B.E - VIII / Mech / Finite Element Analysis / MECH 20-11-14

QP Code : 15677

(3 Hours) **[Total Marks : 100**

N.B. (1) Question No. **1** is **compulsory**.
(2) Attempt any **four** questions from remaining **six** questions.
(3) Assume suitable **data** wherever is **necessary**.
(4) **Figures** to the **right** indicate full **marks**.

1. (a) (i) Explain different types of nodes with suitable examples. **5**
(ii) Give any two fields of engineering problems governed by the second-order differential equation and its parameters. **5**
(b) Use Gaussian Legandre Quadrature Method and for the integral in two dimension (2 × 2) and verify exactness by an analytical integration. **10**

$$I = \int_{-1}^{+1}\int_{-1}^{+1} \left(2x^4 + 3y^2 + x^3y\right) dx\, dy$$

2. (a) Solve the following differential equation by using Galerkin's method. **10**

$\frac{d^2u}{dx^2} = f_c$, where the domain is changing from $(0 \le x \le L)$

and B.C.'s of the problem :

$\frac{du}{dx}(0) = 0$; $\frac{du}{dx}(L) = 0$.

(b) Solve the following differential equation using (i) subdomain (ii) collocation **10**

$$\frac{d}{dx}\left(x\frac{dy}{dx}\right) - 4x = 10 \qquad 1 \le x \le 2$$

subject to y(1) = y(2) = 0.

3. (a) (i) Explain 'h' and 'p' method in FEM. **4**
(ii) Explain at which are the conditions for the Rayleigh Ritz and Galerkin methods yield the same solution. **4**
(b) Develop the Finite Element equation for the most general element using Rayleigh-Ritz method for the mathematical model given **12**

$$\frac{d}{dx}\left(AE\frac{du}{dx}\right) = 0 \qquad 0 \le x \le 12 \text{ cms}$$

Take linear elements. use Lagranges linear shape functions. Use the following data to solve Global equation. Use three elements.
A = 0·1 m^2, for each element, E = 100 GPa for each element.
u(0) = 0 and u(12), p = external force = 10 kN. Find displacements at nodes and forces. Explain each step clearly.

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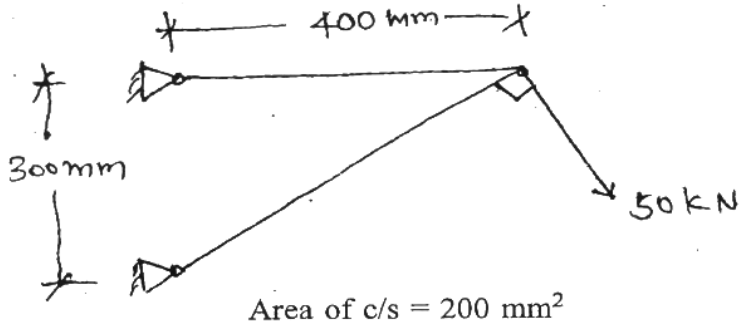
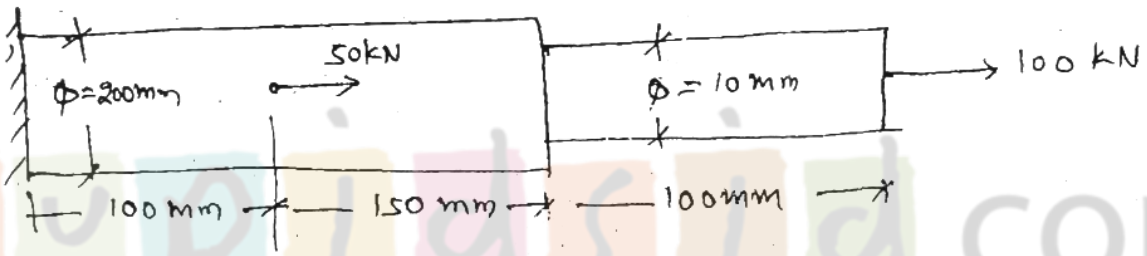
4. (a) Determine the shape functions for Euler Bernoulli Beam. 8
   (b) Analyze the following Truss completely for reactions, stress and strains. 12

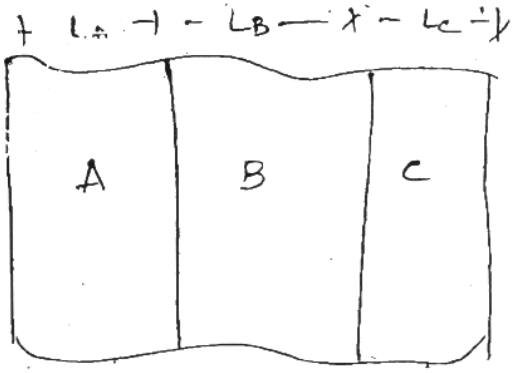


Area of c/s = 200 mm^2
E = 180 GPa.

5. (a) Find the displacement, stresses and strain in the elements of stepped bar as shown in **figure**. Take E = 200 GPa. 10



   (b) Find the temperature at interfaces and heat transfer per unit area through the wall. 10



$T_L = 100°C$
$h_L = 15$ w/m^2 °C

$T_R = 30°C$
$h_2 = 20$ w/m^2 °C
$L_A = 50$ mm
$L_B = 50$ mm
$L_C = 50$ mm

$k_A = 40$ w/m °C, $k_B = 40$ w/m °C, $k_C = 40$ w/m °C

6. (a) (i) Write dow the polynomial expression for quadratic rectangular element for the following :— 4
   — Lagrange Element
   — Serendipity Element
   (ii) Using serendipity concept, find the shape function for the eight nodes rectangular element. 4

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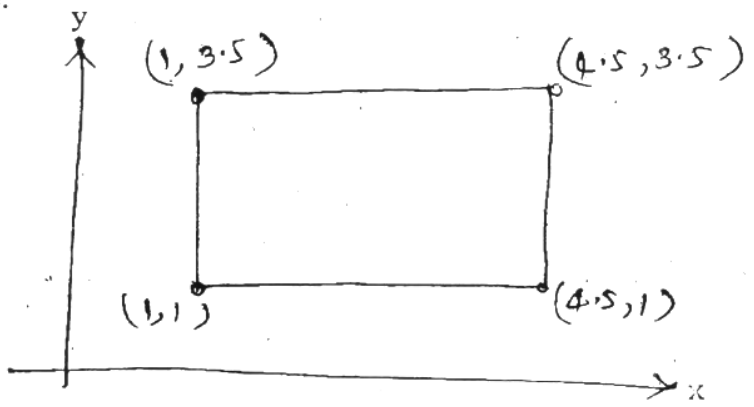
(b) Calculate the linear interpolation function for the linear rectangular elements shown in **figure**. 8



7. (a) (i) Write a notes on PATCH Test and Jacobian Matrix. 5
(ii) Explain compatibility and convergence criteria. 5

(b) Find the natural frequency of the axial vibrations of a fixed free bar of uniform cross section of 50 mm^2 and length of 1 meter using consistent and lumped mass matrix and compare the natural frequencies with exact frequencies. 10

Take E = 200 GPa and density = 7860 kg/m^3. Take two linear elements.
