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B. E. (Eighth Semester) Examination, April-May, 2021

(New Scheme)

(Mech. Engg. Branch)

FINITE ELEMENT METHODS

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all questions. Part (a) is compulsory from each question. Attempt any* ***one*** *part from (b) or (c) in question 1, 3 & 5.*

Attempt any Two Part from (b)/(c) & (d) in Question 2 & 4.

1. (a) Define Field variable. 2

(b) Consider the differential equation

$$-\frac{d^2u}{dx^2} - u + x^2 = 0, \quad u(0) = 0, U'(1) = 1$$

Solve using :

(i) The Collocation method

(ii) The Galerkin method 14

Or

(c) (i) Write the steps of Rayleigh-Ritz method. 4

(ii) Solve using Rayleigh-Ritz method

$$EI\frac{d^4v}{dx^4} - q_0 = 0$$

$$v(0) = 0, \ \frac{d^2v}{dx^2}(0) = 0$$

$$v(L) = 0, \frac{d^2v}{dx^2}(L) = 0.$$

Assume $v(x) = C_1 \sin(\pi x/L)$ as trial function. 10

2. (a) What is Stiffness matrix? Define? 2

(b) Derive shape function matrix for auadratic bar finite element. 7

(c) Derive 7

$$[K]^e = \int [B]^T [B] EA\, dx$$

(d) A composit wall consists of three materials, as shown in figure. The inside wall temperature is 200°C and outside air temperature is 50°C with a convection coefficient of $\beta = 10\ \text{w/m}^2\text{K}$. Determine the temperature along the composite wall. 7

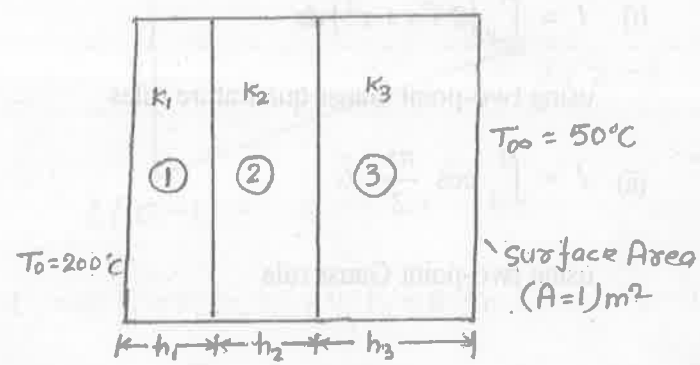
$$-KA\frac{d^2T}{dx^2} = 0 \quad 0 < x \le L$$

$$\& \ T(0) = T_0, \left[KA\frac{dT}{dx} + \beta A(T - T_\infty)\right]_{x=L} = 0$$

$K_1 = 70\ \text{w/mK}, \ K_2 = 40\ \text{w/mK}, \ K_3 = 20\ \text{w/mK}$

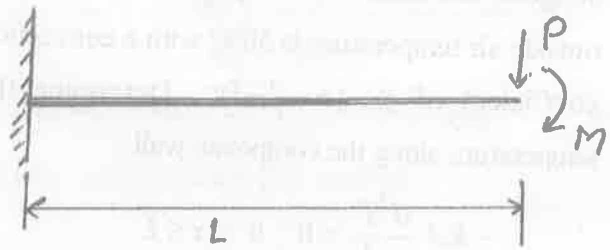
$h_1 = 2\ \text{cm} \quad h_2 = 2\cdot5\ \text{cm} \quad h_3 = 4\ \text{cm}$

$T_\infty = 50°\ \text{C} \quad \beta = 10\ \text{w/m}^2\text{K}$



3. (a) Write difference between Beam and Frame element. 2

(b) Combined beam element matrix for given cantilever beam loaded as shown in figure. Using two-beam element. 14



Or

(c) Derive shape function for Frame element. 14

4. (a) Define natural co-ordinate and its characteristics. 2

(b) Evaluate the integral 7

(i) $I = \int_{-1}^{1} \left(2 + x + x^2\right) dx$

using two-point Gauss quadrature rules

(ii) $I = \int_{-1}^{1} \cos \frac{\pi x}{2} dx$

using two-point Gauss rule

(c) Derive shape function of quadrilateral element by using Natural Co-ordinates. 7

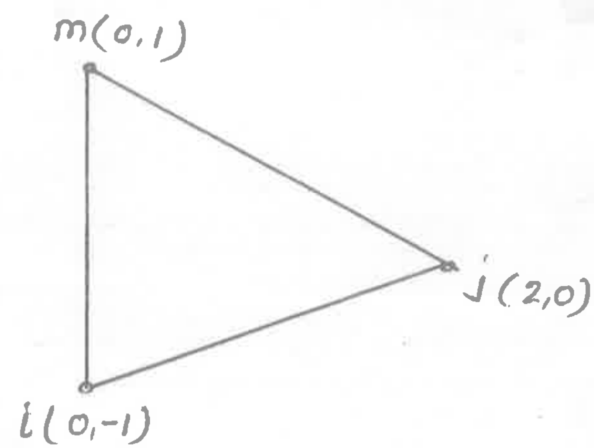
(d) Define : 7

(i) Local co-ordinate system

(ii) Natural co-ordinate system with suitable example

5. (a) Write difference between plain stress and plain strain problem. 2

(b) Evaluate [B] matrix, strain matrix and stress matrix for the following plane stress condition problem



$U_1 = 0,\ V_1 = 0{\cdot}25,\ U_2 = 0,\ V_2 = 0{\cdot}35,\ U_3 = 0,\ V_3 = 0{\cdot}25$

Thickness of element = 10 mm

Young's modulus = 200 GPa

Poisson's ratio = 0·25 14

Or

(c) Derive stress-strain relationship for plane strain conditions. 14