

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER-VII (OLD) - EXAMINATION – SUMMER 2017

Subject Code: 170605

Date: 29/04/2017

Subject Name: Advanced Structural Analysis (Department Elective-I)

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 $E = 2 \times 10^8 \text{ kN/m}^2$, $I = 0.001 \text{ m}^4$, $J = 0.002 \text{ m}^4$, $A = 0.01 \text{ m}^2$, $G = 8 \times 10^7 \text{ kN/m}^2$.

- Q.1** (a) For a continuous beam shown in Figure 1, obtain rearranged joint stiffness matrix. **07**
- (b) Calculate support reactions and the free joint displacements for the above beam as shown in Figure 1. **07**

- Q.2** (a) Obtain rearranged joint stiffness matrix for a plane truss shown in Figure 2. **07**
- (b) Calculate free joint displacements and member end forces for the above truss shown in Figure 2. **07**

OR

- (b) Construct joint stiffness matrix for a composite structure as shown in Figure 3. AB is beam member and BC is plane truss member. A , E and I values are as mentioned in the Instructions. **07**
- Q.3** (a) Construct rearranged joint stiffness matrix for the plane frame shown in Figure 4. **07**
- (b) Calculate support reactions and free joint displacements for the plane frame shown in Figure 4. **07**

OR

- Q.3** (a) Construct rearranged joint stiffness matrix for a grid as shown in Figure 5. **07**
- (b) Obtain load vector for the grid shown in Figure 5. **07**
- Q.4** (a) Give the stepwise procedure of finite element method. **07**
- (b) Determine the shape functions for the Constant Strain Triangle. Use natural coordinate systems. **07**

OR

- Q.4** (a) Write a user defined function to assemble joint stiffness matrix of a continuous beam. Use of comment statement to impart readability of the function program carries weightage. **07**
- (b) List various methods for solution of linear simultaneous equations using matrices. Give algorithm or C/C++ program for any of them. **07**

- Q.5** For a beam shown in Figure 6, obtain beam end forces and deflection under the load using finite element method. Plot shear force and bending moment diagrams. **14**

OR

- Q.5** (a) Obtain load vector for a beam shown in Figure 1 if (a) the temperature of member AB is increased such that bottom and top fibers are at 10^0 C and 20^0 C , **07**

respectively and (b) support A sinks by 2 mm. Neglect the external loads and consider roller support in place of spring at B.

- (b) Obtain rotation transformation matrix for a space truss.

07

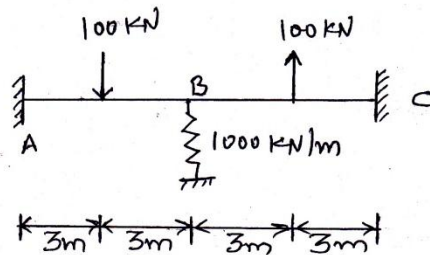


Figure 1

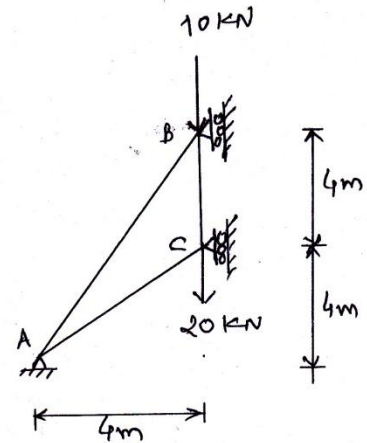


Figure 2

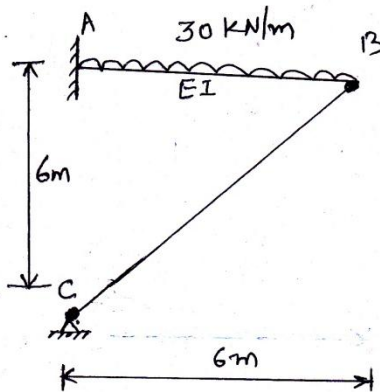


Figure 3

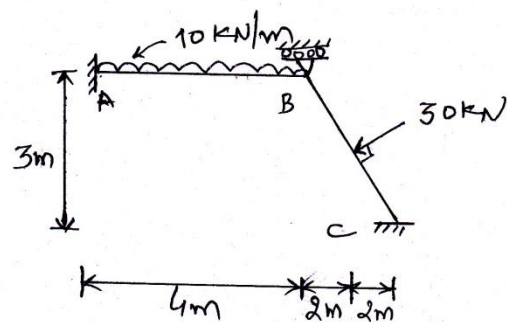


Figure 4

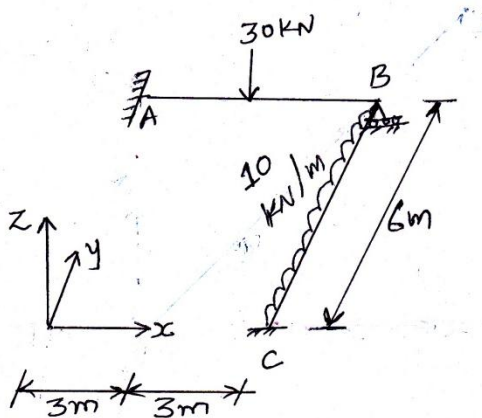


Figure 5

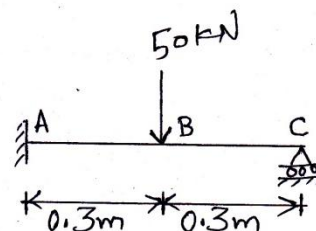


Figure 6

Plane Frame Member Stiffness Matrix for Structure Axes

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

Grid Member Stiffness Matrix for Structure Axes

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