BACHELOR OF TECHNOLOGY (C.B.C.S.) (2020 COURSE)
B.Tech.Sem - V Robotics & Automation Engineering : WINTER- 2022
SUBJECT : INTRODUCTION TO FINITE ELEMENT ANALYSIS

Day : Wednesday | Time : 02:30 PM-06:30 PM

Date : 14-12-2022 | **W-24798-2022** | Max. Marks : 60

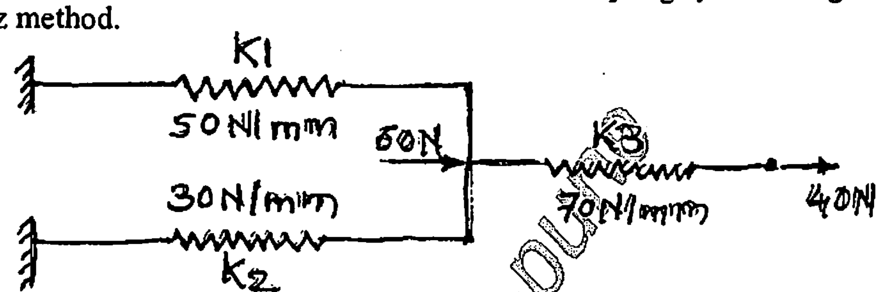
N.B. :

1) All questions are **COMPULSORY.**
2) Figures to the right indicate **FULL** marks.
3) Use of **CALCULATOR** is allowed.
4) Draw neat and labeled diagrams **WHEREVER** necessary.
5) Assume suitable data **WHENEVER**, necessary.

Q.1 Derive the stress-strain relation for plain stress and plain strain problems. **(10)**

OR

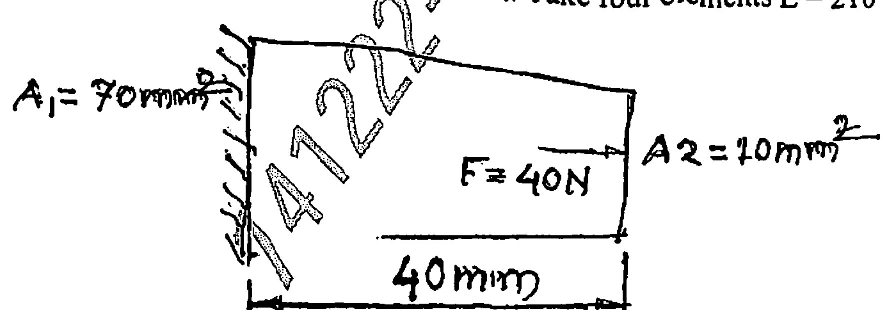
Determine the displacement of the nodes of the spring system using Rayleigh Ritz method. **(10)**



Q.2 Derive the relationship between local and global coordinate system for three nodded element? Also derive the shape function in natural coordinate system? **(10)**

OR

Analyze the bar for axial displacement. Take four elements E = 210 Gpa. **(10)**



Q.3 A CST element has nodal coordinate (20, 20) (90,60) and (100, 40) for nodes 1, 2 and 3 respectively. The element is 2 mm thick and is of material with properties E = 70Gpa and poisons ratio 0.3. Upon loading the model the nodal displacement are found to be **(10)**

$u_1 = 0.02mm$ $u_2 = 0.04mm$ $u_3 = -0.03mm$

$V_1 = -0.04mm$ $V_2 = 0.03mm$ $V_3 = -0.03mm$

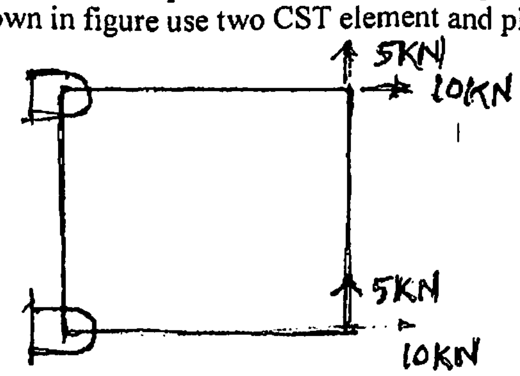
Assume plane stress condition and determine

a) Jacobian for transformation b) Strain displacement relationship

c) Strain d) stresses

OR

Consider a thin plat of 1m thickness subjected to a load of 5 kN and 10 kN as shown in figure use two CST element and plane stress condition. **(10)**



$A = 100mm^2$

$\mu = 0.3$

$E = 60 Gpa$

P.T.O.

Q.4 Derive the shape function for Two, Three and Four noded bar element using Lagrange's Polynomial. **(10)**

OR

Evaluate the following integrals use three point Gaussian quadrature method. **(10)**

$$I=\int_{4}^{5}\frac{2\,\mathrm{Sin}\,(x)}{x^2}\,dx$$

Q.5 The following differential equation a rises in connection with heat transfer through a rectangular fin **(10)**

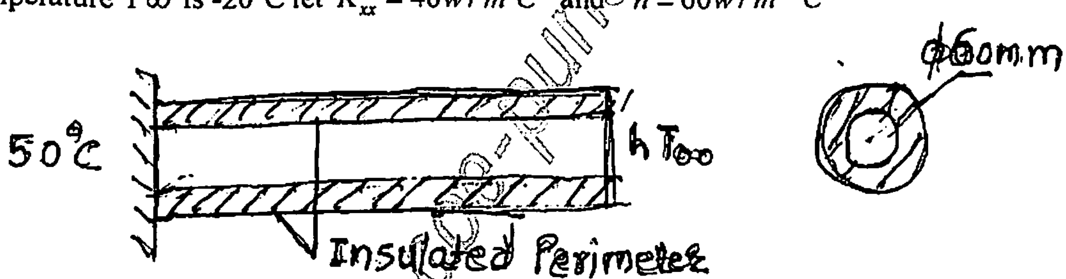
$$-KA\frac{d^2T}{dx^2}+hp(T-T\infty)=0 \quad 0\le x\le 1$$

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

Develop element matrix equation for the linear element.

OR

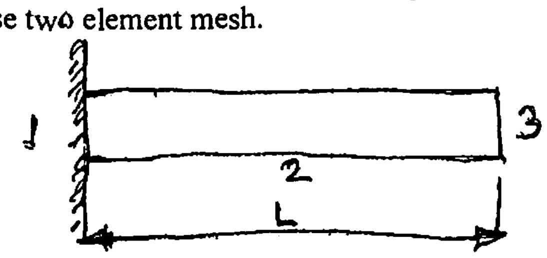
Determine the temperature distribution along the length of the rod (at L/4, L/2, 3L/4 and L) as shown in figure the rod with radius of 25mm is insulated at the perimeter. The left end has a constant temperature of 50^0C and a free stream temperature $T\infty$ is -20^0C let $K_{xx}=40w/m^0C$ and $h=60w/m^2\,{}^0C$ **(10)**



Q.6 Find the dominant eigen value of $A=\begin{bmatrix}8 & 2\\ 2 & 6\end{bmatrix}$ using power method. **(10)**

OR

For a uniform cross section bar of length L = 1m made up of material having E = 210 Gpa and $\rho = 8100kg/m^3$ $A=40\times10^{-6}\,m^2$ Estimate the natural frequencies of axial vibration of the bar using both consistent and lumped mass matrices. Use two element mesh. **(10)**



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