(3 Hours) Max. Marks: 80

Note:

1. Question 1 is Compulsory
2. Solve any three from the remaining five questions
3. Figures to right indicate full marks
4. Assume suitable data if necessary

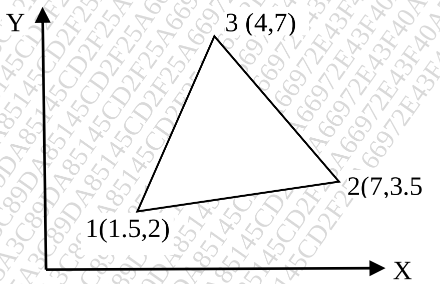
Question No.		Max. Marks
Q.1	Attempt any **four**	20
	a) Explain the importance of node numbering with example in FEA.	
	b) What is convergence and state the conditions to achieve it.	
	c) State and explain the principle of minimum potential energy	
	d) Explain terms i) Plane stress ii) Plane strain iii) DOF iv) Element v) Node	
	e) Explain with example the types of boundary conditions used in FEA.	

Q.2 a) Solve the Differential Equation using Galerkin method and Least square Method. Also compare the results with classical method at x=0.5. **12**

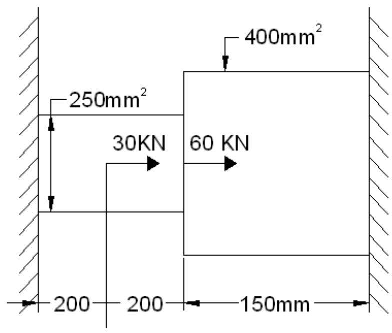
$$-\frac{d^2u}{dx^2} + u + x = 0 \; ; \; 0<x<1$$

Given Boundary Conditions are: u(0) = (du/dx)(1) =0

b) Evaluate the shape function at the nodes and prove its property, for triangular element as shown in figure. **08**



Q.3 a) Consider the Bar shown in Fig. Determine the Nodal Displacement, Element Stress and Reactions if the Temperature is increased by 60ºC. Assume Modulus of Elasticity for the complete Bar as 200 GPa & Coefficient of Thermal expression as 12×10^{-6} per ºC. **10**



b) What is serendipity element?. Derive the shape function for eight noded rectangular element. 10

Q.4 a) A constant strain triangle element has the nodal coordinates (15,-8), (10,5) and (2,0) mm for i , j & k nodes respectively. The element is 2 mm thick and is of material with properties E=70GPa and Poisson's ratio 0.3. Upon loading of the model, the nodal deflections were found to be: 12

u_i = 100µm u_j = 75µm u_k =80µm
v_i = -50µm v_j = -40µm v_k =-45µm

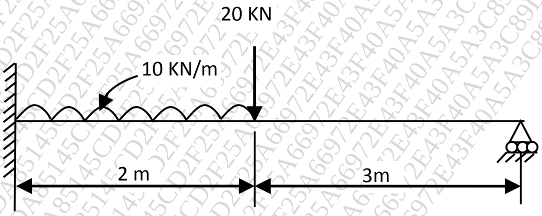
Determine-

1. The Jacobian for (x,y)-(ξ,η) transformation
2. The strain-displacement relation matrix
3. The strains
4. The element stresses.

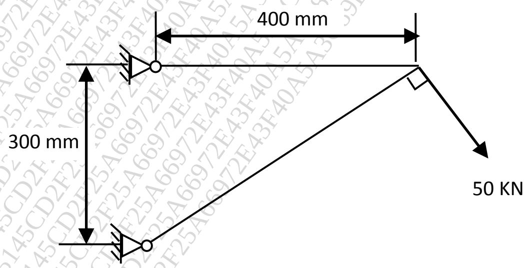
b) Differentiate between lower and higher order element. Derive shape function for linear cubic element by using Lagrange's interpolation function 08

Q.5 a) Find the natural frequency of axial vibrations of a bar of uniform cross section of 30×10^{-4} m^2, length 1m with left end fixed. Take E = 2×10^{11} N/m^2 and ρ = 7800 kg/m^3. Take two linear elements. 10

b) Find using FEA the deflection and slopes at nodes and reactions at supports for the beam as shown in figure. Take EI = 5000 KN-m^2. 10



Q.6 a) Analyze the following Truss completely for reactions, stress and strains. Area of c/s = 200 mm^2 and E = 180 GPa. 10



b) Develop the Finite Element Equation for the most general element using Rayleigh Ritz method for the mathematical model given 10

$$\frac{d}{dx}\left(AE\,\frac{du}{dx}\right) = 0 \quad \text{for } 0 < x < 12 \text{ cms}$$

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