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M.E. Second Semester (Mechanical Engineering) (CAD / CAM) (F.T.) (CGS)

13493 : Finite Element Analysis : 2 MCC 1

P. Pages : 3 | **AU - 3295**

Time : Three Hours | Max. Marks : 80

Notes :
1. Answer **three** question from Section A and **three** question from Section B.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Retain the construction lines.
5. Illustrate your answer necessary with the help of neat sketches.
6. Use of pen Blue/Black ink/refill only for writing the answer book.

SECTION - A

1. a) Explain the general steps in FEA. **5**

b) State and explain Saint Venant's Principle. **3**

c) State various application of FEM and features of FEM. **6**

2. a) Explain Rayleigh Ritz FEM with example. **8**

b) Derive the expression for element strain displacement for the 2 noded 1 D bar element. **5**

3. An axial load of P = 400 kN is applied at 20°C to the rod as shown in fig. Q. 3. The temperature is then raised to 60°C. Determine the elemental stresses. **13**

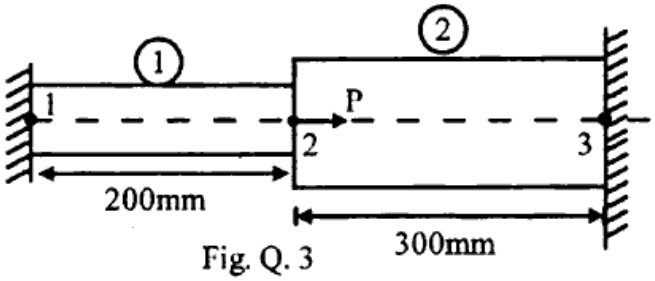

Fig. Q. 3

$E_1 = 70\times10^9\,N/m^2$; $A_1 = 900\,mm^2$;

$E_2 = 200\times10^9\,N/m^2$; $A_2 = 1200\,mm^2$;

$\alpha_1 = 23\times10^{-6}\,per\,°C$; $\alpha_2 = 11.7\times10^{-6}\,per\,°C$;

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4. a) Determine the support reaction forces at two ends of the bar shown below [Q. 4 (a)], given the following : **8**

$P = 60\,kN$, $E = 20 \times 10^3\,N/mm^2$;

$A = 250\,mm^2$; $L = 150\,mm$; $\Delta = 1.2\,mm$.

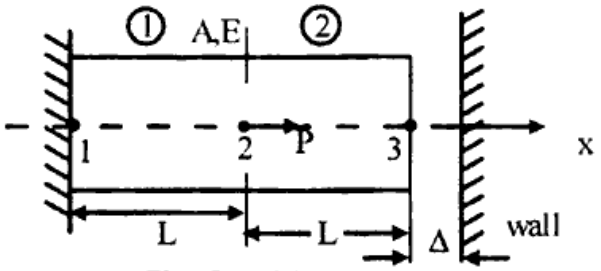

Fig. Q. 4 (a)

b) What are the different types of finite elements used? Draw their figure also. **5**

5. A circular fin of 40 mm diameter is fixed to a base maintained at 50°C. The fin is insulated on the surface except the end face which is exposed to air at 25°C. The length of the fin is 990 mm. The fin is made of metal with thermal conductivity of 37w/m°K. If the convection heat transfer coefficient with air is $15w/m^2\,°K$. Find the temperatures at 3 equally spaced points from the base. **13**

SECTION - B

6. a) Given that

$$A = \begin{bmatrix} 8 & -2 & 0 \\ -2 & 4 & -3 \\ 0 & -3 & 3 \end{bmatrix}; \quad d = \begin{Bmatrix} 2 \\ -1 \\ 3 \end{Bmatrix}$$

determine :

i) $I = dd^T$ **3**

ii) det A **2**

b) Solve by Gaussian Elimination Method : **6**

$$x - 4y - 5z = 4;$$
$$3y + 4z = -1;$$
$$-2x - y + 2z = -3;$$

c) State the various FEA packages. **3**

7. a) Differentiate between CST and LST elements. **5**

b) What is post processing? Explain with example. **5**

c) State Fourier's law of heat conduction used in FEA. **3**

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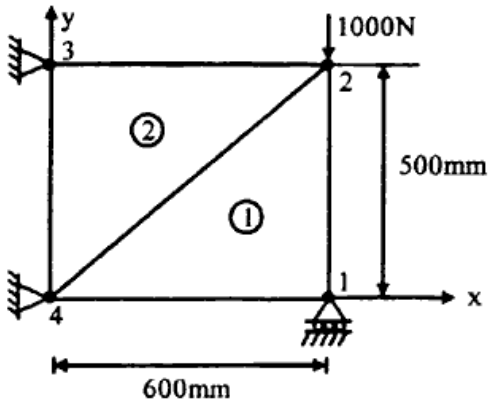
8. a) In a triangular element the nodes 1, 2 and 3 have cartesian co-ordinates (20, 30), (130, 60) and (70, 130) respectively. **9**
The displacements in mm at nodes 1, 2 and 3 are (0.05, 0.25); (0.3, 0.25) and (0.2, 0.15) respectively.
The point P within the triangular element has cartesian co-ordinates. (68, 86)
Determine for point P :
i) The natural co-ordinates
ii) Shape functions
iii) The displacement

b) Differentiate between 'h' element & 'p' element. **4**

9. For the 2D loaded plate shown in Fig. Q. 9, determine the material property matrix [D], element strain displacement matrices $\left[B^e\right]$ for the two elements using plane stress condition. **13**
Take thickness of the plate
$t = 5\,mm$; $E = 30\times10^9\,N/m^2$; $\nu = 0.25$.



10. Determine the fluid head distribution along the length of pipe and velocity and volumetric flow rate in the upper part. The fluid head at the top is 250 mm and that at the bottom is 25 mm. Assume permeability coefficient of Coarse gravelly medium to be $K_{xx} = 12.5\,mm/sec.$ and cross sectional Area of $A = 625\,mm^2$. Use 3 finite elements of equal length. **13**

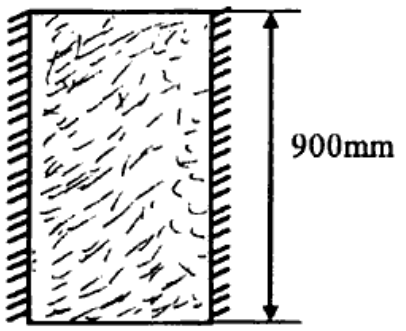


Fig. Q 10

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