MACHAKOS UNIVERSITY

University Examination 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

THIRD YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR IN CIVIL ENGINEERING

ECV 312 THEORY OF STRUCTURES IV

DATE: 27/9/2019 **TIME: 2.00-4.00 PM**

INSTRUCTIONS TO CANDIDATES

- THIS IS A CLOSED BOOK EXAMINATION
- ATTEMPT ANY THREE QUESTIONS
- ALL SYMBOLS USED HAVE USUAL MEANINGS
- PROGRAMMABLE CALCULATORS AND OTHER ELECTRONIC GADGETS ARE NOT ALLOWED IN THE EXAMINATION ROOM. SHARING OF CALCULATORS IS PROHIBITED.

QUESTION ONE [20 MARKS]

Determine the displacement of the joints, member axial forces and the reactions of the truss shown in **Figure 1**. All dimensions are in meters. Take E=70GPa, cross-sectional area for member, 1-2 and 4-5=20cm^2, cross-sectional area for member 3-4,2-4 and 2-3=50cm^2

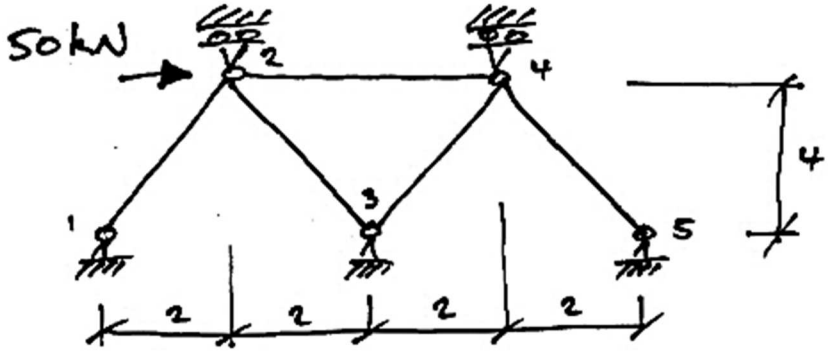

Figure 1

QUESTION 2 [20 MARKS]

Draw the bending moment and shear force diagram of the beam shown in **Figure 2**. Take EI=20x10^{3}kNm^2

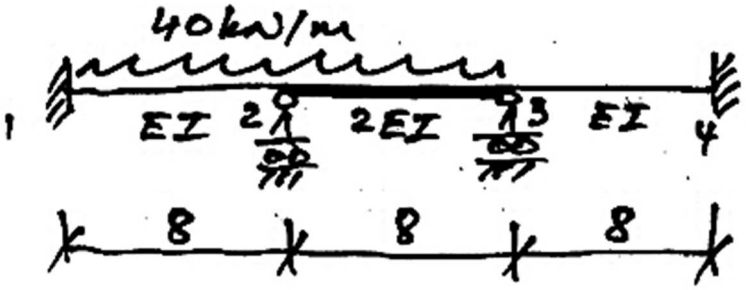

Figure 2

QUESTION 3 [20 MARKS]

Draw the bending moment and shear force diagram of the frame shown in **Figure 3**.

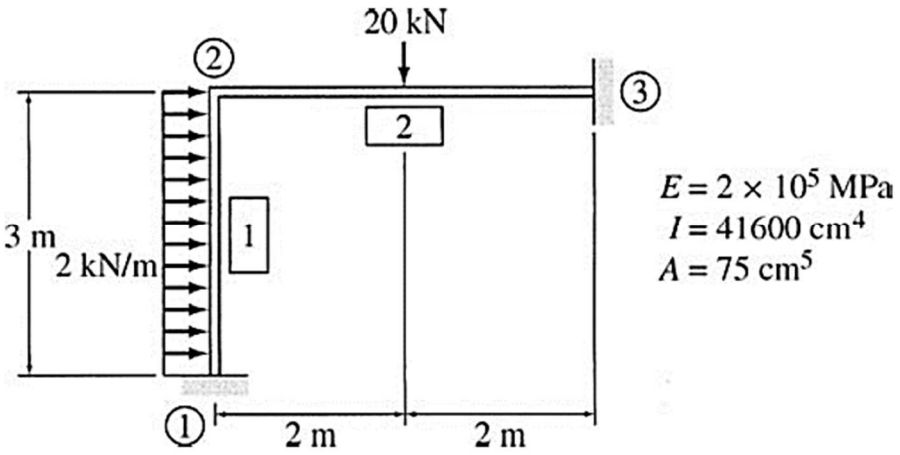

Figure 3

QUESTION 4 [20 MARKS]

Draw the bending moment and shear force diagram of the frame shown **Figure 4**. Assume all supports and joints are fixed. Take E=200 GPa, I=300x10^6mm^4, A=10000mm^2

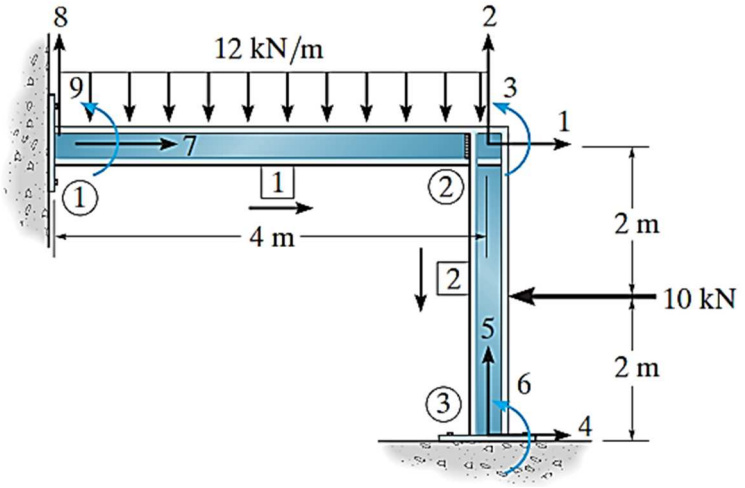

Figure 4

HINTS

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

$$\mathbf{K} = \begin{bmatrix} \frac{EA}{L}c^2 + \frac{12EI}{L^3}s^2 & \frac{EA}{L}cs - \frac{12EI}{L^3}cs & -\frac{6EI}{L^2}s & -\frac{EA}{L}c^2 - \frac{12EI}{L^3}s^2 & -\frac{EA}{L}cs + \frac{12EI}{L^3}cs & -\frac{6EI}{L^2}s \\ & \frac{EA}{L}s^2 + \frac{12EI}{L^3}c^2 & \frac{6EI}{L^2}c & -\frac{EA}{L}cs + \frac{12EI}{L^3}cs & -\frac{EA}{L}s^2 - \frac{12EI}{L^3}c^2 & \frac{6EI}{L^2}c \\ & & \frac{4EI}{L} & \frac{6EI}{L^2}s & -\frac{6EI}{L^2}c & \frac{2EI}{L} \\ & & & \frac{EA}{L}c^2 + \frac{12EI}{L^3}s^2 & \frac{EA}{L}cs - \frac{12EI}{L^3}cs & \frac{6EI}{L^2}s \\ & \text{SYM} & & & \frac{EA}{L}s^2 + \frac{12EI}{L^3}c^2 & -\frac{6EI}{L^2}c \\ & & & & & \frac{4EI}{L} \end{bmatrix}$$

FIXED END FORCES

At A $M_A = -\frac{Wab^2}{L^2}$ $\quad R_A = -\frac{Wb}{L^3}(l^2 + ab - a^2)$

At B $M_B = -\frac{Wa^2b}{L^2}$ $\quad R_B = -\frac{Wa}{L^3}(l^2 + ab - b^2)$