

Note:

1. Question 1 is Compulsory
2. Solve any three from remaining five
3. Figures to right indicate full marks
4. Assume suitable data if necessary



Question No.

Max. Marks

Q.1

- a) Explain Pre and post processing in FEM
- b) Derive shape function for 1D quadratic element in natural coordinates
- c) Explain the significance of Jacobian matrix.
- d) Explain Convergence of results

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Q.2

- a) Solve the following differential Equation using Galerkin Method.

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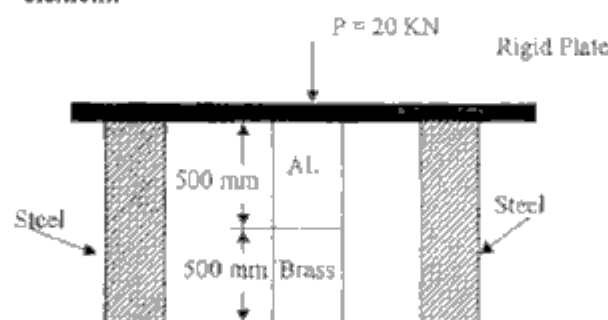
$$\frac{d^2y}{dx^2} + 3x \frac{dy}{dx} - 6y = 0 \quad 0 < x < 1.$$

Boundary Conditions are: $y(0)=1$, $y'(1)=0.1$

Find $y(0.2)$ and compare with exact solution.

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- b) For the given, steel blocks supporting rigid plates shown in figure, determine displacement matrix and stresses in each element.



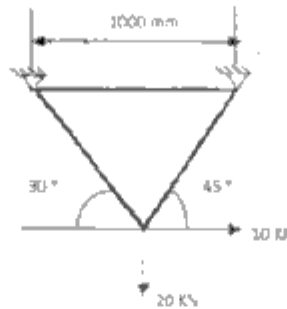
Take:

Properties	Steel	Aluminium	Brass
C/S Area (mm ²)	200	370	370
E (N/mm ²)	2×10^5	7×10^4	8.8×10^4

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- Q.3 a) What do you mean by consistent and lumped mass matrices? 10
Derive the same for linear bar element.
- b) Consider the truss shown in figure. Given $E = 210 \text{ GPa}$ and cross section area $A = 1 \text{ cm}^2$ for each element. Determine 10
1. Displacement at each node.
 2. Stresses induced in each element.
 3. Reaction at supports

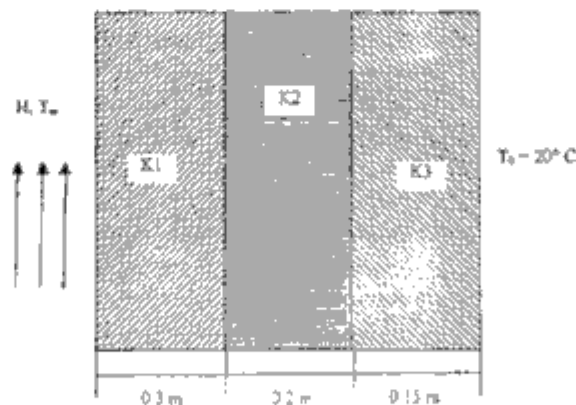


- Q.4 a) It is required to carry out one dimensional structural analysis of a circular bar of length 'L', fixed at one end and carries a point load 'P' at other end. Find the suitable differential equation with required boundary condition (justify) and solve it by using Rayleigh - Ritz method for two linear element. 10
- b) A composite wall consists of three materials, as shown in figure. The outer temperature $T_0 = 20^\circ\text{C}$. Convection heat transfer takes place on the inner surface of the wall with $T_\infty = 800^\circ\text{C}$ and $h = 30 \text{ W/m}^2 \text{ } ^\circ\text{C}$. Determine temperature distribution in the wall. 10

$$K_1 = 25 \text{ W/m}^\circ\text{C}$$

$$K_2 = 30 \text{ W/m}^\circ\text{C}$$

$$K_3 = 70 \text{ W/m}^\circ\text{C}$$



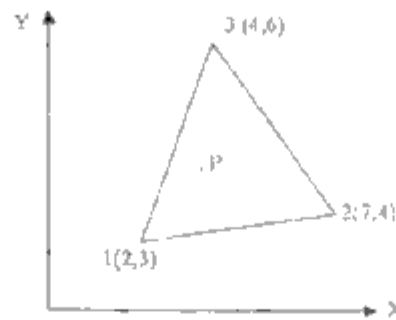
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Q.5

- a) The nodal coordinate of the triangular element are as shown in figure. At the interior point P, the x-coordinate is (4.5) and $N_1=0.3$. Determine N_2 , N_3 and y-coordinate of point P.

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- b) For a CST element the nodal displacement vector $Q^T = [0, 0, 0, 0, 2, -0.1]$ mm. Find the element stress. Take $E=200\text{GPa}$, plate thickness $t=5\text{mm}$ and Poisson's ratio $\nu=0.3$

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Q.6

- a) What are serendipity elements? Derive and graphically represent interpolation functions for 8 nodeded Quadrilateral elements.
- b) Find the natural frequency of axial vibrations of a bar of uniform cross section of 20mm^2 and length 1m . Take $E = 2 \times 10^5 \text{ N/mm}^2$ and $\rho = 8000 \text{ kg/m}^3$. Take two linear elements.

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