B.Tech III Year II Semester (R09) Supplementary Examinations May/June 2017

FINITE ELEMENT METHODS

(Mechatronics)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions
All questions carry equal marks

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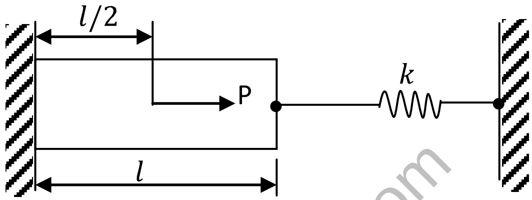
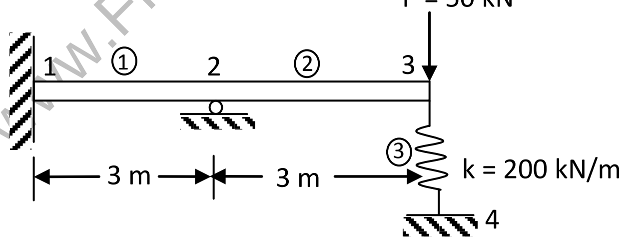
1 (a) What are the various basic elements used in finite element analysis? Explain its importance.
(b) Explain various steps to be followed in finite element method.
(c) List five advantages of the finite element method.

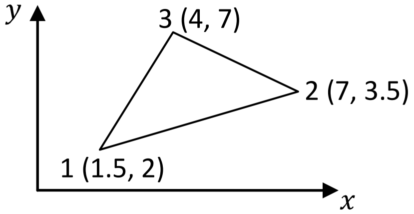
2 A bar of cross-section A, Young's modulus E as shown in figure below is fixed at one end. The other end is connected to a spring of stiffness k, a load P is applied at the mid length. Using direct finite element method, find the spring compression, by two ways:
(i) Taking two elements in the rod and put spring force as the natural boundary condition and
(ii) Taking two elements in the rod and treating spring as third element apply essential boundary conditions at the both ends.



3 A beam as shown in figure below contains Young's modulus of 210 GPa and moment of inertia of 2 x 10^{-4} m^4 which are constant throughout the beam and the spring constant of 200 kN/m. Use two beam elements of equal length and one spring element to model the structure. Derive the global beam equation and solve by using suitable boundary conditions with the given data.



4 (a) What is a CST element?
(b) Determine the Jacobian of the transformation and strain-nodal displacement matrix for the element shown in figure below.



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5 The nodal coordinates for an axisymmetric triangular element are given below.

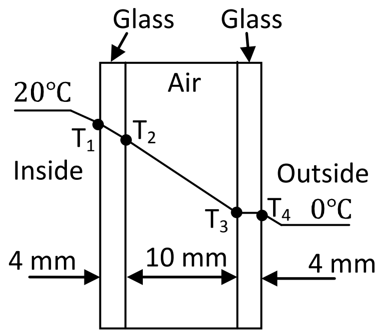
$r_1 = 20$ mm, $z_1 = 10$ mm,

$r_2 = 40$ mm, $z_2 = 10$ mm,

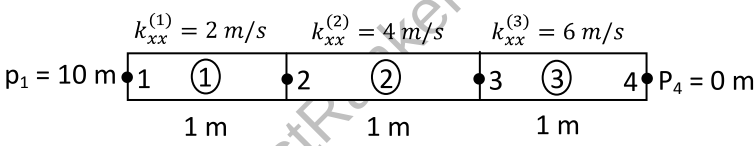
$r_3 = 30$ mm, $z_3 = 50$ mm,

Determine the strain displacement matrix for the element.

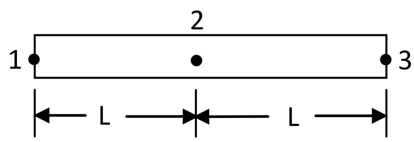
6 A double-pane glass window shown in figure below, consists of two 4 mm thick layers of glass with $k = 0.80\ W/m$-℃ separated by a 10 mm thick stagnant air space with $k = 0.025\ W/m$-℃. Determine: (i) The temperature at both surfaces of the inside layer of glass and the temperature at the outside surfaces of glass. (ii) The steady rate of heat transfer in Watts through the double pane. Assume the inside room temperature is 20℃ with convection coefficient of 10 W/m^2-℃ and the outside temperature is 0℃ with convection coefficient of 30 W/m^2-℃. Assume one-dimensional heat flow through the glass.



7 For the one-dimensional flow through the porous media shown in figure below, determine the potentials at one-third and two-thirds of the length. Also determine the velocities in each element. Let A = 0.2 m^2.



8 Determine the consistent-mass matrix for the one-dimensional bar discretized into two elements as shown in figure below. Let the bar have modulus of elasticity E, mass density ρ, and cross-sectional area A.



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