B.E/B.TECH. Degree Examination, December 2020

Semester - VI

ME16603 – FINITE ELEMENT ANALYSIS

(Regulation 2016)

Time: Three hours Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. Indicate the wrong statement:
   (a) FEA is a method to get the numerical solution of a differential equation.
   (b) Many times, partial differential equation represent a problem involving spatial as well as temporal coordinates are included in the same problem.
   (c) FEA is not useful for solving coupled ordinary or partial differential equations.
   (d) Analytical solutions for coupled partial differential equations are not easy to achieve.
2. Essential boundary conditions are conditions that _____.
   (a) Specify primary variable.
   (b) Specify secondary variable.
   (c) Specifies the value that the derivative of a primary variable on the boundary of the domain.
   (d) None of the above.
3. The number of columns in a connectivity matrix [B] corresponds to _____.
   (a) Total number of nodes in the entire domain.
   (b) Minimum number of nodes in any element.
   (c) Maximum number of nodes in any element.
   (d) Number of elements.
4. What are the limits of Gaussian quadrature integration domain?
   (a) -1 to +1
   (b) $-\infty$ to $+\infty$
   (c) 0 to 1
   (d) Depends on domain element
5. Name the weighted residual method. Justify the best method adopted with suitable reason.
6. For an analysis of a dam cross section, which suitable element may be adopted? Why?
7. Discuss why polynomial type of interpolation functions are preferred over trigonometric formulation?
8. Why Iso-parametric element is better than super-parametric element?

PART B - (4 X 16 = 64 marks)

09. (a) A simply supported beam is subjected to uniformly distributed load over entire span. Calculate the bending moment and deflection at the mid span using Rayleigh-Ritz method.

If the length of the span is 10 m and UDL is 3 kN/m over the entire span with EI = 20000 kNm^2, what will the percentage of variation of maximum deflection in Ritz method with respect to analytical solution. **(16)**

(OR)

(b) Determine a three-parameter solution of the following using Galerkin's method.

$$\frac{d^2y}{dx^2} = -\cos \pi x \qquad ,0 \le x \le 1$$
$$u(0) = 0 \ \ , u(1) = 0$$

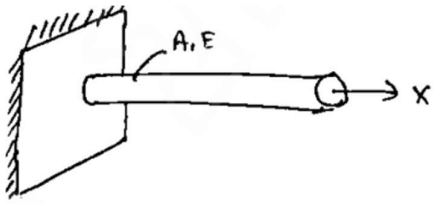
(16)

Justify what happen when only one parameter is used to find the solution of the above equation.

10. (a) A composite wall through which heat inside layer with K_1 = 0.02 W/cm°C, middle layer K_2 = 0.005 W/cm°C, outer layer K_3 = 0.0035 W/cm°C. The thickness of each layer is 13 mm, 80 mm and 25 mm respectively. Inside temperature of the wall is 20°C and outside temperature of the wall is -15°C. Determine the nodal temperatures in between layers. **(16)**

(OR)

(b) Using two equal-length finite elements, determine the natural frequencies of the solid circular shaft fixed at one end shown in figure below, using bar element. **(16)**

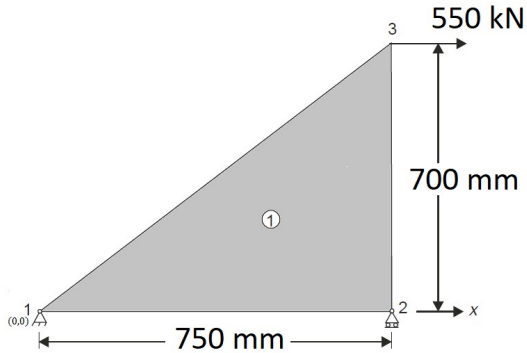


11. (a) Using Lagrange functions write shape functions for the nine-noded rectangular element.

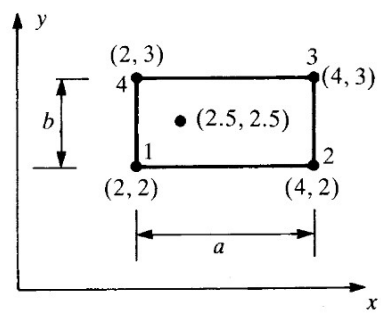
Assuming that the centroid of the rectangle is located at the origin (0,0), what will be the interpolation functions of this nine-noded element for a rectangle of breadth 2 mm and height 1 mm. **(16)**

(OR)

(b) Compute the nodal displacement and element stress for a CST element which has hinge joint at node 1 and a roller joint in node 2 as shown in figure. Assume Plane stress condition with thickness of 15 mm. Take Poisson ratio as 0.25 and Young' modulus as 2 x 10^5 N/mm^2. **(16)**



12. (a) A quadrilateral element is shown in an x, y coordinate system in figure shown. The nodes are located at the coordinate points as illustrated, and a temperature distribution has been computed at each nodes are T_1 = 100°C, T_2 = 60°C, T_3 = 50°C and T_4 = 90°C. Use the shape function derived and compute the temperature at x = 2.5 and y = 2.5. **(16)**



(OR)

(b) Check what order of Gauss quadrature (i.e No of points) would exactly integrate the equation $y = \int_{-1}^{1} \left(2 + 3x^2 + 5x^3 - 15x^5\right) dx$. Also discuss how this helps in FEM? **(16)**