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## QUESTION PAPER CODE 23591

**B.E./B.Tech DEGREE EXAMINATION, MAY/JUNE 2009**

SIXTH SEMESTER

AERONAUTICAL ENGINEERING

**AE 1007 FINITE ELEMENT METHOD**

PART - A

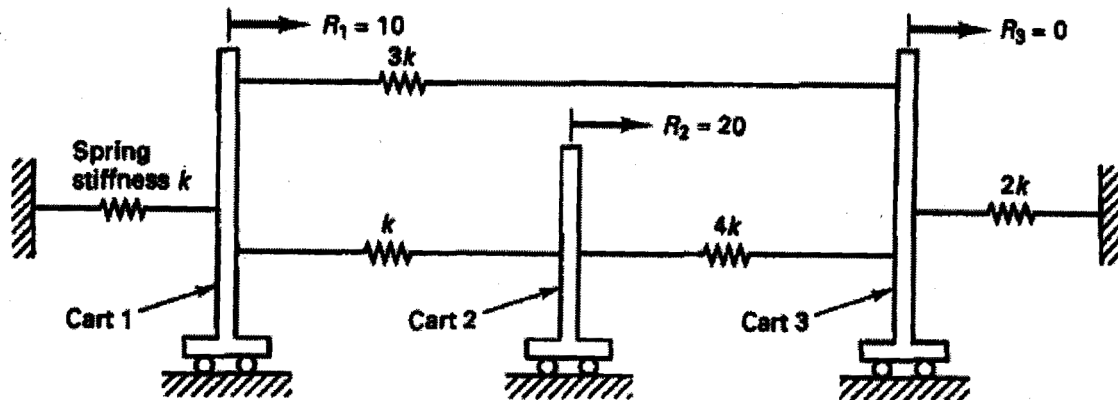
(10 x 2 = 20)

Answer ALL the Questions

1. Define the term finite element.
2. What are compatible elements?
3. State the principle of minimum potential energy.
4. Write the stiffness matrix for a plane frame element.
5. What is an isoparametric element?
6. Differentiate consistent and lumped mass matrices.
7. What is meant by a mode in dynamic analysis?
8. Sketch a linear and Quadratic hexahedral element.
9. What is the significance of node numbering?
10. Mention the limitations of Finite Element analysis.

Answer All the Questions

11. (a) Explain the terms node and mesh. (4)  
 (b) Establish the governing equations for the cart system shown below.



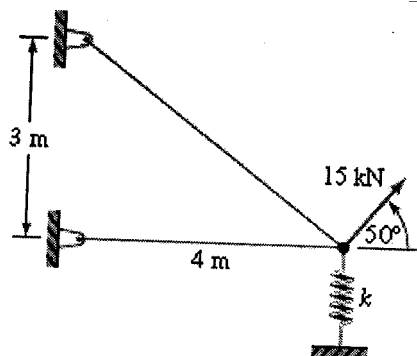
(or)

12. Solve the following system of algebraic equation

$$\begin{bmatrix} 10 & -10 & 0 & 0 \\ -10 & 20 & -10 & 0 \\ 0 & -10 & 20 & -10 \\ 0 & 0 & -10 & 10 \end{bmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} = \begin{pmatrix} F_1 \\ F_2 \\ F_3 \\ F_4 \end{pmatrix}$$

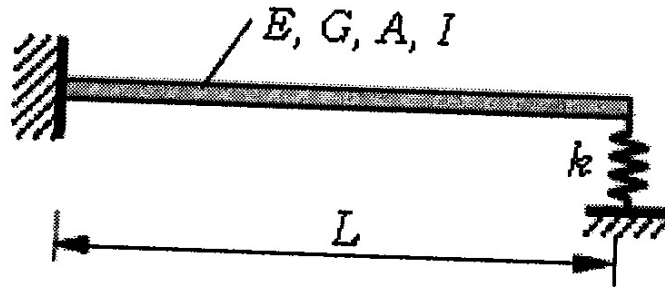
Assume  $x_1 = 0$ ,  $x_3 = 1.5$ ,  $F_2 = 20$  N and  $F_4 = 35$  N.

13. A two member truss is supported by a linear elastic spring. The truss members are of solid circular cross section having  $d = 20$  mm and  $E = 80$  GPa. The spring has a stiffness constant of  $50$  N/mm. Find the Nodal displacements and reactions.

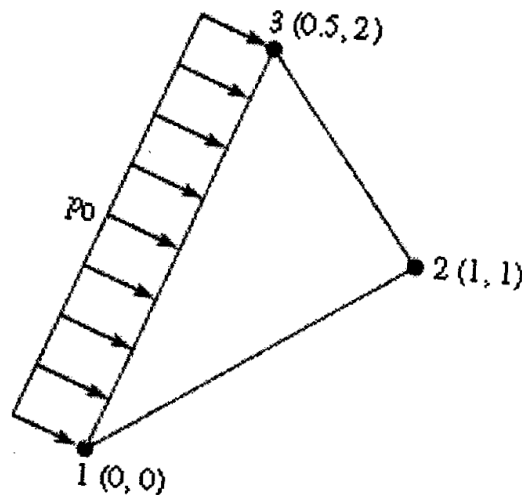


(or)

14. Determine the fundamental natural frequency of the beam (of Young's modulus  $E$ , Shear modulus  $G$ , area of cross section  $A$ , second moment area about the axis of bending  $I$ , and length  $L$ ) with its left end ( $x = 0$ ) clamped and its right end ( $x = L$ ) supported vertically by a linear elastic spring as shown below.



15. Assuming plane stress condition derive the element stiffness matrix for the three noded triangular element subjected to uniformly distributed pressure. The element is of a material with  $E = 210\text{Gpa}$  and Poisson ratio  $= 0.3$ .



(or)

16. Derive the shape function for a six noded triangular element using area coordinates. Evaluate  $\int_v N_3 N_5 dV$  for an axisymmetric element using the above shape functions.

17. Evaluate  $\int_{-1}^1 \int_{-1}^1 \int_{-1}^1 (r^3 - r)(s + 4)(t^2 - 1) dr ds dt$

(or)

18. The X,Y,Z coordinates of the nodes of a tetrahedron element are 1(15,0,0), 2(0,5,0), 3(10,10,5) and 4(0,0,10). The coordinates are in mm. The bottom face contains the nodes 1,2,3. Derive the stiffness matrix of the element assuming that  $E = 30 \times 10^6$  and  $\gamma = 0.32$ .
19. Explain the various stages involved in solving a problem using a commercial Finite element package.
- (or)
20. Mention few finite Element packages. Explain briefly their applications in various fields of Engineering.