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10ME64

**Sixth Semester B.E. Degree Examination, June/July 2017**  
**Finite Element Methods**

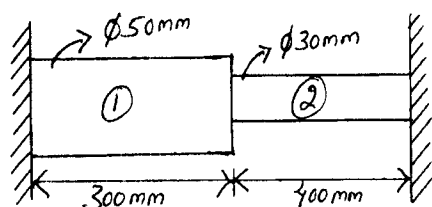
Time: 3 hrs.

Max. Marks:100

**Note: 1. Answer FIVE full questions, selecting at least TWO questions from each part.**  
**2. Missing data may suitably be assumed.**

**PART – A**

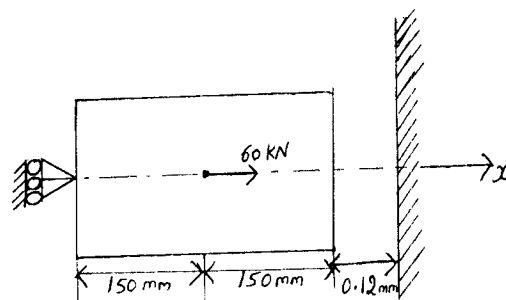
- 1 a. Explain with neat sketch, plain stress and plain strain. (06 Marks)  
 b. Sketch the different types of 1D, 2D and 3D elements used in the finite element analysis. (06 Marks)  
 c. Derive the equilibrium equation in elasticity of 3D elastic body subjected to a body force and traction force. (08 Marks)
- 2 a. Write the properties of stiffness matrix and derive the element stiffness matrix for a 1D bar element. (10 Marks)  
 b. A cantilever beam of span 'L' is subjected to a point at free end. Derive an equation for the deflection at free end by using Rayleigh Ritz method. Assume polynomial displacement function. (10 Marks)
- 3 a. Define interpolation polynomial, simplex, complex and multiplex element. (04 Marks)  
 b. Explain two Dimensional Pascal's triangle. (06 Marks)  
 c. Derive the shape function for C.S.T element. (10 Marks)
- 4 a. Determine the nodal displacements, elemental stresses and support reactions for the Fig Q4(a). Use elimination approach to handle the Boundary conditions. (10 Marks)



- (1) Aluminium  
 $E_1 = 0.7 \times 10^5 \text{ MPa}$
- (2) Steel  
 $E_2 = 2 \times 10^5 \text{ MPa}$

Fig Q4(a)

- b. Consider the bar shown Fig Q4 (b). An axial load  $P = 60 \times 10^3 \text{ N}$  is applied at its mid point. Using penalty method of handling Boundary conditions. Determine the nodal displacement and support reactions. (10 Marks)



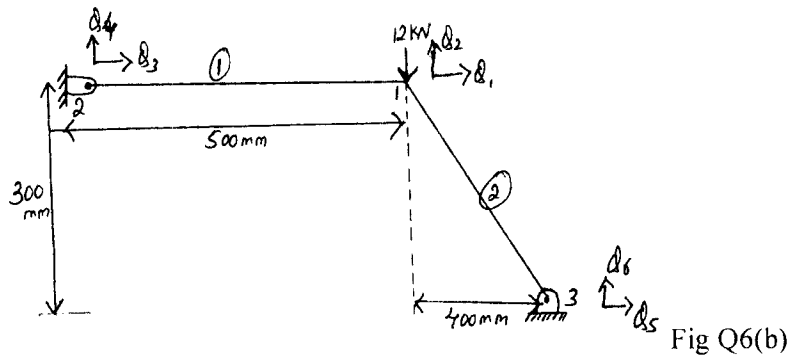
$A = 250 \text{ mm}^2$   
 $B = 200 \text{ GPa}$

Fig Q4(b)

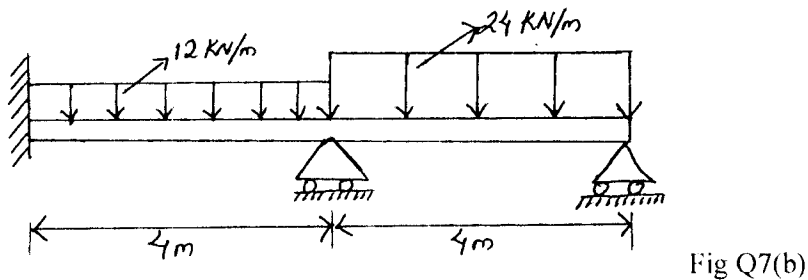
Important Note: 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages so as to avoid any revealing or identification, appeal to evaluator and/or equations written e.g. +2, -8, 20, will be treated as inappropriate.

**PART – B**

- 5 a. Derive the shape function for a quadratic bar element using Lagrange's interpolation. (05 Marks)  
 b. With a neat sketch explain iso, sub and super parametric elements. (06 Marks)  
 c. Derive Lagrange quadratic quadrilateral element (9 noded quadrilateral element). (09 Marks)
- 6 a. Derive the expression for stiffness matrix of a truss element. (08 Marks)  
 b. Find the nodal displacement, stress and reaction of truss element shown in the Fig Q6(b). Take  $A = 200\text{mm}^2$ ,  $E = 70\text{GPa}$ . (12 Marks)



- 7 a. Derive the Hermite shape function of a beam element. (08 Marks)  
 b. For the beam and loading shown in the Fig Q7(b). Determine the end reaction and deflection at midspan. Take  $E = 200\text{GPa}$ ,  $I = 4 \times 10^6\text{mm}^4$ . (12 Marks)



- 8 a. Discuss the derivation of one dimensional heat transfer in thin fins. (08 Marks)  
 b. Determine the temperature distribution in the composite wall using 1D heat elements, use penalty approach of handling boundary conditions (Fig Q8(b)). (12 Marks)

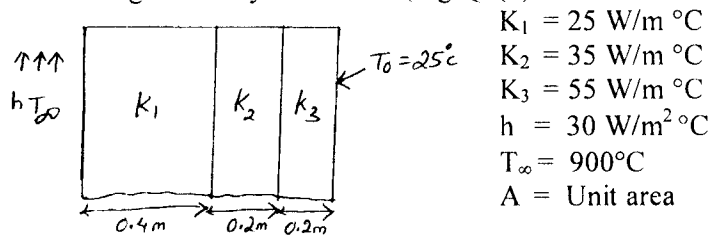


Fig Q8(b)

- $K_1 = 25\text{ W/m}^\circ\text{C}$
- $K_2 = 35\text{ W/m}^\circ\text{C}$
- $K_3 = 55\text{ W/m}^\circ\text{C}$
- $h = 30\text{ W/m}^2\text{ }^\circ\text{C}$
- $T_\infty = 900^\circ\text{C}$
- $A = \text{Unit area}$

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