B.E.(with Credits)-Regular-Semester 2012-Mechanical Engineering Sem VII

Elective-I : ME - Finite Element Method

P. Pages : 4 **GUG/W/16/6621**

Time : Three Hours * 4 6 8 8 * Max. Marks : 80

Notes : 1. All questions carry equal marks.
2. Answer Q. No. 1 or 2, 3, or 4, 5 or 6 and 7 or 8.
3. Illustrate your answers wherever necessary with the help of neat sketches.

1. a) Solve using matrix method. **8**

i) $2x + y + z = 10$;
$3x + 2y + 3z = 18$;
$x + 4y + 9z = 16$

ii) $2x + 2y + z = 12$; **8**
$3x + 2y + 2z = 8$;
$5x + 10y - 8z = 6$

b) State and explain Saint Venant's principle. **4**

OR

2. a) Use Rayleigh Ritz method to find the displacement field u(x) of the rod shown in fig. Q. 2 (a) Element 1 is made of aluminium and element 2 is made of steel **16**
Given :

$E_{al} = 70$ GPa $E_{st} = 200$ GPa

$A_{al} = 500$ mm^2 $A_{st} = 900$ mm^2

$L_{al} = 200$ mm $L_{st} = 300$ mm

P = 7000 N

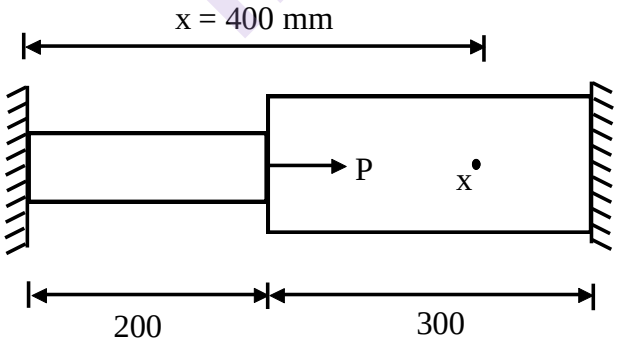

Fig. Q. 2 (a)

Assume a piece-wise linear displacement field

$u = a_1 + a_2 x$ for $0 \le x \le 200$ mm

and $u = a_3 + a_4 x$ for $200 \le x \le 500$ mm

b) What do you understand by discretization. Explain. **4**

3. a) Describe shape functions for linear bar element in detail. **6**

b) For the tapered rod shown in fig. Q. 3(b) find displacement at node position & stress & strains in each element. Further find the overall elongation of element neglect mass. **14**

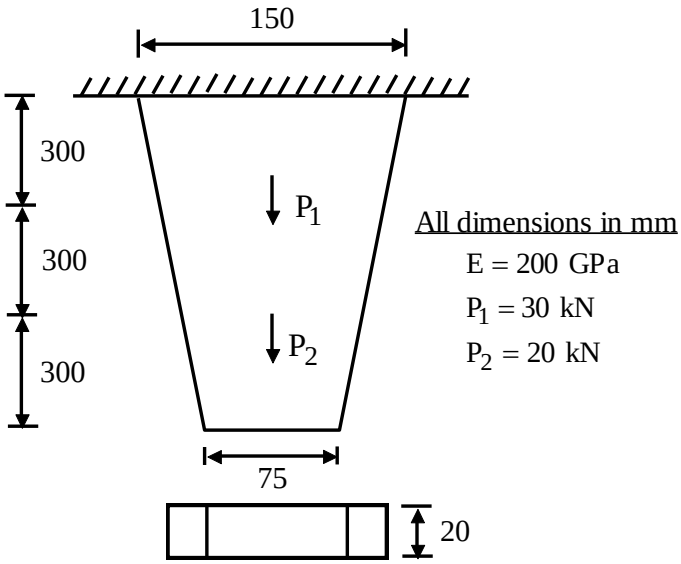

Fig. Q. 3 (b)

OR

4. Determine the nodal displacement and stresses in the elements of the truss as shown in fig. Q. 4. Take area of cross section of each element = 200 mm^2 and E = 200 GPa, P = 15 kN. **20**

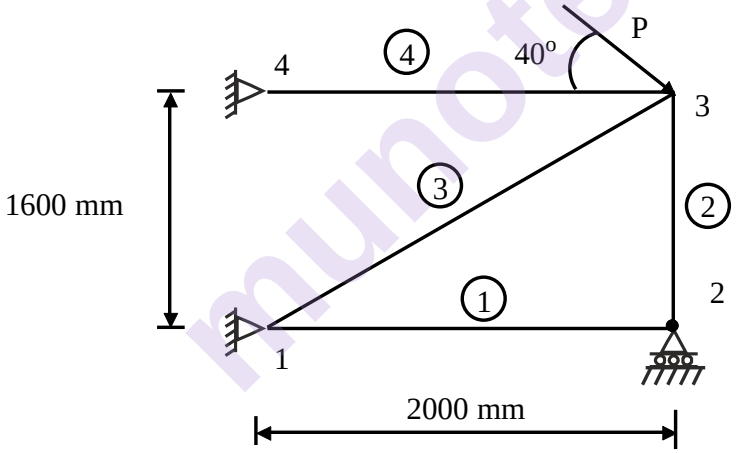

Fig. Q. 4

5. a) Describe shape functions for CST element. **6**

b) For a CST element shown in fig. Q. 5(b) find x & y co-ordinates of point P if $N_1 = 0.4$, $N_2 = 0.2$ at P. **8**

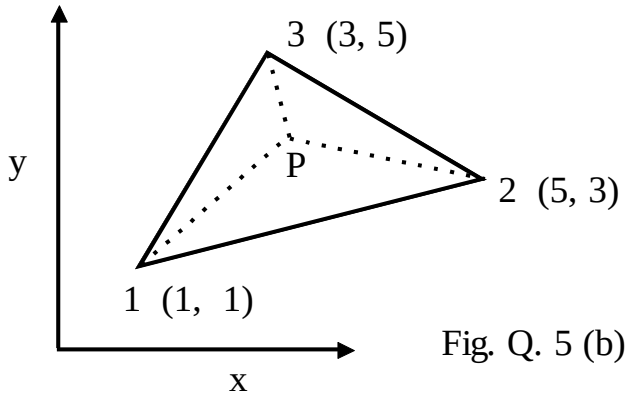

Fig. Q. 5 (b)

Hence find areas of triangles $\Delta 1P3$, $\Delta 2P3$, $\Delta 1P2$ and $\Delta 123$.

c) Find strain displacement matrix for element shown in fig. 5 (b), & determine ϵ_x, ϵ_y & γ_{xy} if **6**

$q_1 = 0.01$ $q_2 = 0.02$

$q_3 = -0.03$ $q_4 = 0.06$

$q_5 = 0.004$ $q_6 = -0.001$

OR

6. The two dimensional loaded plate is shown in fig. Q. 6 Using CST element determine stresses in each of the element, 1 and 2. Take thickness of plate as 20 mm, E = 200 GPa and $\nu = 0.3$. **20**

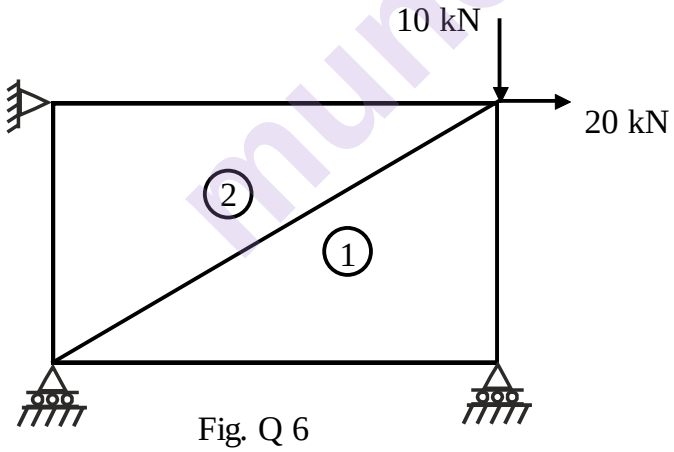

Fig. Q 6

7. The outside of the heating plate is insulated, while the inside is attached to one face of a 2 mm thick stainless steel plate (k = 16.6 W/m ^{o}C). The other face of the plate is exposed to the surroundings, which are at a temperature of 20^{o}C. Heat is supplied at a rate of 500 W/m^{2}. Determine the temperature of the face to which the heating tape is attached. **20**

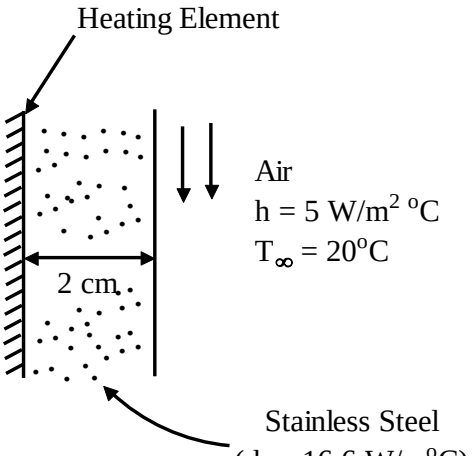

Fig. Q. 7

OR

8. Write short notes on **any four.**

i) Quadratic bar element. **5**

ii) Isoparametrix representation. **5**

iii) Beam element. **5**

iv) Modelling of forced and natural convection in heat transfer problems. **5**

v) Penalty approach. **5**

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