



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

1. Attempt any **four** of the following :—

- (a) Briefly explain application of FEM in various fields. 5
- (b) Explain Principle of minimum Potential Energy. 5
- (c) Explain different sources of error in a typical F.E.M. Solution. 5
- (d) Briefly explain Node Numbering Scheme. 5
- (e) Explain properties of Global Matrix. 5

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

$$3 \frac{d^2 u}{dx^2} - 3u + 4x^2 = 0 \text{ with boundary conditions } u(0) = u(1) = 0. \text{ Assume Cubic Polynomial for approximate solution.}$$

(b) Solve the following differential equation using Rayleigh - Ritz method 10

$$3 \frac{d^2 y}{dx^2} - \frac{dy}{dx} + 8 = 0, 0 < x < 1 \text{ with boundary conditions } y(0) = 1 \text{ and } y(1) = 2. \text{ Assume Cubic Polynomial for trial solution. Find the value at } y(0.3) \text{ and } y(0.8)$$

3. (a) Evaluate the following integral using Gauss Quadrature. Compare your answer with exact 12

$$I = \int_{-1}^1 \int_{-1}^1 (r^3 - 1)(s-1)^2 dr ds$$

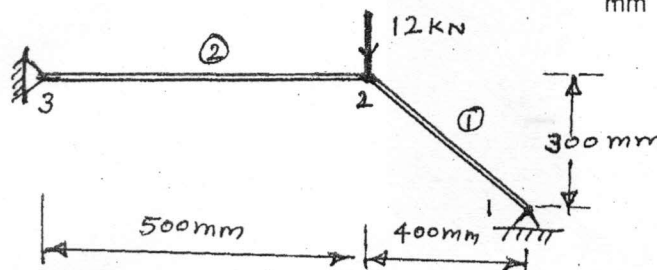
n	ξ	w
1	0.0	2
2	± 0.5774	1
3	+ 0.0 ± 0.7746	0.8889 0.5556

(b) Explain the following :— 8

- (i) Convergence requirements
- (ii) Global, Local and Natural co-ordinate system.

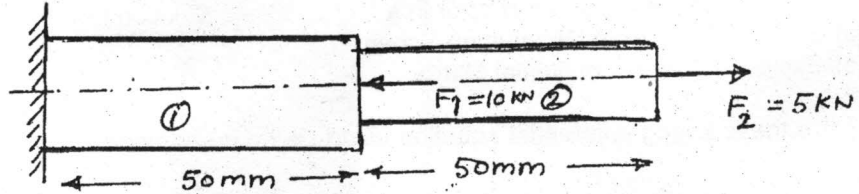
4. (a) For the two bar truss shown in **figure**, determine the nodal displacement; stresses 15

in each element and reaction at support. Take $E = 2 \times 10^5 \frac{N}{mm^2}$, $A = 200 \text{ mm}^2$



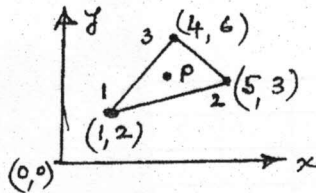
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- (b) Explain Band Width. 5
5. (a) Using Direct Stiffness method, determine the nodal displacements of stepped bar shown in figure. 12



Take $E_1 = 200 \text{ GPa}$ $A_1 = 150 \text{ mm}^2$ $F_1 = 10 \text{ kN}$
 $E_2 = 70 \text{ GPa}$ $A_2 = 100 \text{ mm}^2$ $F_2 = 5 \text{ kN}$

- (b) Derive the shape function for a Quadratic bar element [3 noded 1 dimensional bar] using Lagrangian Polynomial in (i) Global co-ordinates and (ii) Natural co-ordinates. 8
6. (a) Find the shape function for two dimensional Nine noded rectangular elements mapped into natural coordinates. 12
- (b) The nodal co-ordinates of a triangular element are as shown in figure. The x co-ordinate of interior point P is 3.3 and shape function $N_1 = 0.3$. Determine N_2 , N_3 and y co-ordinate of point P. 8



7. (a) Find the natural frequency of axial Vibrations of a bar of uniform cross section 10

of 20 mm^2 and length 1 m. Take $E = 2 \times 10^5 \frac{\text{N}}{\text{mm}^2}$ and $\rho = 8000 \frac{\text{kg}}{\text{m}^3}$.

Take 2 linear elements

- (b) Discuss briefly higher order and isoparametric elements with suitable sketches. 10