U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

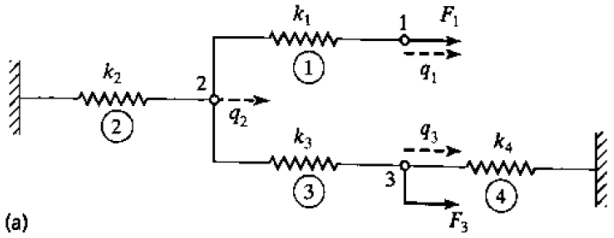
Autonomous Institute Affiliated to VTU

July 2024 Semester End Main Examinations

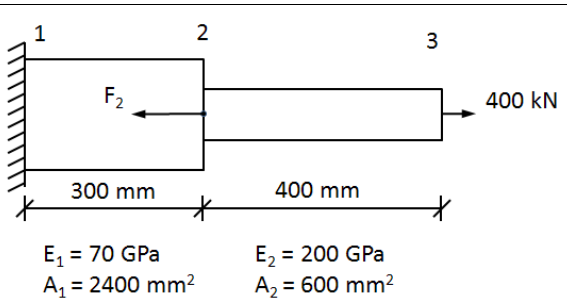
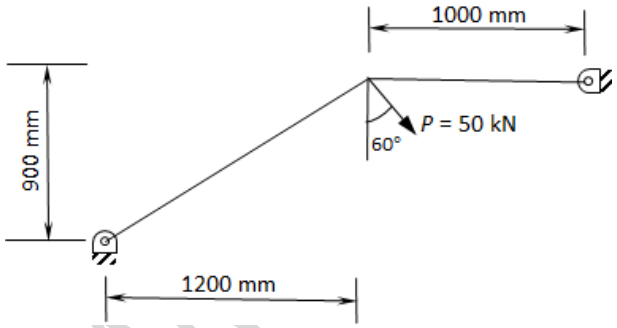
Programme: B. E. **Semester: V**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 22ME5PCMFE **Max Marks: 100**
Course: Modelling and Finite Element Analysis

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

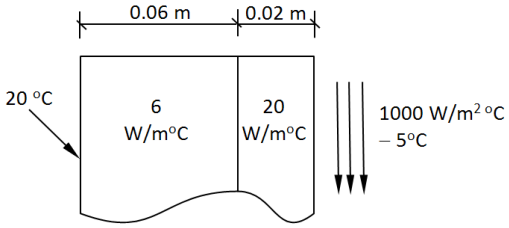
Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	CO	PO	Marks
1	a)	State and explain the principle of minimum potential energy. Figure Q1a shows a system of springs. Apply the principle to obtain the equilibrium equation and express it in matrix form.  **Figure Q1a**	CO1	PO1	**10**
	b)	Derive the sampling points and weight function for 1-point Gauss quadrature. Apply the same to evaluate I = $\int_1^3 x^3 + 1 \cdot dx$.	CO1	PO1	**10**
		OR			
2	a)	Differentiate plane-stress and plane-strain conditions with examples. Write the stress-strain relation in matrix form for the two cases.	CO1	PO1	**10**
	b)	Apply Rayleigh-Ritz method to find the expression for deflection in a cantilever subjected to end load. Deduce the expression for maximum deflection.	CO1	PO1	**10**
		UNIT - II			
3	a)	Derive the shape functions for one-dimensional linear element. For this element with nodal coordinates x_1 = 100 mm and x_2 = 500 mm, the nodal displacements are q_1 = 1 mm and q_2 = 4 mm. Find the displacement at x = 400 mm.	CO2 CO3	PO1 PO2	**10**
	b)	A stepped bar is loaded as shown in figure Q3b. Find the value of F_2 such that nodal displacement at *2* is restricted to zero. Also compute nodal displacement at *3* and reaction at the support.	CO3	PO1	**10**

REAPPEAR 2023-24

			 **Figure Q3b**			
			UNIT - III			
4	a)		Derive the Hermite shape functions for a 2-noded beam element. Sketch their variation over the element.	*CO2*	*PO2*	**10**
	b)		A mechanical linkage loaded as shown in figure Q4b is to be analysed using truss elements. Develop the finite element model for the same. Obtain the global stiffness matrix and the load vector. Solve for the nodal displacements using elimination approach. Take E = 70 GPa and A = 200 mm^2 for both the members.  **Figure Q4b**	*CO3*	*PO1*	**10**
			UNIT - IV			
5	a)		Differentiate Lagrangian and Serendipity elements. Describe the requirements for convergence of a displacement model.	*CO2*	*PO2*	**10**
	b)		Write the interpolation polynomial for a CST element. Using appropriate shape functions, obtain the relationship between elemental strain components and nodal displacements. Deduce the strain-displacement matrix.	*CO2*	*PO2*	**10**
			OR			
6	a)		Apply Lagrangian interpolation and derive shape functions for a bar element of quadratic order. Sketch the variation of these shape functions.	*CO2*	*PO2*	**10**
	b)		Illustrate tetrahedral element in natural coordinates. Identify the *dof* at each node. Using suitable properties, derive the shape functions for the same.	*CO2*	*PO2*	**10**

REAPPEAR 2023-24

			UNIT – V			
	7	a)	Illustrate the problem of 1D heat transfer through heat fins through a neat sketch. Identify the geometric properties, material properties and boundary conditions involved in the problem. Write the element matrices and thermal force vectors encountered in analysis.	*CO2*	*PO2*	**10**
		b)	A composite wall consists of two materials with inner surface maintained at 20^{o}C and outer surface exposed to a hot fluid as shown in figure Q7b. Prepare the finite element model for the problem using two elements. Solve the FE equation for nodal temperatures.  **Figure Q7b**	*CO3*	*PO1*	**10**

****

REAPPEAR EXAMS 2023-24