B.E. Mechanical Engineering (Model Curriculum) Semester-VIII

PEC-MEL-433 - Finite Element Methods

P. Pages : 3 **GUG/W/23/14373**

Time : Three Hours * 7 9 1 2 * Max. Marks : 80

Notes : 1. Due credit will be given to neatness and adequate dimensions.
2. Assume suitable data wherever necessary.
3. Illustrate your answers wherever necessary with the help of neat sketches.
4. Attempt Que 1 or 2, 3 or 4, 5 or 6, 7 or 8, 9 or 10.

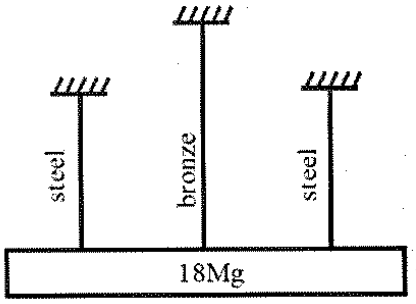
1. a) State the Principle of minimum potential energy. Write down expression for total potential energy of general elastic body and explain each term. **8**

b) With suitable example explain body force and traction force. **4**

c) State different types of finite element based on geometry with suitable example for each. **4**

OR

2. The lower ends of the three bars shown in figure are at the same level before the rigid homogeneous 18Mg block is attached. Each steel bar has an area of 600mm^2, E = 200GPa & length of 1.0m. For bronze bar, the area is 900mm^2, E = 83GPa and length is 1.6m. Find the stress developed in each bar. **16**



3. a) What are different types of errors of finite element method solutions? **4**

b) Figure 2, shows a thin plate having uniform thickness t = 20mm, Modulus of elasticity E = 2x10^5 N/mm^2. In addition to its self-weight it is subjected to two point loads as shown. The density = 37.86 gm/cm^3. Model the plate with two one dimensional finite elements and determine: **12**

i) Stresses in each member.
ii) Displacement of the bottommost point

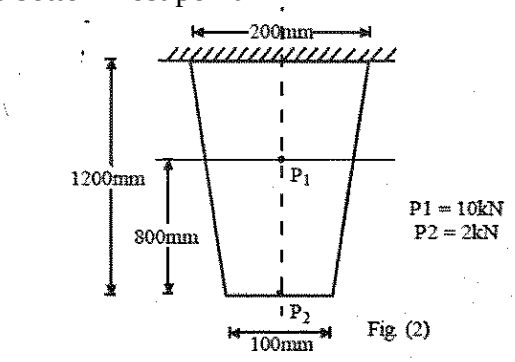
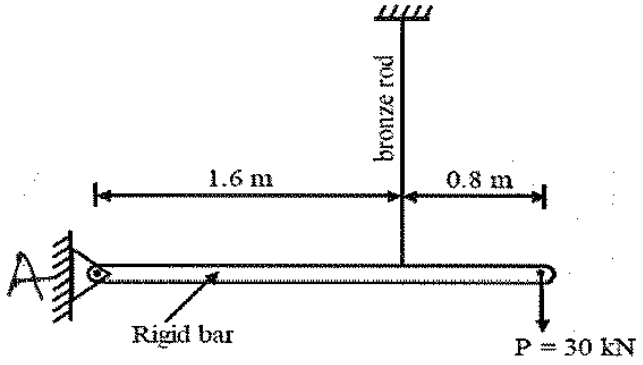


Fig. (2)

OR

4. A horizontal rigid bar of negligible mass, hinged at A in fig., is supported by a bronze rod 2m long having cross section area 300 mm^2 and E = 83 GPa. Determine displacement at a node at which force of P = 30 kN is applied and Hence find stress in bronze rod. **16**

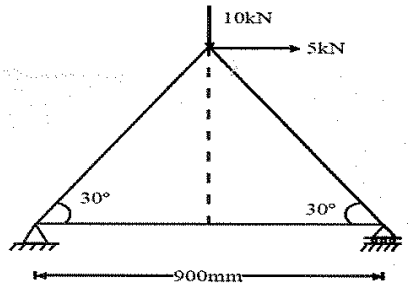


5. a) What do you understand by "post processing" in finite element analysis? **8**

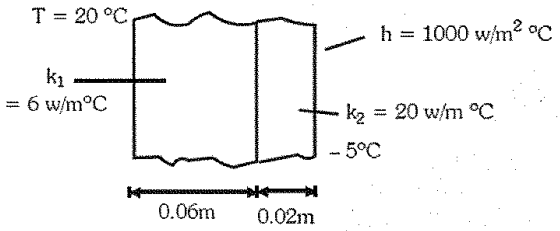
b) Explain in brief the types of element used in FEM along with their characteristics. **8**

OR

6. For the truss shown in figure, determine the displacement of nodes, stresses in members and reactions at the support, cross – sectional area of all members is 400 mm^2 and E = $200x10^9 N/m^2$ **16**



7. a) Determine the temperature distribution through the composite wall subjected to convective heat transfer through wall on right side with convective heat transfer coefficient as shown in figure. The ambient temperature is – 5ºC **16**



OR

8. a) Evaluate the shape functions N1, N2 and N3 at the interior point P for the triangular element bound by nodes 1(2,4), 2(7,9) and 3(5,11). The co-ordinates of P are P(5, 9). **8**

b) Find the Eigen values of the matrix A. **8**

$$A = \begin{bmatrix} 2 & 3 & -2 \\ 1 & 4 & -2 \\ 2 & 10 & 5 \end{bmatrix}$$

9. For Truss shown in fig (4), Cross section area of all elements is 250 mm^2 & E = 200GPa **16**

i) Determine element stiffness matrix for each element.
ii) Assemble the structural stiffness matrix for entire truss.
iii) Find nodal displacement.
iv) Find stresses in all elements.
v) Calculate the reaction force.

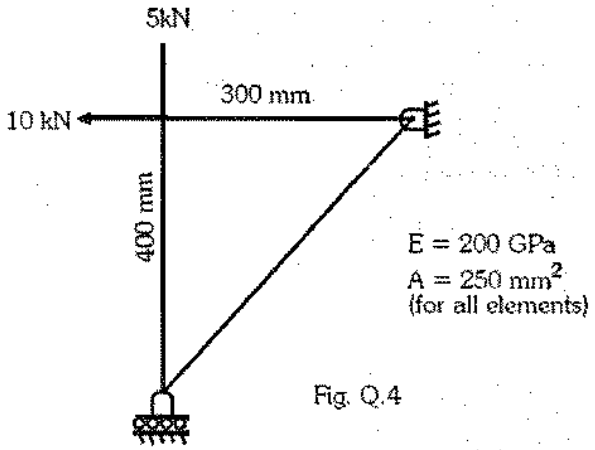


Fig. Q.4

OR

10. Write Short Notes on **any four.** **16**

a) Pre and Post processing in FE.
b) Vibration Analysis using FEM.
c) Algorithms for F. E. Solution.
d) Properties of Stiffness matrix
e) Discretization of the continuum

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