Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER II (OLD) – • EXAMINATION – SUMMER 2016

Subject Code: 1720801 **Date:17/05/2016**

Subject Name: Finite Element Method

Time:10:30 am to 01:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1	**(a)**	1. Enlist properties of global stiffness matrix for a 1-D structural element. 2. Derive stiffness matrix for the truss element.	**03** **04**
	(b)	Write and explain steps to be followed for obtaining solution of a problem using finite element method.	**07**
Q.2	**(a)**	For the system shown in Fig. 1, nodal displacements are indicated with U_i and nodal forces are depicted with R_i. Derive the global stiffness matrix.	**07**
	(b)	The potential energy of a linear elastic rod as shown in Fig. 2, is given as follows. Determine the displacement of mid-point of the rod using Rayleigh Ritz method. Neglect the effect of body force. Use second order polynomial. $\pi = \frac{1}{2}\int_0^L EA\left(\frac{du}{dx}\right)^2 dx - 2u_1$, where u_1 is displacement of mid-point denoted as 1	**07**
		OR	
	(b)	Derive the stiffness matrix of a 1-D bar element using Galerkin's method.	**07**
Q.3	**(a)**	For the plane trusses shown in Fig. 3, determine the horizontal and vertical displacements of node 1. All elements have E=210 GPa and A = 4×10^{-4} m^2. Forces are acting along negative directions.	**06**
	(b)	Explain following terms: Nonlinearity, Isoparametric formulation, Sub-parametric formulation, Superparametric formulation.	**08**
		OR	
Q.3	**(a)**	For the CST element shown in Fig. 4, evaluate shape functions at point P and determine the Jacobian of the element.	**07**
	(b)	Derive the strain displacement relation for a CST element.	**07**
Q.4	**(a)**	Enlist and draw shape function for a quadrilateral element and LST element.	**07**
	(b)	For the mesh shown in Fig. 5, determine equivalent nodal loads on 7, 8 and 9 if, section is 10 mm thick.	**07**
		OR	
Q.4	**(a)**	Loading of a beam is shown in Fig. 6. Determine slopes at nodes 2 and 3. Also determine deflection of the mid-point of span '2'.	**07**
	(b)	A composite wall consists of three materials, as shown in Fig. 7. The outer temperature is 20° C. Convection heat transfer takes place on the inner wall with $T_\infty = 800^o$ C and h = 25 W/m^2 ^oC. Determine temperature distribution in the wall.	**07**
Q.5	**(a)**	A metallic fin with an insulated tip is 1 mm thick and 100 mm long, extends from a wall whose temperature is 235 ^oC. The fin has thermal conductivity of 360 W/m^oC. Determine termpearture distribution and amount of heat transferred from fin to the air at 20 ^oC and h = 9 W / m^2 ^oC. Assume fin width to be 1m and use three elements.	**07**
	(b)	Differential between consistence mass matrix and lumped mass matrix. Write consistent mass matrices for bar element, truss element and CST element.	**07**

OR

Q.5 **(a)** Enlist methods for determining eigenvalues and eigen vectors. Explain any one. **07**

(b) Consider a bar with uniform cross section of length 2L. Its material has properties E and ρ. Estimate first two natural frequencies of axial vibration of the bar. Use two element model with lumped mass matrices. **07**

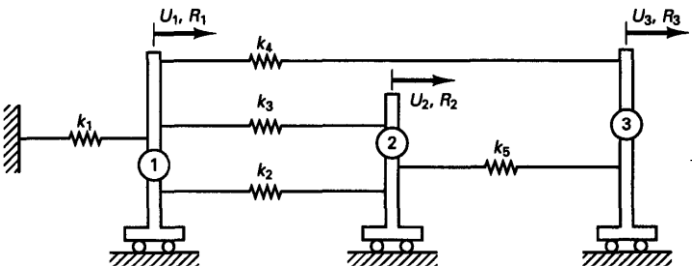

Figure 1

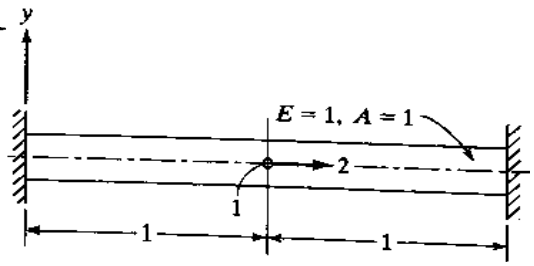

Figure 2

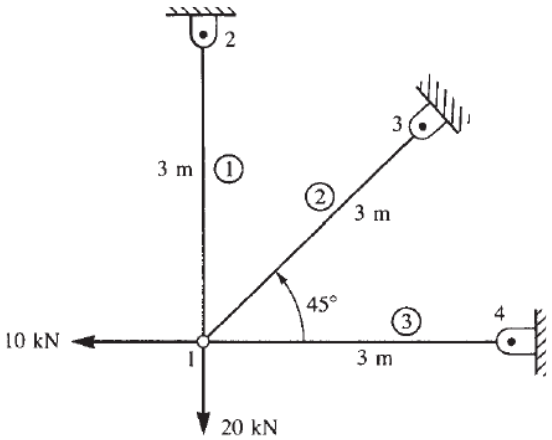

Figure 3

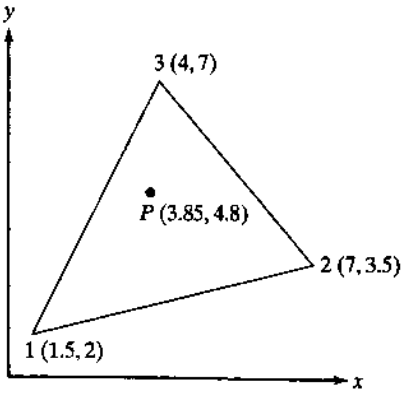

Figure 4

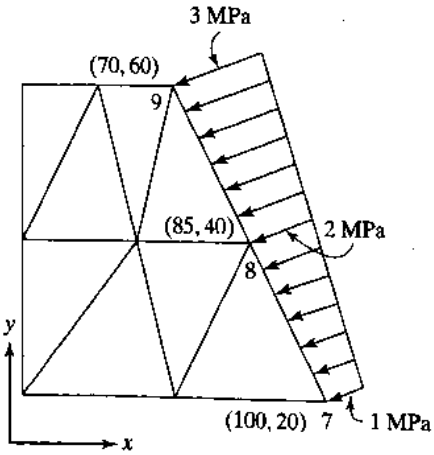

Figure 5

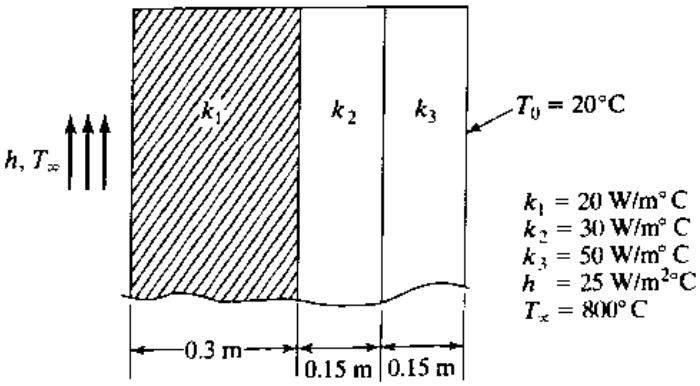

Figure 7

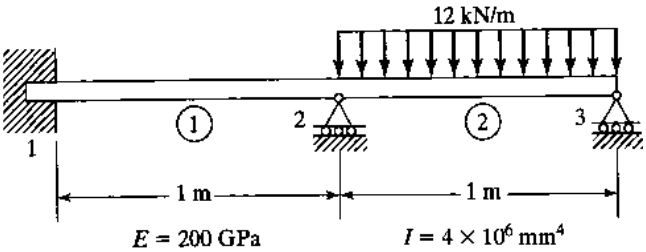

Figure 6

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