

GUJARAT TECHNOLOGICAL UNIVERSITY
ME – SEMESTER I (OLD) – • EXAMINATION – SUMMER 2016

Subject Code: 712001N**Date: 16/05/2016****Subject Name: Advanced Structural Analysis****Time: 02:30 pm to 05:00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Take $E = 2 \times 10^8 \text{ kN/m}^2$, $I_Z = 0.001 \text{ m}^4$, $A_X = 0.01 \text{ m}^2$, $I_X = 0.002 \text{ m}^4$ and $G = 8 \times 10^7 \text{ kN/m}^2$ unless and otherwise given.

Q.1 (a) Analyse the truss shown in Figure 1, using member approach stiffness method. **14**
 Tabulate the member forces.

Q.2 (a) Derive the relation $S_{MS} = R_T^T S_M R_T$ with usual notations. Also write R_T **07**
 matrix for plane truss, plane frame and grid structures.

(b) Derive rotation transformation matrix for a space truss member. **07**

OR

(b) Define the types of non-linearity, list the methods of non-linear analysis and explain any one of them in detail. **07**

Q.3 Analyse a composite structure shown in Figure 2 using stiffness method **14**
 member approach. Beam AB is made of steel ($E = 200 \text{ GPa}$) with square cross-section of $100 \text{ mm} \times 100 \text{ mm}$. Cable BC is also made of steel with 10 mm diameter.

OR

Q.3 Analyse the plane frame shown in Figure 3, using member approach stiffness **14**
 method.

Q.4 (a) Explain method to solve simultaneous equations giving computer program. **07**

(b) Derive stiffness matrix for a beam member considering shear deformation. **07**

OR

Q.4 Analyse the plane frame shown in Figure 4 using flexibility member method. **14**

Q.5 Analyse the plane truss shown in Figure 1 using flexibility member method **14**

OR

Q.5 Analyse the beam shown in Figure 5, using member approach stiffness **14**
 method.

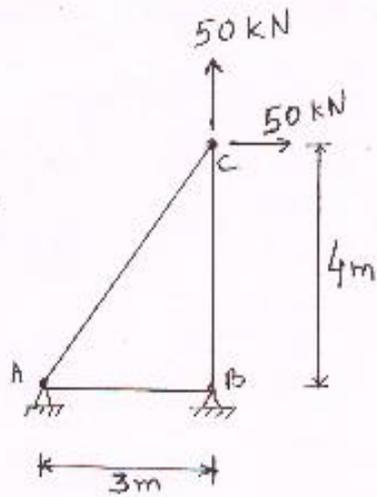


Figure 1

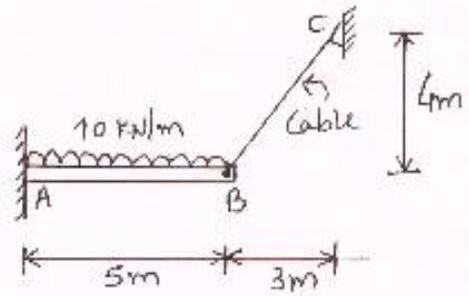


Figure 2

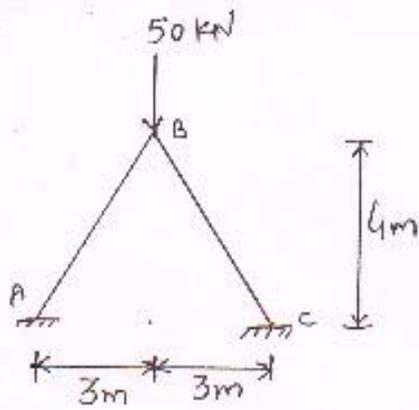


Figure 3

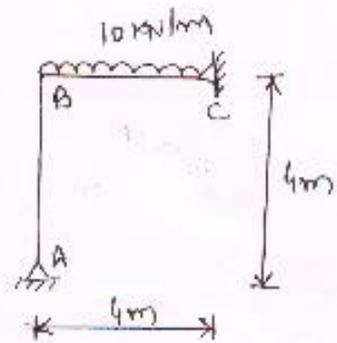


Figure 4

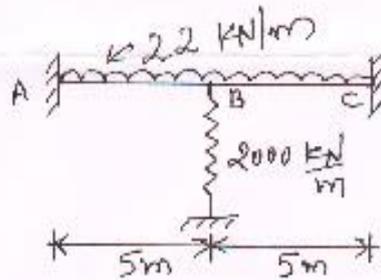


Figure 5

Plane Frame Member Stiffness Matrix for Structure Axes

$$S_{MSi} = \begin{bmatrix} \frac{EA_X}{L} C_X^2 + \frac{12EI_Z}{L^3} C_Y^2 & \left(\frac{EA_X}{L} - \frac{12EI_Z}{L^3}\right) C_X C_Y & -\frac{6EI_Z}{L^2} C_Y & -\left(\frac{EA_X}{L} C_X^2 + \frac{12EI_Z}{L^3} C_Y^2\right) & -\left(\frac{EA_X}{L} - \frac{12EI_Z}{L^3}\right) C_X C_Y & -\frac{6EI_Z}{L^2} C_Y \\ \left(\frac{EA_X}{L} - \frac{12EI_Z}{L^3}\right) C_X C_Y & \frac{EA_X}{L} C_Y^2 + \frac{12EI_Z}{L^3} C_X^2 & \frac{6EI_Z}{L^2} C_X & -\left(\frac{EA_X}{L} - \frac{12EI_Z}{L^3}\right) C_X C_Y & -\left(\frac{EA_X}{L} C_Y^2 + \frac{12EI_Z}{L^3} C_X^2\right) & \frac{6EI_Z}{L^2} C_X \\ -\frac{6EI_Z}{L^2} C_Y & \frac{6EI_Z}{L^2} C_X & \frac{4EI_Z}{L} & \frac{6EI_Z}{L^2} C_Y & -\frac{6EI_Z}{L^2} C_X & \frac{2EI_Z}{L} \\ -\left(\frac{EA_X}{L} C_X^2 + \frac{12EI_Z}{L^3} C_Y^2\right) & -\left(\frac{EA_X}{L} - \frac{12EI_Z}{L^3}\right) C_X C_Y & \frac{6EI_Z}{L^2} C_Y & \frac{EA_X}{L} C_X^2 + \frac{12EI_Z}{L^3} C_Y^2 & \left(\frac{EA_X}{L} - \frac{12EI_Z}{L^3}\right) C_X C_Y & \frac{6EI_Z}{L^2} C_Y \\ -\left(\frac{EA_X}{L} - \frac{12EI_Z}{L^3}\right) C_X C_Y & -\left(\frac{EA_X}{L} C_Y^2 + \frac{12EI_Z}{L^3} C_X^2\right) & -\frac{6EI_Z}{L^2} C_X & \left(\frac{EA_X}{L} - \frac{12EI_Z}{L^3}\right) C_X C_Y & \left(\frac{EA_X}{L} C_Y^2 + \frac{12EI_Z}{L^3} C_X^2\right) & -\frac{6EI_Z}{L^2} C_X \\ -\frac{6EI_Z}{L^2} C_Y & \frac{6EI_Z}{L^2} C_X & \frac{2EI_Z}{L} & \frac{6EI_Z}{L^2} C_Y & -\frac{6EI_Z}{L^2} C_X & \frac{4EI_Z}{L} \end{bmatrix}$$