NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF CIVIL AND WATER ENGINEERING

STRUCTURAL ANALYSIS I

TCW 3102

Examination Paper

November /December 2015

This examination paper consists of 7 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements:

Examiner's Name: Miss Diana Makweche/ Engineer Noreen Dube

INSTRUCTIONS

1. Answer any four (4) questions
2. Each question carries 25 marks
3. Use of calculators is permissible

MARK ALLOCATION

QUESTION	MARKS
1.	**25**
2.	**25**
3.	**25**
4.	**25**
5.	**25**
TOTAL	**100**

QUESTION 1

(i) Given the following deflected shapes and point loads in Figure Q1A:
(a) Draw the reactions in their correct directions
(b) Sketch the qualitative bending moment, shear force and axial force (where relevant) diagrams. [13]

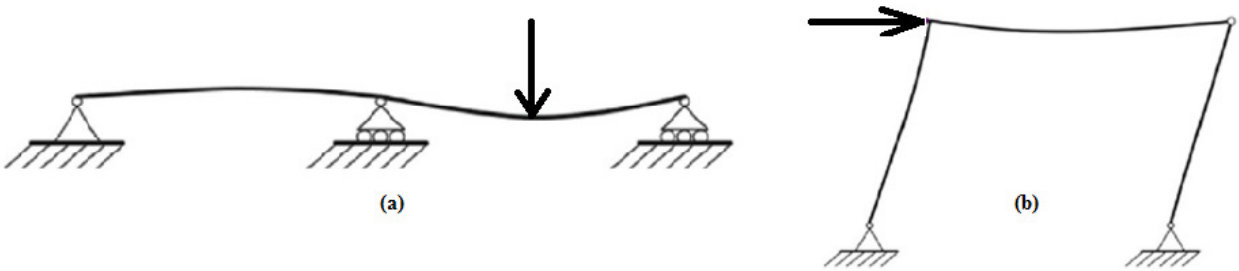


Figure Q1A

(ii) The beam is loaded with concentrated loads which are moving from right to left as shown in Figure Q1B . Calculate the maximum moment at the section C. [12]

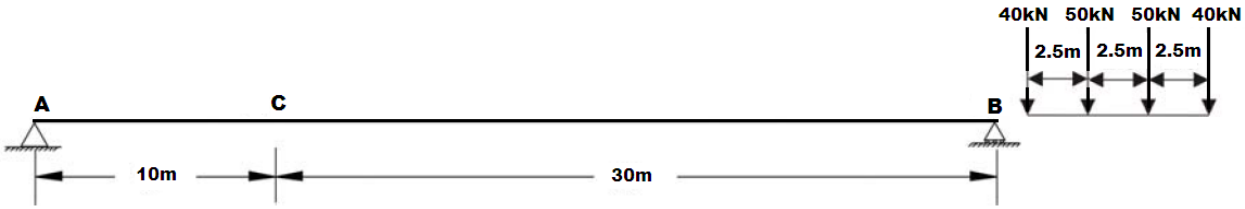


Figure Q1B

QUESTION 2

(i) Figure Q2 shows a propped cantilever fixed at A and supported on a roller at C. It carries a point load of 15kN at mid-span. By taking the support at C as the redundant reaction,
(a) Determine the value of the support reactions
(b) Sketch the shear force and bending moment diagrams. [25]

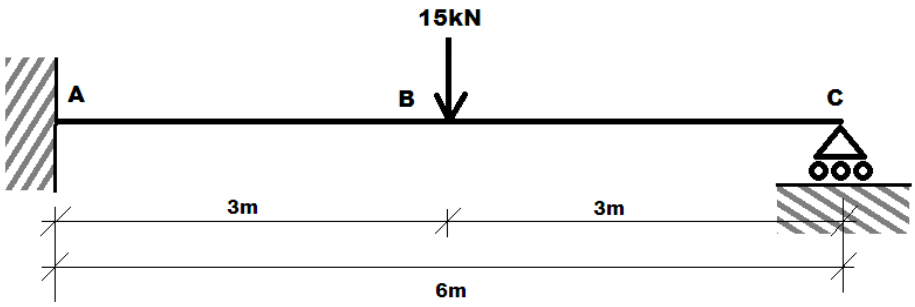


Figure Q2

QUESTION 3

The frame in Figure Q3 is has constant Modulus of Elasticity, E, but varying values of moment of inertia, I, as shown.

(i) Sketch the deflected shape of the frame under the action of the load.

(ii) Analyse the frame using the Moment Distribution Method.

(iii) Determine the support reactions and sketch the bending moment diagram. [25]

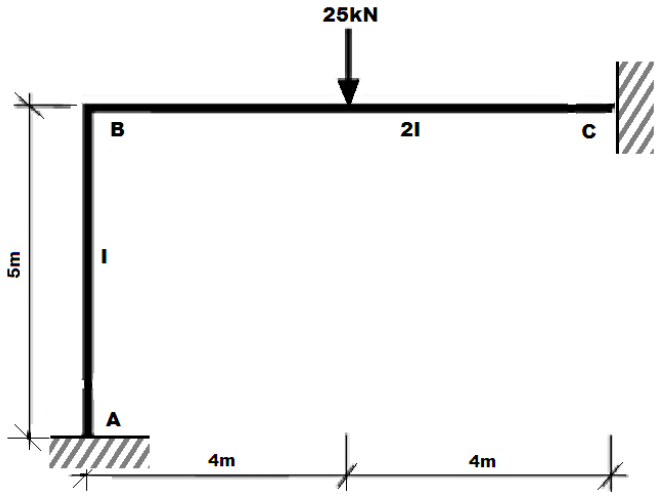


Figure Q3

QUESTION 4

Determine all the member forces and support reactions for the truss in Figure Q4.
Take $E = 205kN/mm^2$ and $A = 175mm^2$ for all members.

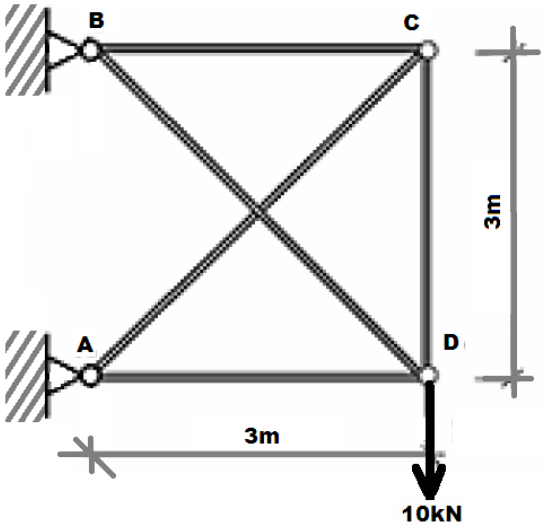


Figure Q4

QUESTION 5

The frame in Figure Q5 sways under the action of the applied loading.

(i) Sketch the deflected shape of the frame.

(ii) Taking EI as constant, analyse the structure and sketch the bending moment diagram.

[25]

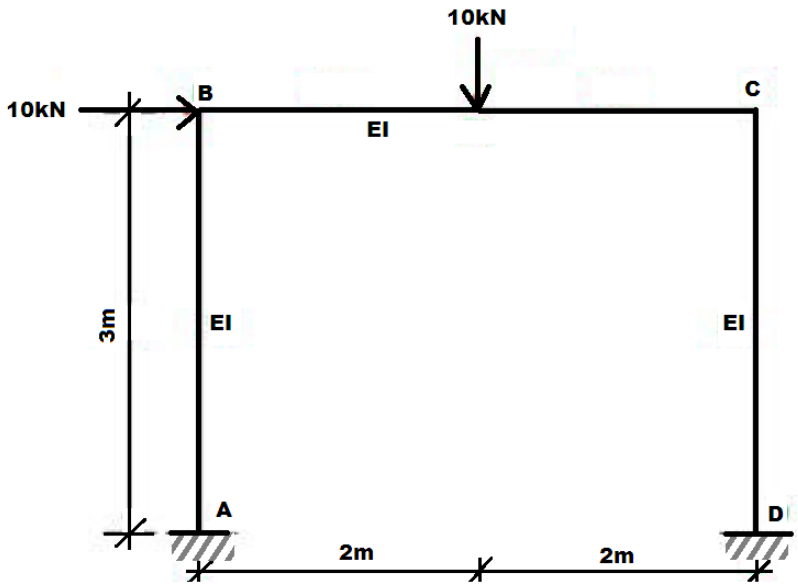
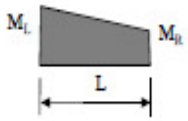
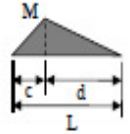
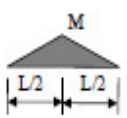
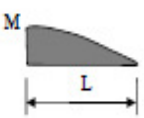
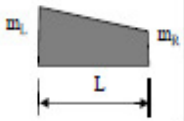
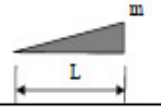
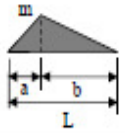
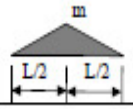


Figure Q5

To Evaluate Product Integrals of the Form: $\int_0^L mMdx$

							
	LmM	$\frac{L}{2}m(M_L + M_R)$	$\frac{L}{2}mM$	$\frac{L}{2}mM$	$\frac{L}{2}mM$	$\frac{L}{3}mM$	$\frac{2L}{3}mM$
	$\frac{L}{2}(m_L + m_R)M$	$\frac{L}{6}[m_L(2M_L + M_R) + m_R(M_L + 2M_R)]$	$\frac{L}{6}(2m_L + m_R)M$	$\frac{L}{6}\left[m_L\left(1+\frac{d}{L}\right) + m_R\left(1+\frac{c}{L}\right)\right]M$	$\frac{L}{4}(m_L + m_R)M$	$\frac{L}{12}(3m_L + m_R)M$	$\frac{L}{12}(5m_L + 3m_R)M$
	$\frac{L}{2}mM$	$\frac{L}{6}m(2M_L + M_R)$	$\frac{L}{3}mM$	$\frac{L}{6}m\left(1+\frac{d}{L}\right)M$	$\frac{L}{4}mM$	$\frac{L}{4}mM$	$\frac{5L}{12}mM$
	$\frac{L}{2}mM$	$\frac{L}{6}m(M_L + 2M_R)$	$\frac{L}{6}mM$	$\frac{L}{6}m\left(1+\frac{c}{L}\right)M$	$\frac{L}{4}mM$	$\frac{L}{12}mM$	$\frac{L}{4}mM$
	$\frac{L}{2}mM$	$\frac{L}{6}m\left[M_L\left(1+\frac{b}{L}\right) + M_R\left(1+\frac{a}{L}\right)\right]$	$\frac{L}{6}m\left(1+\frac{b}{L}\right)M$	$\frac{(L^2 - a^2 - c^2)}{6bc}LmM$ *only for a < c*	$\left(\frac{3L^2 - 4a^2}{12bL}\right)LmM$	$\frac{L}{12}m\left(1+\frac{b}{L} + \frac{b^2}{L^2}\right)M$	$\frac{L}{12}m\left(5-\frac{a}{L} - \frac{a^2}{L^2}\right)M$
	$\frac{L}{2}mM$	$\frac{L}{4}m(M_L + M_R)$	$\frac{L}{4}mM$	$\left(\frac{3L^2 - 4c^2}{12dL}\right)LmM$	$\frac{L}{3}mM$	$\frac{7L}{48}mM$	$\frac{17L}{48}mM$

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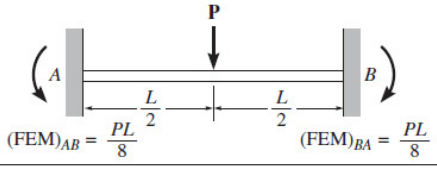
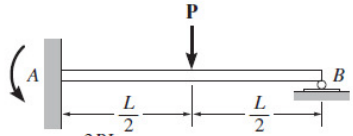
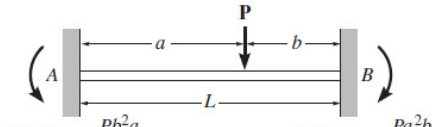
Fixed End Moments



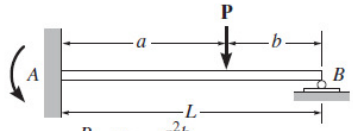
$(FEM)_{AB} = \frac{PL}{8}$ $(FEM)_{BA} = \frac{PL}{8}$



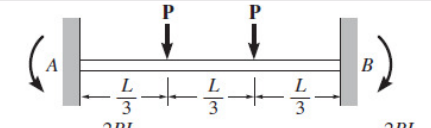
$(FEM)'_{AB} = \frac{3PL}{16}$



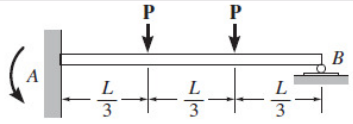
$(FEM)_{AB} = \frac{Pb^2a}{L^2}$ $(FEM)_{BA} = \frac{Pa^2b}{L^2}$



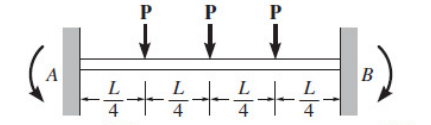
$(FEM)'_{AB} = (\frac{P}{L^2})(b^2a + \frac{a^2b}{2})$



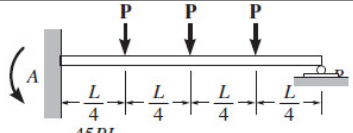
$(FEM)_{AB} = \frac{2PL}{9}$ $(FEM)_{BA} = \frac{2PL}{9}$



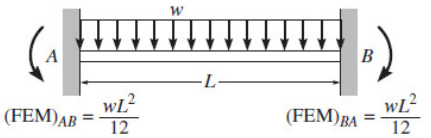
$(FEM)'_{AB} = \frac{PL}{3}$



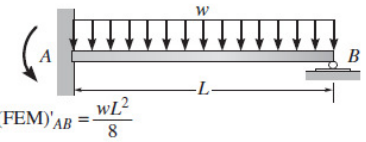
$(FEM)_{AB} = \frac{5PL}{16}$ $(FEM)_{BA} = \frac{5PL}{16}$



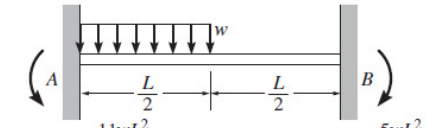
$(FEM)'_{AB} = \frac{45PL}{96}$



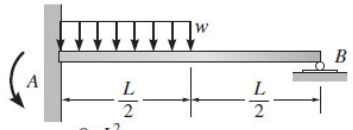
$(FEM)_{AB} = \frac{wL^2}{12}$ $(FEM)_{BA} = \frac{wL^2}{12}$



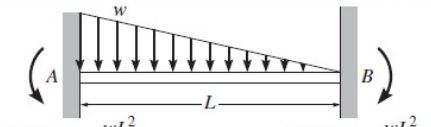
$(FEM)'_{AB} = \frac{wL^2}{8}$



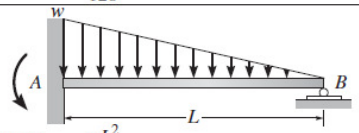
$(FEM)_{AB} = \frac{11wL^2}{192}$ $(FEM)_{BA} = \frac{5wL^2}{192}$



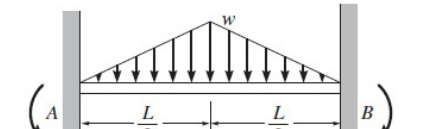
$(FEM)'_{AB} = \frac{9wL^2}{128}$



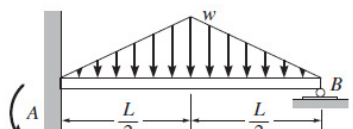
$(FEM)_{AB} = \frac{wL^2}{20}$ $(FEM)_{BA} = \frac{wL^2}{30}$



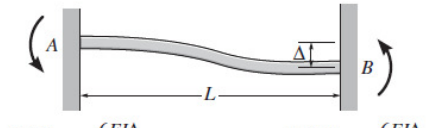
$(FEM)'_{AB} = \frac{wL^2}{15}$



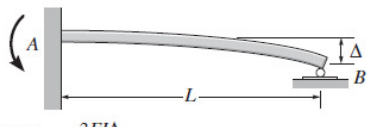
$(FEM)_{AB} = \frac{5wL^2}{96}$ $(FEM)_{BA} = \frac{5wL^2}{96}$



$(FEM)'_{AB} = \frac{5wL^2}{64}$



$(FEM)_{AB} = \frac{6EI\Delta}{L^2}$ $(FEM)_{BA} = \frac{6EI\Delta}{L^2}$



$(FEM)'_{AB} = \frac{3EI\Delta}{L^2}$

Slope Deflection Equations

$$M_N = 2Ek(2\theta_N + \theta_F - 3\psi) + (FEM)_N$$

$$M_N = 3Ek(\theta_N - \psi) + (FEM)_N$$