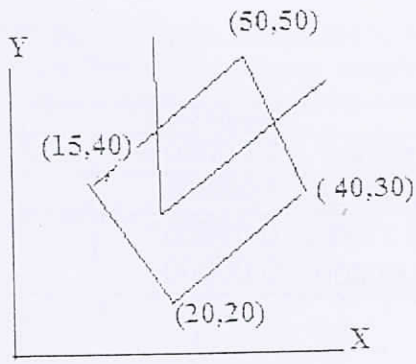


Fig 15a

(ii) Clearly bring out the difference between sub, iso and super parametric element. (8 Marks)

(OR)

15.b) (i)Evaluate the integral of the function using Gaussian intergration.Compare with exact values (6 Marks)

$I=\int(1+\varepsilon+\varepsilon^2+\varepsilon^3)d\varepsilon$

(ii) What is the concept behind Gauss intergration method? Why should the weights add to 2? (2 Marks)

(ii) Derive the shape function for one corner node and one mid side node of a quadratic quadrilateral serendipity element.(8 Marks)

$$K = \frac{EI}{L^3}\begin{bmatrix} 12 & 6L & -12 & 6L \\ 6L & 4L^2 & -6L & 2L^2 \\ -12 & -6L & 12 & -6L \\ 6L & 2L^2 & -6L & 4L^2 \end{bmatrix}$$

$$M = \frac{\rho AL}{420}\begin{bmatrix} 156 & 22L & 54 & -13L \\ 22L & 4L^2 & 13L & -3L^2 \\ 54 & 13L & 156 & -22L \\ -13L & -3L^2 & -22L & 4L^2 \end{bmatrix}$$

$$\{F\} = \frac{fL}{12}\begin{Bmatrix} 6 \\ L \\ 6 \\ -L \end{Bmatrix}$$

$$N_1(x) = 1 - 3x^2/L^2 + 2x^3/L^3$$
$$N_2(x) = x - 2x^2/L + x^3/L^2$$
$$N_3(x) = 3x^2/L^2 - 2x^3/L^3$$
$$N_4(x) = -x^2/L + x^3/L^2$$

No.of points	Location	Weight W_i
1	ξ_1 = 0.00000	2,00000
2	ξ_1, ξ_2 ± 0.57735	1.000000
3	ξ_1,ξ_3= ± 0.77459 ξ_2 = ± 0.00000	0.55555 0.00000