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15ME61

Sixth Semester B.E. Degree Examination, June/July 2018
Finite Element Analysis

Time: 3 hrs.

Max. Marks: 80

**Note: Answer any FIVE full questions, choosing
ONE full question from each module.**

Module-1

1   a. Define FEM. Discuss various applications of FEA in different domain.   (04 Marks)
     b. Explain convergence requirements of a displacement field.   (04 Marks)
     c. Using minimum potential energy determine the nodal displacement of a spring system shown in Fig. Q1(c).   (08 Marks)
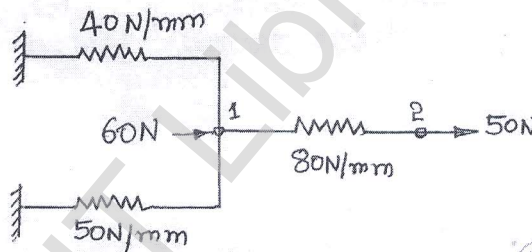

Fig.Q1(c)

OR

2   a. Using Rayleigh – Ritz method, determine the displacement at midpoint and stress variation in a one dimensional rod as shown in Fig.Q2(a).   (09 Marks)
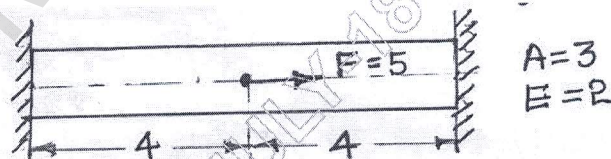

Fig.Q2(a)

     b. Write stress-strain relations for plain stress and plain strain conditions.   (04 Marks)
     c. What do you mean by simplex, complex and multiplex elements?   (03 Marks)

Module-2

3   a. What are higher order element? Derive shape function for 1D quadratic element in natural co-ordinates.   (06 Marks)
     b. Deduce expression for shape function for four noded tetrahedral element (TET4) using Lagrange interpolation functions.   (06 Marks)

     c. Evaluate $\int_{-1}^{+1}(x^2 + \sin\frac{\pi x}{2})\,dx$ using suitable Gauss points numerical integration.   (04 Marks)

OR

4 a. For the stepped bar shown in Fig.Q4(a). Determine the nodal displacements, stress in each element and left support reaction. **(10 Marks)**
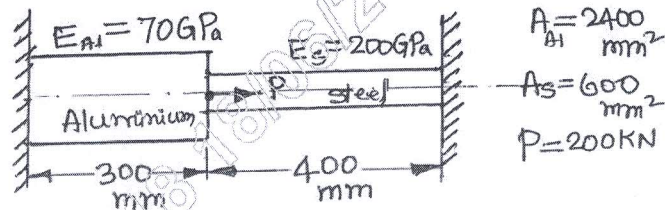

Fig.Q4(a)

b. With assumptions, deduce element stiffness matrix used for analysis of trusses. **(06 Marks)**

Module-3

5 a. Derive Hermite shape function for a beam element. **(08 Marks)**

b. For the beam and loading as shown in Fig.Q5(b), determine deflection, slope and support reaction. Take E = 110GPa, I = $5 \times 10^{-4} m^4$. **(08 Marks)**
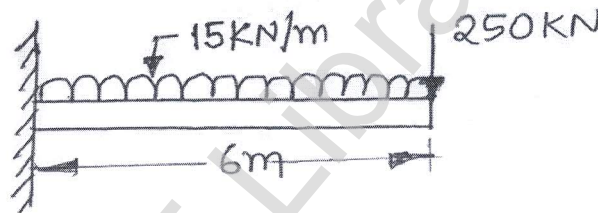

Fig.Q5(b)

OR

6 a. Derive torsional stiffness matrix for a circular shaft subjected to pure torsion. **(06 Marks)**

b. For the circulars stepped shaft shown in Fig.Q6(b) determine stresses and angle of twist. **(10 Marks)**
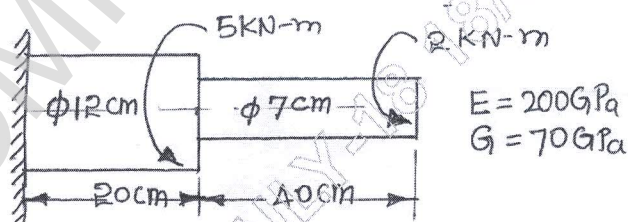

Fig.Q6(b)

Module-4

7 a. Briefly describe rate equations and boundary conditions in heat transfer analysis. **(06 Marks)**

b. Determine the temperature distribution through composite wall shown in Fig.Q7(b) when the convective heat loss occurs on the right surface. Take K_1 = 6W/m°C and K_2 = 20 W/m°C. **(10 Marks)**
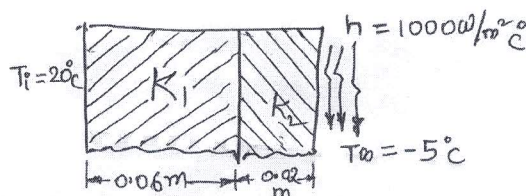

Fig.Q7(b)

OR

8 a. Deduce the governing differential equation for one-dimensional fluid flow through a process medium. **(06 Marks)**

b. For the smooth pipe of variable c/s shown in Fig.Q8(b). Determine the potential at the junction the velocities in each section of pipe and the volumetric flow rate. The potential at the left end is $P_1 = 12 m^2/S$ and that at right end is $P_4 = 3 m^2/S$. Take $K_x = 1$. **(10 Marks)**
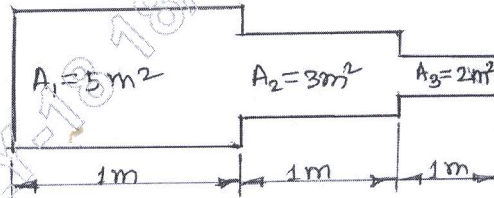

Fig.Q8(b)

Module-5

9 a. What is an axisymmetric element? Derive Jacobian matrix for axisymmetric triangular element. **(08 Marks)**

b. For the element of an axisymmetric body rotating with constant angular velocity $W = 1000$ rev/min as shown in Fig.Q9(b). Determine the body force vector including weight of material with specific density is $7850 \ kg/m^3$. **(08 Marks)**
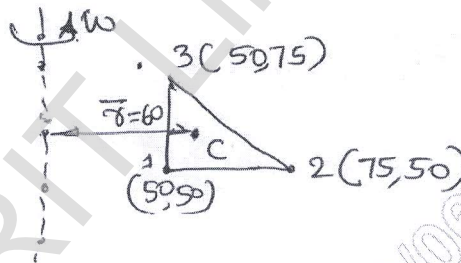

Fig.Q9(b)

OR

10 a. Derive an expression of element mass matrix for a bar element. **(06 Marks)**

b. For the stepped bar shown in Fig.Q10(b) determine the eigen values and eigen vector. Take $A_1 = 400 mm^2$, $A_2 = 200 mm^2$, $\rho = 7850 \ kg/m^3$, $E = 200 GPa$. **(10 Marks)**
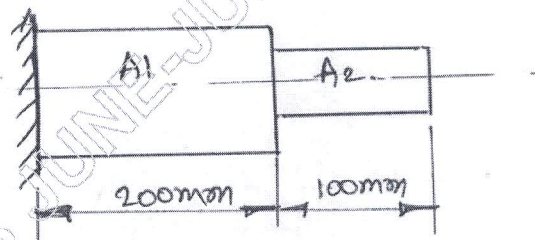

Fig.Q10(b)

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