B. Sc. Engg. (CEE)/7th Semester

9 October, 2023

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Mid Examination | **Winter Semester: 2022–2023**
Course Number: CEE 4711 | **Full Marks: 75**
Course Title: Structural Analysis and Design II | **Time: 1.5 Hours**

There are 4 (four) questions. Question no. 1 is compulsory. Answer any 2 from question 2, 3 and 4. The figures in the right margin indicate full marks. Cos and POs are also specified in the right margin of the questions. The symbols have their usual meaning.

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1. (a) Define rotational stiffness and derive the stiffness factor of a beam element having its far end fixed. **(CO1) (PO1)** **(5)**

   (b) Analyze the frame shown in Fig. 1 using moment distribution method and determine the moments at each joint of the frame. The moment of inertia of each member is indicated in the figure. **(CO2) (PO2)** **(20)**

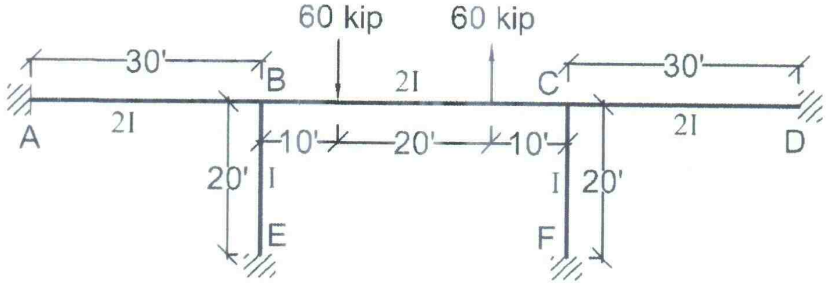


Fig. 1 for Question 1(b)

2. (a) Analyze the beam shown in Fig. 2 using flexibility method and draw the shear force diagram and bending moment diagram. **(CO2) (PO2)** **(15)**

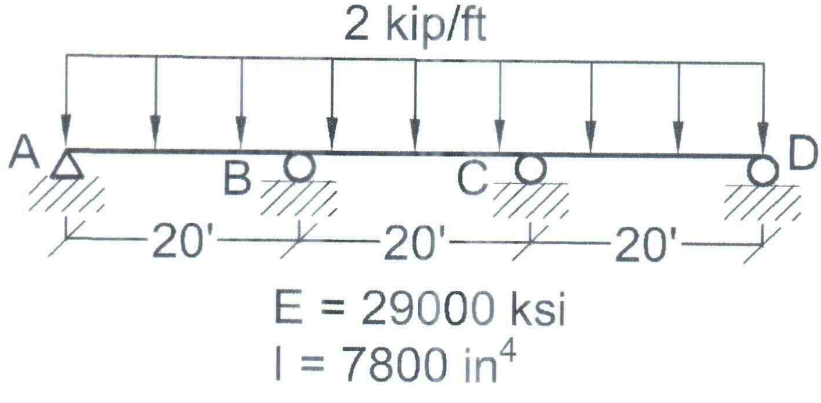


Fig.2 for Question 2(a)

(b) Analyze the frame shown in Fig.3 using flexibility method and determine the moments at each joint and reactions at the supports. **(CO2) (PO2)** **(10)**

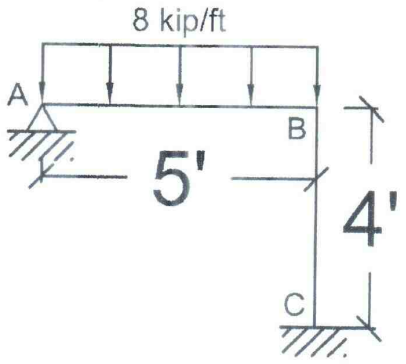


Fig.3 for Question 2(b)

3. Analyze the beam shown in Fig.4 and determine the moments at B, C and D, also draw the shear force and bending moment diagram. EI is constant. **(CO2)** **(PO2)** **(25)**

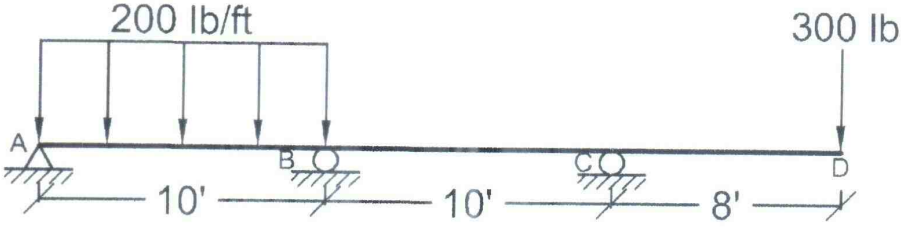


Fig. 4 for Question 3

4. Analyze the frame shown in Fig. 5 using moment distribution method and determine the moments at each joint of the frame. The moment of inertia of each member is indicated in the figure. **(CO2)** **(PO2)** **(25)**

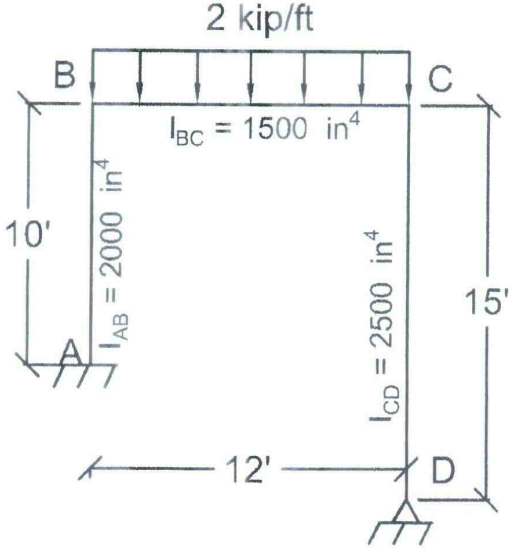
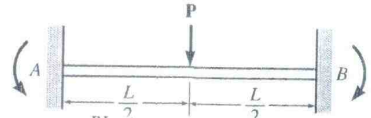
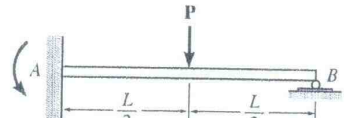


Fig.5 for Question 4

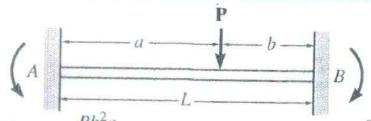
Fixed End Moments



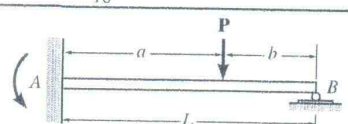
$(FEM)_{AB} = \frac{PL}{8}$ $(FEM)_{BA} = \frac{PL}{8}$



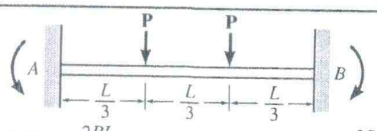
$(FEM)'_{AB} = \frac{3PL}{16}$



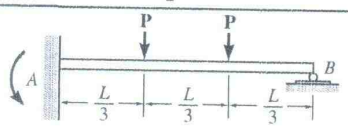
$(FEM)_{AB} = \frac{Pb^2a}{L^2}$ $(FEM)_{BA} = \frac{Pa^2b}{L^2}$



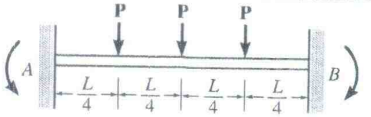
$(FEM)'_{AB} = (\frac{P}{L^2})(b^2a + \frac{a^2b}{2})$



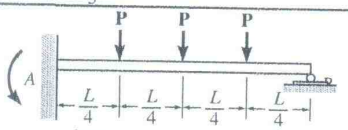
$(FEM)_{AB} = \frac{2PL}{9}$ $(FEM)_{BA} = \frac{2PL}{9}$



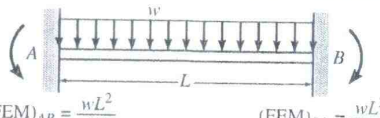
$(FEM)'_{AB} = \frac{PL}{3}$



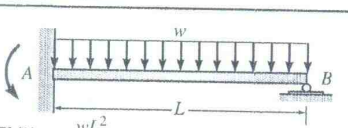
$(FEM)_{AB} = \frac{5PL}{16}$ $(FEM)_{BA} = \frac{5PL}{16}$



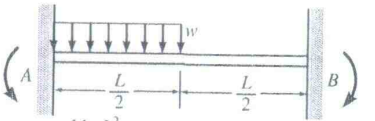
$(FEM)'_{AB} = \frac{45PL}{96}$



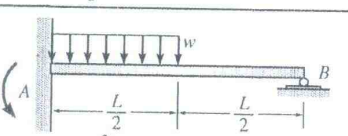
$(FEM)_{AB} = \frac{wL^2}{12}$ $(FEM)_{BA} = \frac{wL^2}{12}$



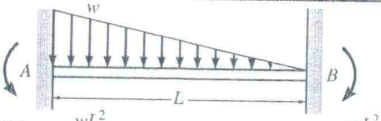
$(FEM)'_{AB} = \frac{wL^2}{8}$



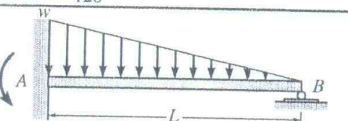
$(FEM)_{AB} = \frac{11wL^2}{192}$ $(FEM)_{BA} = \frac{5wL^2}{192}$



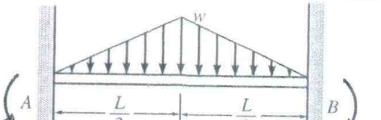
$(FEM)'_{AB} = \frac{9wL^2}{128}$



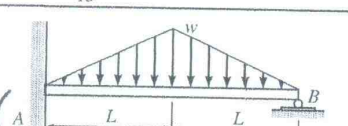
$(FEM)_{AB} = \frac{wL^2}{20}$ $(FEM)_{BA} = \frac{wL^2}{30}$



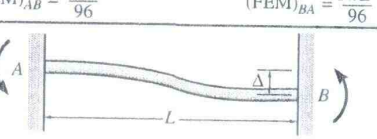
$(FEM)'_{AB} = \frac{wL^2}{15}$



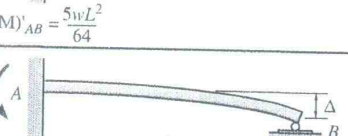
$(FEM)_{AB} = \frac{5wL^2}{96}$ $(FEM)_{BA} = \frac{5wL^2}{96}$



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

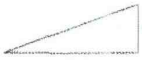
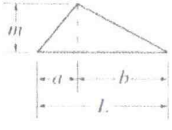


$(FEM)_{AB} = \frac{6EI\Delta}{L^2}$ $(FEM)_{BA} = \frac{6EI\Delta}{L^2}$

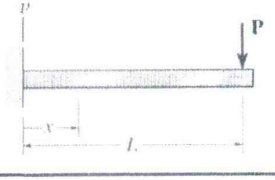
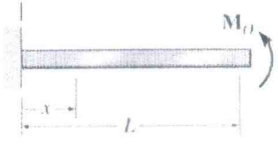


$(FEM)'_{AB} = \frac{3EI\Delta}{L^2}$

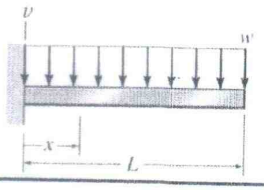
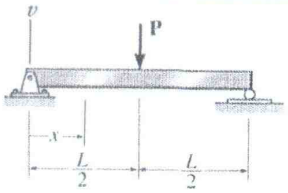
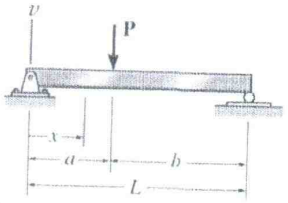
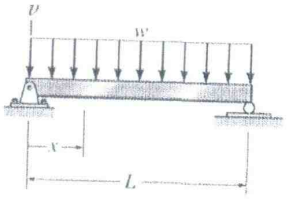
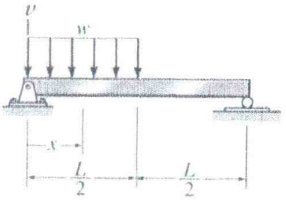
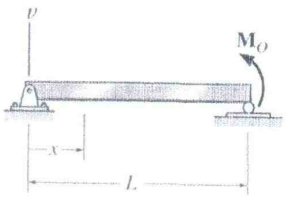
Table for Evaluating $\int_0^L m\, m'\, dx$

$\int_0^L m\, m'\, dx$				
	$mm'L$	$\frac{1}{2}mm'L$	$\frac{1}{2}m(m'_1 + m'_2)L$	$\frac{2}{3}mm'L$
	$\frac{1}{2}mm'L$	$\frac{1}{3}mm'L$	$\frac{1}{6}m(m'_1 + 2m'_2)L$	$\frac{5}{12}mm'L$
	$\frac{1}{2}m'(m_1 + m_2)L$	$\frac{1}{6}m'(m_1 + 2m_2)L$	$\frac{1}{6}[m'_1(2m_1 + m_2) + m'_2(m_1 + 2m_2)]L$	$\frac{1}{12}[m'(3m_1 + 5m_2)]L$
	$\frac{1}{2}mm'L$	$\frac{1}{6}mm'(L + a)$	$\frac{1}{6}m[m'_1(L + b) + m_2(L + a)]$	$\frac{1}{12}mm'\left(3 + \frac{3a}{L} - \frac{a^2}{L^2}\right)L$
	$\frac{1}{2}mm'L$	$\frac{1}{6}mm'L$	$\frac{1}{6}m(2m'_1 + m'_2)L$	$\frac{1}{4}mm'L$

Beam Deflections and Slopes

Loading	v + ↑	θ + ↶	Equation + ↑ + ↶
	$v_{max} = -\frac{PL^3}{3EI}$ at $x = L$	$\theta_{max} = -\frac{PL^2}{2EI}$ at $x = L$	$v = \frac{P}{6EI}(x^3 - 3Lx^2)$
	$v_{max} = \frac{M_O L^2}{2EI}$ at $x = L$	$\theta_{max} = \frac{M_O L}{EI}$ at $x = L$	$v = \frac{M_O}{2EI}x^2$

Beam Deflections and Slopes (continued)

	$v_{max} = -\frac{wL^4}{8EI}$ at $x = L$	$\theta_{max} = -\frac{wL^3}{6EI}$ at $x = L$	$v = -\frac{w}{24EI}(x^4 - 4Lx^3 + 6L^2x^2)$
	$v_{max} = -\frac{PL^3}{48EI}$ at $x = L/2$	$\theta_{max} = \pm\frac{PL^2}{16EI}$ at $x = 0$ or $x = L$	$v = \frac{P}{48EI}(4x^3 - 3L^2x)$, $0 \le x \le L/2$
		$\theta_L = -\frac{Pab(L + b)}{6LEI}$ $\theta = \frac{Pab(L + a)}{6LEI}$	$v = -\frac{Pbx}{6LEI}(L^2 - b^2 - x^2)$ $0 \le x \le a$
	$v_{max} = -\frac{5wL^4}{384EI}$ at $x = \frac{L}{2}$	$\theta_{max} = \pm\frac{wL^3}{24EI}$	$v = -\frac{wx}{24EI}(x^3 - 2Lx^2 + L^3)$
		$\theta_L = -\frac{3wL^3}{128EI}$ $\theta_R = \frac{7wL^3}{384EI}$	$v = -\frac{wx}{384EI}(16x^3 - 24Lx^2 + 9L^3)$ $0 \le x \le L/2$ $v = -\frac{wL}{384EI}(8x^3 - 24Lx^2 + 17L^2x - L^3)$ $L/2 \le x \le L$
	$v_{max} = -\frac{M_OL^2}{9\sqrt{3}EI}$	$\theta_L = -\frac{M_OL}{6EI}$ $\theta_R = \frac{M_OL}{3EI}$	$v = -\frac{M_Ox}{6EIL}(L^2 - x^2)$