

**PARUL UNIVERSITY**  
**FACULTY OF ENGINEERING & TECHNOLOGY**  
**B. Tech. Winter 2022 - 23 Examination**

Semester: 7

Subject Code: 03109430

Subject Name: Finite Element Methods

Date: 12/10/2022

Time: 02:00 pm to 04:30 pm

Total Marks: 60

**Instructions:**

1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.
4. Start new question on new page.

**Q.1 Objective Type Questions - (Each of one mark) All questions are compulsory (15)**

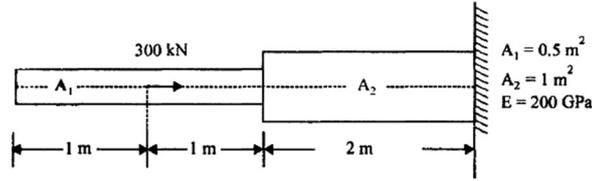
1. Write down the stiffness matrix equation for two dimensional CST elements.
2. Penalty approach leads to \_\_\_\_\_ displacements at supports.
3. State the principle of virtual energy:
4. If the functions of same order are used to represent displacement as well as geometry, then the element is called an \_\_\_\_\_?
5. Crankshaft vibration problem falls under which category of dynamic analysis problems?
6. Name any two FEA softwares.
7. When fewer nodes are used to define the geometry than are used to define the displacement, the element is called \_\_\_\_\_ element.
8. Accuracy of solution \_\_\_\_\_ with increase of number of beam elements.
9. How do you calculate the size of the global stiffness matrix?
10. What is CST element?
11. To solve FEM problems, it subdivides a large problem into smaller, simpler parts that are called:  
a finite elements                      b infinite elements                      c dynamics elements                      d static elements
12. Finite element method formulation of problem results in a system of :  
a logical equations                      b algebraic equations                      c Arithmetic equations                      d flow equations
13. Displacement method of FEM for structural analysis gives :  
a flexibility matrix                      b stiffness matrix                      c conductance matrix                      d mixed matrix
14. Elements connecting lower order elements and higher order elements in a mesh is called  
a transition elements                      b sub-parametric elements                      c iso-parametric elements                      d super-parametric elements
15. Primary variable in FEM structural analysis is  
a Displacement                      b Strain                      c Stress                      d Force

**Q.2 Answer the following questions. (Attempt any three) (15)**

- A) State different types of errors involved in solution of FEA.
- B) Differentiate between Finite Difference Method (FDM) and Finite Element Method (FEM)
- C) State basic theorems of Iso-parametric concept.
- D) Explain Aspect Ratio in terms of finite elements.

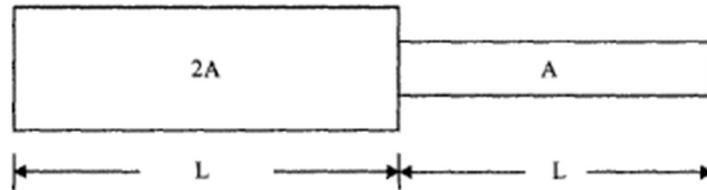
Q.3 A) Explain steps involved in Finite Element Method. (07)

B) Determine the nodal displacements and element stresses by finite element formulation for the following axial bar. Use  $P = 300 \text{ kN}$ ;  $A_1 = 0.5 \text{ m}^2$ ;  $A_2 = 1 \text{ m}^2$ ;  $E = 200 \text{ GPa}$  (08)



OR

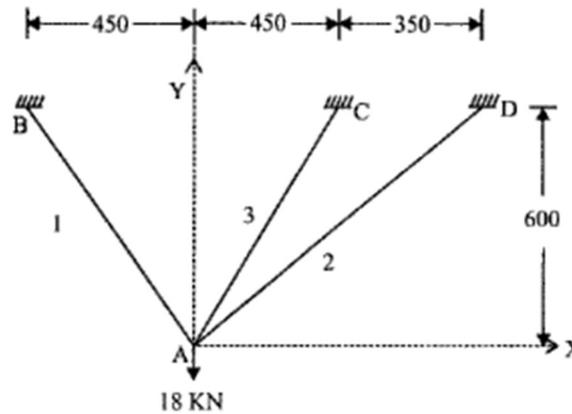
B) Find the natural frequencies of longitudinal vibrations of the unconstrained stepped shaft of areas  $A$  and  $2A$  and of equal lengths ( $L$ ), as shown below. (08)



Q.4 A) Classify finite elements according to Simplex, Complex and Multiplex categories. (07)

OR

A) For the three bar truss shown in figure below, determine the displacements of node 'A' and the stress in element 3. (07)



$$A = 250 \text{ mm}^2; E = 200 \text{ GPa}$$

B) A metallic fin, with thermal conductivity  $360 \text{ W/m}^\circ\text{K}$ ,  $0.1 \text{ cm}$  thick and  $10 \text{ cm}$  long extends from a plane wall whose temperature is  $235^\circ\text{C}$ . Determine the temperature distribution along the fin if heat is transferred to ambient air at  $20^\circ\text{C}$  with heat transfer coefficient of  $9 \text{ W/m}^2\text{K}$ . Take width of the fin as  $1 \text{ m}$ . (08)