2023
B.E. (Mechanical Engineering)
Sixth Semester
MEC-602: Finite Element Methods

Time allowed: 3 Hours   Max. Marks: 50

NOTE: *Attempt* *five* *questions in all, including Question No. 1 (Section-I) which is compulsory and selecting two questions each from Section II-III. Make assumptions in case of missing data or wherever you feel it necessary.*
x-x-x

Section I

1. Write brief answers of the following questions.   2 x 5= 10
   (a) Which strains are negligible in a plane strain condition? Illustrate with the help of a neat sketch.
   (b) Briefly explain any three post-processing options available in a software tool.
   (c) What are the steps for finding an approximate solution using Rayleigh Ritz method?
   (d) Find out shape functions of the point P lying on the element shown in figure A. Coordinates of point 1 are (1,0), point 2 (8,0) and point P (5,0).


Fig. A

   (e) With the help of a neat sketch, differentiate between two-dimensional truss element with the three-dimensional truss element.

Section II

2. A bar shown in the figure B is loaded with a horizontal force. Find out the approximate solution for displacement and stress, using Rayleigh's method and potential energy approach. The approximation function you choose should be quadratic.   (10)

Fig. B

Fig. C
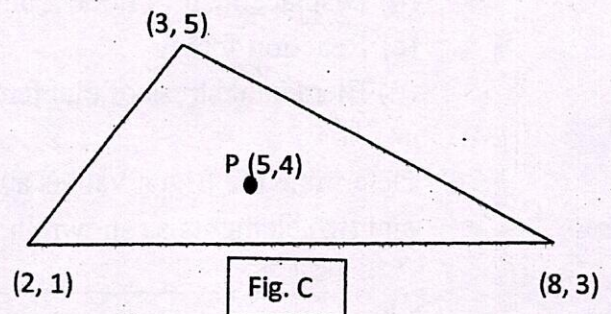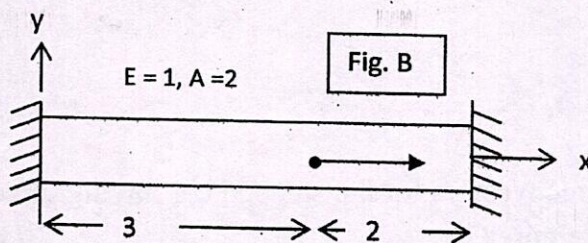
3. (a) Find out the shape functions for a point P shown inside a triangular element shown in the figure C.   (5)
   (b) Find strain displacement matrix for the elements shown in the figure D.   (5)

Fig. D

P.T.O.
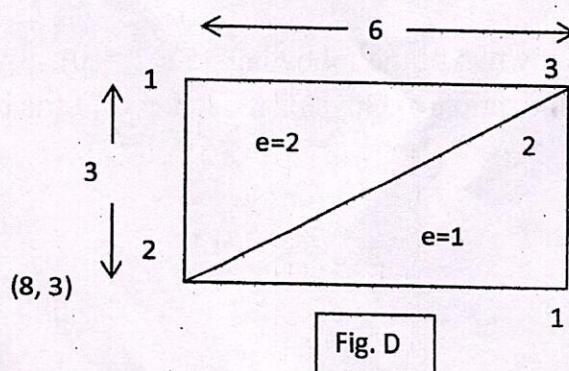
4. Consider the plate with unit thickness as shown in the figure E. An axial load (P= 20 kN) is applied on the bar. Use the FEM approach with three elements to find the following. (a) Element stiffness matrices (b) Combined stiffness matrix (c) Nodal displacements (d) Element stress. You may ignore the gravitational forces. Take following material properties, specific gravity = 10 gm/cm³, E = 100 GPa. Make assumptions if required. (10)

Fig E

E = 120 GPa
Area of cross
section 1 cm²

Fig. F
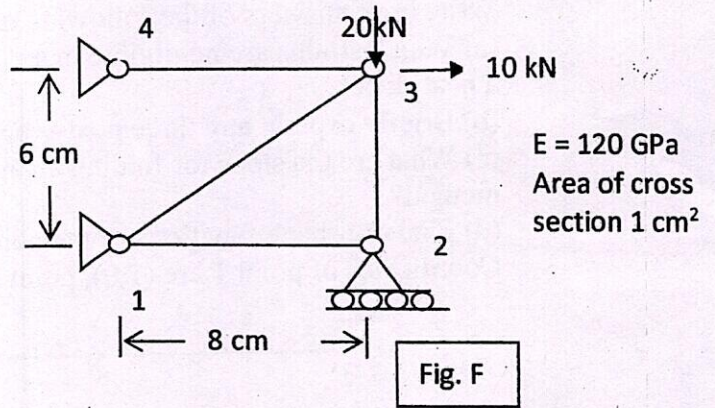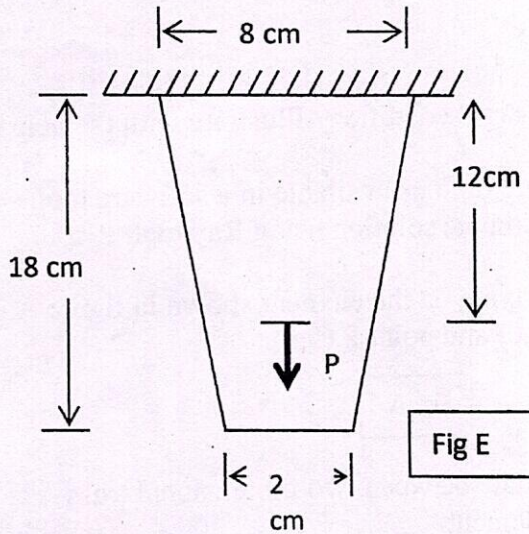
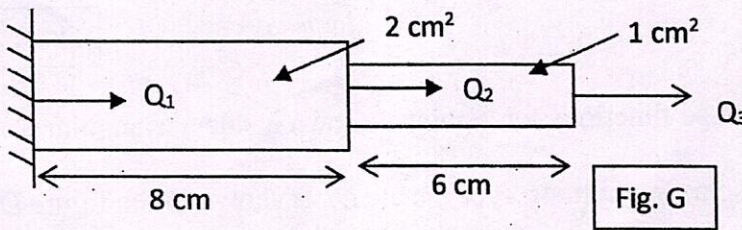## Section III

5. The four bar truss shown in the figure F. Find the following using FEM approach.
(10)

   (a) Combined stiffness matrix
   (b) Displacement of node 2 and 3
   (c) Reaction forces
   (d) Elemental stress of elements 1-3, 2-3.

6. Determine the Eigen values and eigenvectors for the stepped bar having three nodes and two elements as shown in the figure G. (10)

Fig. G

7. Write short notes on any two of the following. (5 x 2 =10)
   (a) Design parameterization (b) Guyen's reduction (c) Structural optimization

x-x-x