

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER-VI(NEW) – EXAMINATION – SUMMER 2019

Subject Code:2160609

Date:27/05/2019

Subject Name:Computational Mechanics

Time:10:30 AM TO 01:30 PM

Total Marks: 70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Draw neat sketch /diagram wherever necessary.

- Q.1**
- (a) Derive member stiffness matrix of the beam member with usual notations. **03**
 - (b) Explain symmetry and anti-symmetry with suitable examples. **04**
 - (c) Analyse continuous beam ABC as shown in **Figure-1** using stiffness member approach and draw bending moment and shear force diagram. Assume EI to be constant for all members. **07**

- Q.2**
- (a) Explain the concept of rotation of axes in 2D and derive relation $A_M = R_T A_S$, from first principles. **03**
 - (b) Explain material and geometric nonlinearities using suitable examples. **04**
 - (c) Determine the displacement and rotation under the force and moment located at the center of the beam in **figure-2** using stiffness member approach. Consider $E = 210\text{GPa}$ and $I = 4 \times 10^{-4} \text{ m}^4$. **07**

OR

- (c) Using stiffness member approach compute reactions continuous beam ABCD as shown in **Figure-3** when Support **B** sinks down by 0.005m and support **C** sinks down 0.01. Assume $E = 200 \text{ GPa}$ and $I = 4 \times 10^{-4} \text{ m}^4$. **07**
- Q.3**
- (a) For the plane truss shown in **figure-4**, determine the joint displacements and support reactions using stiffness member approach. Take modulus of elasticity $E = 200 \text{ GPa}$ and area of member AB=1500mm² and area of BC=CA=1500mm². **07**
 - (b) Using member stiffness method obtain the member forces in the plane truss shown in **figure-5** and determine the support reactions. Take $E = 200 \text{ GPa}$ and $A = 2000 \text{ mm}^2$. **07**

OR

- Q.3**
- (c) Analyze the rigid frame shown in **figure- 6** by direct stiffness method. Assume $E = 200\text{GPa}$; $I_{ZZ} = 1.33 \times 10^4 \text{ m}^4$ and $A = 0.04\text{m}^2$. EI and axial rigidity AE are the same for both the members. **07**
 - (b) A rigid frame is loaded as shown in the **figure-6**, Compute the reactions and draw bending moment, shear force and axial force diagram if the support 'C' settles by 10 mm vertically downwards. **07**
- Q.4**
- (a) Determine rearranged joint stiffness matrix for the grid shown in **figure-7**. Both members have same torsional rigidity and flexural rigidity. Take $GJ = 0.8EI$. Consider $P = 10\text{kN}$ and $L = 4\text{m}$. **07**
 - (b) Determine the joint displacements of the truss shown in **figure-8** by member stiffness method. Assume that all members have the same axial rigidity $AE = \text{constant}$. **07**

OR

- Q.4**
- (a) Enlist various steps of finite element method. **03**
 - (b) Derive shape functions for 2-noded bar element. **04**
 - (c) Derive the equation $[k]\{q\} = \{f\}$ using minimum potential energy approach. **07**
- Q.5**
- (a) Determine the shape functions for a Constant Strain Triangular (CST) element in cartesian coordinate systems. **03**

- (b) Evaluate strain-displacement matrix of the CST element of **figure -9**. The coordinates are given in units of millimeters. Let $E = 210 \text{ GPa}$, Poisson's ratio $= 0.25$ and plate thickness $= 10 \text{ mm}$. **04**
- (c) Three springs are joined together as shown in **figure-10**. Evaluate nodal displacements and forces in the springs. **07**

OR

- Q.5** (a) Determine the element stiffness matrix for the element having coordinates as shown in **figure-11** in units of mm. Assume plane stress conditions. Consider $E = 30 \times 10^6 \text{ N/mm}^2$, Poisson's ratio $= 0.25$, and thickness $t = 1 \text{ mm}$. The element nodal displacements have been determined to be $u_1 = 0.0$, $v_1 = 0.0025 \text{ mm}$, $u_2 = 0.0012 \text{ mm}$, $v_2 = 0$, $u_3 = 0$ and $v_3 = 0.0025 \text{ mm}$. **07**
- (b) For the plane stress CST element shown in **figure-11**, Determine the element stresses σ_x , σ_y , τ_{xy} . **07**


