MACHAKOS UNIVERSITY

University Examinations for 2020/2021Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

THIRD YEAR SPECIAL/ SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 312: THEORY OF STRUCTURES IV

DATE: 26/3/2021 **TIME: 11.00-1.00 PM**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (20 MARKS)

Determine the reactions and the force in each member of the truss shown in the Figure 1 below by finite element method. EA=constant

QUESTION TWO (20 MARKS)

Determine the reactions and the member end forces for the three-span continuous beam shown in the Figure 2 below using finite element method. E=200 GPa, I=216(10^6) mm^4

QUESTION THREE (20 MARKS)

Determine the reactions and the member forces the two-member frame shown in the Figure 3 below. Take I=243(10^6) mm^4, A=6000 mm^2 and E=200 Gpa for both members.

QUESTION FOUR (20 MARKS)

Determine the reactions and the member end forces of the frame shown in the Figure 4 below. Take I=250(10^6) mm4, A=900mm^2 and E=200 Gpa for each member.

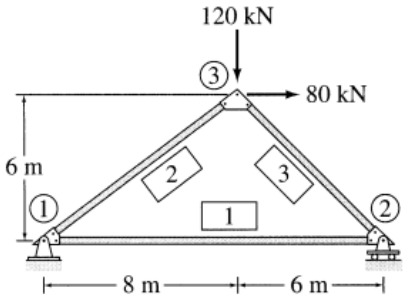

Figure 1

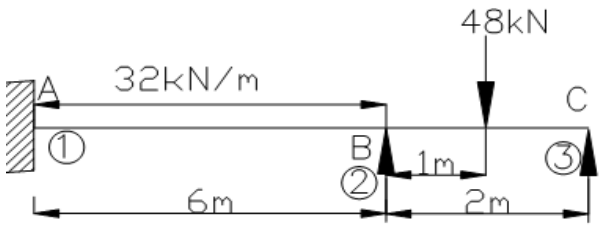

Figure 2

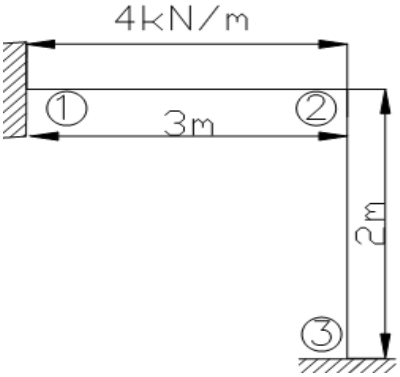

Figure 3

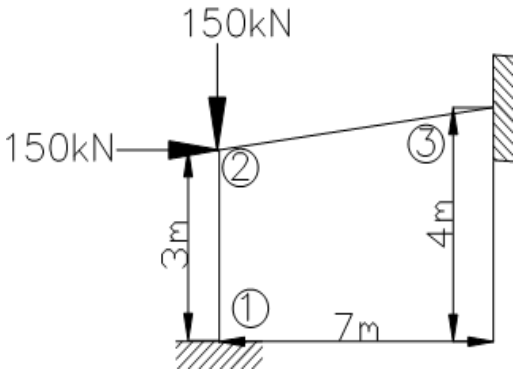

Figure 4

HINTS

$$\begin{bmatrix} \frac{EA}{L} & 0 & 0 & -\frac{EA}{L} & 0 & 0 \\ 0 & \frac{12EI}{L^3} & \frac{6EI}{L^2} & 0 & -\frac{12EI}{L^3} & \frac{6EI}{L^2} \\ 0 & \frac{6EI}{L^2} & \frac{4EI}{L} & 0 & -\frac{6EI}{L^2} & \frac{2EI}{L} \\ -\frac{EA}{L} & 0 & 0 & \frac{EA}{L} & 0 & 0 \\ 0 & -\frac{12EI}{L^3} & -\frac{6EI}{L^2} & 0 & \frac{12EI}{L^3} & -\frac{6EI}{L^2} \\ 0 & \frac{6EI}{L^2} & \frac{2EI}{L} & 0 & -\frac{6EI}{L^2} & \frac{4EI}{L} \end{bmatrix}$$

$\lambda_x = \cos\theta_x$

$\lambda_y = \cos\theta_y$

$$\begin{bmatrix}
\left(\frac{AE}{L}\lambda_{ix}^2+\frac{12EI}{L^3}\lambda_{iy}^2\right) & \left(\frac{AE}{L}-\frac{12EI}{L^3}\right)\lambda_{ix}\lambda_{iy} & -\frac{6EI}{L^2}\lambda_{iy} & -\left(\frac{AE}{L}\lambda_{ix}\lambda_{jx}+\frac{12EI}{L^3}\lambda_{iy}\lambda_{jy}\right) & -\left(\frac{AE}{L}\lambda_{ix}\lambda_{jy}-\frac{12EI}{L^3}\lambda_{iy}\lambda_{jx}\right) & -\frac{6EI}{L^2}\lambda_{iy} \\
\left(\frac{AE}{L}-\frac{12EI}{L^3}\right)\lambda_{ix}\lambda_{iy} & \left(\frac{AE}{L}\lambda_{iy}^2+\frac{12EI}{L^3}\lambda_{ix}^2\right) & \frac{6EI}{L^2}\lambda_{ix} & -\left(\frac{AE}{L}\lambda_{iy}\lambda_{jx}-\frac{12EI}{L^3}\lambda_{ix}\lambda_{jy}\right) & -\left(\frac{AE}{L}\lambda_{iy}\lambda_{jy}+\frac{12EI}{L^3}\lambda_{ix}\lambda_{jx}\right) & \frac{6EI}{L^2}\lambda_{ix} \\
-\frac{6EI}{L^2}\lambda_{iy} & \frac{6EI}{L^2}\lambda_{ix} & \frac{4EI}{L} & \frac{6EI}{L^2}\lambda_{jy} & -\frac{6EI}{L^2}\lambda_{jx} & \frac{2EI}{L} \\
-\left(\frac{AE}{L}\lambda_{ix}\lambda_{jx}+\frac{12EI}{L^3}\lambda_{iy}\lambda_{jy}\right) & -\left(\frac{AE}{L}\lambda_{iy}\lambda_{jx}-\frac{12EI}{L^3}\lambda_{ix}\lambda_{jy}\right) & \frac{6EI}{L^2}\lambda_{jy} & \left(\frac{AE}{L}\lambda_{jx}^2+\frac{12EI}{L^3}\lambda_{jy}^2\right) & \left(\frac{AE}{L}-\frac{12EI}{L^3}\right)\lambda_{jx}\lambda_{jy} & \frac{6EI}{L^2}\lambda_{jy} \\
-\left(\frac{AE}{L}\lambda_{ix}\lambda_{jy}-\frac{12EI}{L^3}\lambda_{iy}\lambda_{jx}\right) & -\left(\frac{AE}{L}\lambda_{iy}\lambda_{jy}+\frac{12EI}{L^3}\lambda_{ix}\lambda_{jx}\right) & -\frac{6EI}{L^2}\lambda_{jx} & \left(\frac{AE}{L}-\frac{12EI}{L^3}\right)\lambda_{jx}\lambda_{jy} & \left(\frac{AE}{L}\lambda_{jy}^2+\frac{12EI}{L^3}\lambda_{jx}^2\right) & -\frac{6EI}{L^2}\lambda_{jx} \\
-\frac{6EI}{L^2}\lambda_{iy} & \frac{6EI}{L^2}\lambda_{ix} & \frac{2EI}{L} & \frac{6EI}{L^2}\lambda_{jy} & -\frac{6EI}{L^2}\lambda_{jx} & \frac{4EI}{L}
\end{bmatrix}$$

FIXED END FORCES

At A

$$M_A = -\frac{Wab^2}{L^2}$$

$$R_A = -\frac{Wb}{L^3}(l^2 + ab - a^2)$$

At B

$$M_B = -\frac{Wa^2b}{L^2} R_A = -\frac{Wa}{L^3}(l^2 + ab - b^2)$$