Final exam for Engi 3335FB

Duration: 3 hours, 1:00PM- 4:00PM, Dec 13, 2014; Gym ROWS: MOQ

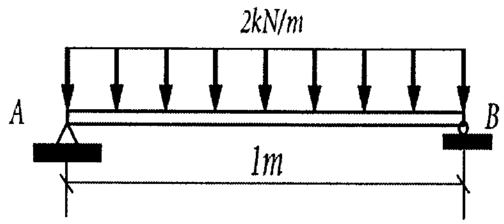
Student Name: ____________________ ID:_________________.

(1) Closed book. Any books, course notes, sheets, programmable-calculators, and assignments are NOT allowed.
(2) There are _7_ problems in total.
(3) Some formulas and useful materials are attached at the end.
(4) Directly and clearly write your corresponding detailed solutions under each problem.
(5) If the space underneath is not enough, solutions may be written on the blank paper or paper back.
(6) You must submit all the papers and materials.

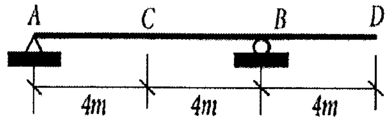
Problems	Marks	Your marks
1	15	
2	15	
3	15	
4	10	
5	15	
6	15	
7	15	
Total	100	

PGS 8, 10, 11, 12 were blank & not scanned

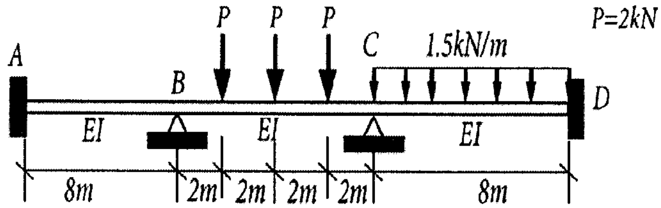
Problem 1. (15 marks) Determine the slope at point B of the beam loaded by a uniformly-distributed force by the virtual work method. A is a pin, B is a roller. Take E=1GPa, I=$0.5(10^6)mm^4$.



Problem 2. (15 marks) For the beam AD, construct the influence line for the shear force at point C, using both tabulate values and influence-line equations. A is a pin, B is a roller, point C is on the beam, D is a free end.



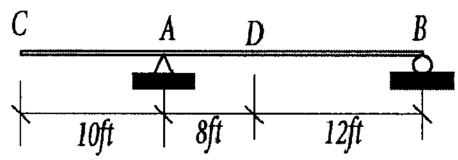
Problem 3. (15 marks) Use the moment distribution method to determine the member moments, and then calculate the support reactions and draw the shear diagram. EI is constant.



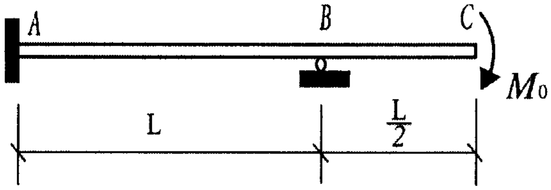
Problem 4. (10 marks)

(1)Using Muller-Breslau's principle, sketch influence lines for the shears at D. A is a pin, B is a roller, C is a free end.

(2)Using the sketched influence line, determine the maximum negative shear force that developed at point D due to a concentrated moving load of 10 kips.

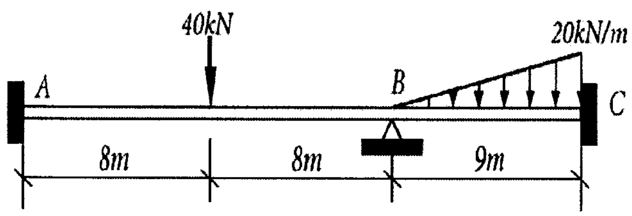


Problem 5. (15 marks) Determine the reactions for the beam and draw its shear diagram **using the force (flexibility) method of analysis**. A is fixed, B is a roller, C is loaded by a moment M_0.

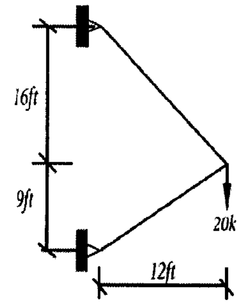


Problem 6. (15 marks)

Using the slope-deflection method, determine the moments acting at A, B, and C. Assume A is fixed, B is a roller, and C is fixed. EI is constant. (12 marks)
Draw shear and moment diagrams. (3 marks)



Problem 7. (15 marks) Using the stiffness method, determine the reactions and the bar forces for the truss. E=$30 \times 10^3 ksi$, $A = 1\ inch^2$.



Part 2: Some formulas and useful materials:

(1) Principle of virtual work for beams:

$$1 \cdot \delta_A = \int_0^L m \cdot d\theta = \int_0^L \frac{mMdx}{EI}, \qquad 1 \cdot \theta_A = \int_0^L m_\theta \cdot d\theta = \int_0^L \frac{m_\theta Mdx}{EI}$$

(2)Stiffness factor for members having a far end fixed: K=4EI/L;

Stiffness factor for members having a far end pinned or roller supported: K=3EI/L.

(3) Slope-deflection equations:

$$M_{AB} = \frac{2EI}{L}\left(2\theta_A + \theta_B - \frac{3\Delta}{L}\right) + (FEM)_{AB} \text{ and } M_{BA} = \frac{2EI}{L}\left(2\theta_B + \theta_A - \frac{3\Delta}{L}\right) + (FEM)_{BA}.$$

(4) Member stiffness matrix for trusses:

$$[K]_n = \frac{EA}{L} \begin{array}{c} \begin{array}{cccc} N_x & N_y & F_x & F_y \end{array} \\ \begin{bmatrix} \lambda_x^2 & \lambda_x\lambda_y & -\lambda_x^2 & -\lambda_x\lambda_y \\ \lambda_x\lambda_y & \lambda_y^2 & -\lambda_x\lambda_y & -\lambda_y^2 \\ -\lambda_x^2 & -\lambda_x\lambda_y & \lambda_x^2 & \lambda_x\lambda_y \\ -\lambda_x\lambda_y & -\lambda_y^2 & \lambda_x\lambda_y & \lambda_y^2 \end{bmatrix} \end{array} \begin{array}{c} N_x \\ N_y \\ F_x \\ F_y \end{array}$$

$$\lambda_x = \cos\theta_x = \frac{x_F - x_N}{L} = \frac{x_F - x_N}{\sqrt{(x_F - x_N)^2 + (y_F - y_N)^2}}$$

$$\lambda_y = \cos\theta_y = \frac{y_F - y_N}{L} = \frac{y_F - y_N}{\sqrt{(x_F - x_N)^2 + (y_F - y_N)^2}}$$

(5)Global force and displacement relation: $Q = KD$ or $\begin{bmatrix} Q_k \\ Q_u \end{bmatrix} = \begin{bmatrix} K_{11} & K_{12} \\ K_{21} & K_{22} \end{bmatrix} \begin{bmatrix} D_u \\ D_k \end{bmatrix}$.

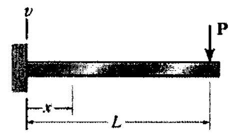
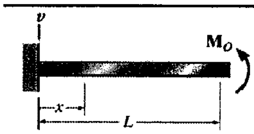
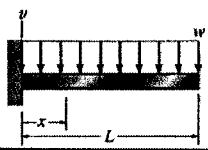
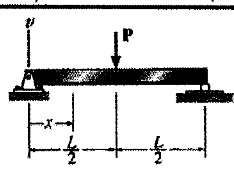
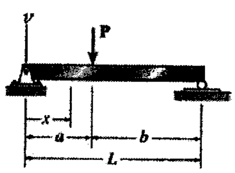
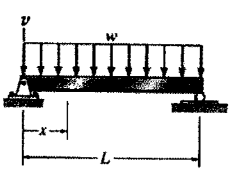
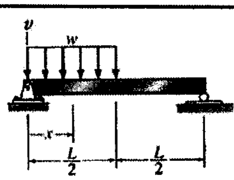
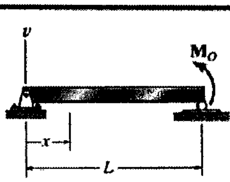
(6)Member forces for trusses: $[q_s] = \frac{EA}{L}[-\lambda_x \quad -\lambda_y \quad \lambda_x \quad \lambda_y] \begin{bmatrix} D_{N_x} \\ D_{N_y} \\ D_{F_x} \\ D_{F_y} \end{bmatrix}$.

(7)Inverse of a matrix: $\begin{bmatrix} a & b \\ c & d \end{bmatrix}^{-1} = \frac{1}{ad-bc}\begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$.

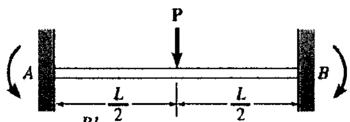
(8)Table: Beam deflections and slopes (on page II).

(9)Table: Fixed end moments (on page III).

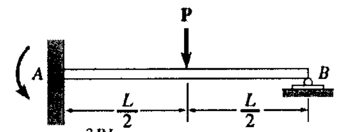
Beam Deflections and Slopes

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 $x = L$	$v = \frac{M_O}{2EI}x^2$
	$v_{max} = -\frac{wL^4}{8EI}$ 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 $x = \frac{L}{2}$	$\theta_{max} = \pm\frac{wL^3}{24EI}$	$v = -\frac{wx}{24EI}(x^3 - 2Lx^2 + L^3)$
		$\theta_L = -\frac{3wL^3}{128EI}$ $\theta_R = \frac{7wL^3}{384EI}$	$v = -\frac{wx}{384EI}(16x^3 - 24Lx^2 + 9L^3)$ $0 \le x \le L/2$ $v = -\frac{wL}{384EI}(8x^3 - 24Lx^2 + 17L^2x - L^3)$ $L/2 \le x \le L$
	$v_{max} = -\frac{M_O L^2}{9\sqrt{3}EI}$	$\theta_L = -\frac{M_O L}{6EI}$ $\theta_R = \frac{M_O L}{3EI}$	$v = -\frac{M_O x}{6EIL}(L^2 - x^2)$

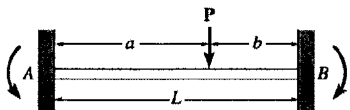
Fixed End Moments



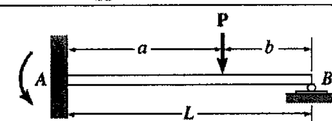
$(FEM)_{AB} = \frac{PL}{8}$ $(FEM)_{BA} = \frac{PL}{8}$



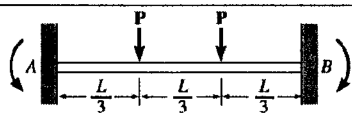
$(FEM)'_{AB} = \frac{3PL}{16}$



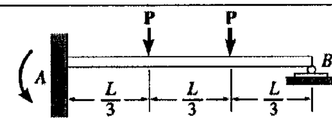
$(FEM)_{AB} = \frac{Pb^2a}{L^2}$ $(FEM)_{BA} = \frac{Pa^2b}{L^2}$



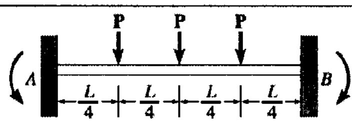
$(FEM)'_{AB} = (\frac{P}{L^2})(b^2a + \frac{a^2b}{2})$



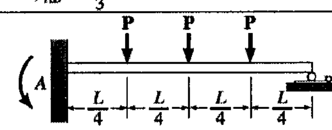
$(FEM)_{AB} = \frac{2PL}{9}$ $(FEM)_{BA} = \frac{2PL}{9}$



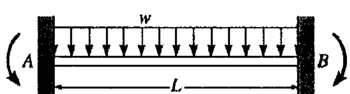
$(FEM)'_{AB} = \frac{PL}{3}$



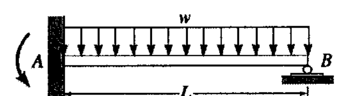
$(FEM)_{AB} = \frac{5PL}{16}$ $(FEM)_{BA} = \frac{5PL}{16}$



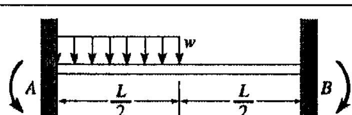
$(FEM)'_{AB} = \frac{45PL}{96}$



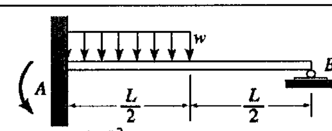
$(FEM)_{AB} = \frac{wL^2}{12}$ $(FEM)_{BA} = \frac{wL^2}{12}$



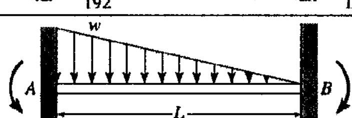
$(FEM)'_{AB} = \frac{wL^2}{8}$



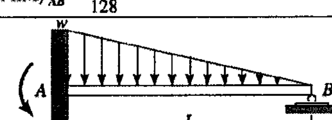
$(FEM)_{AB} = \frac{11wL^2}{192}$ $(FEM)_{BA} = \frac{5wL^2}{192}$



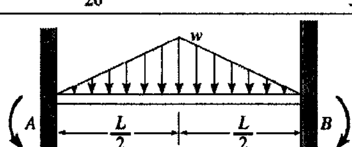
$(FEM)'_{AB} = \frac{9wL^2}{128}$



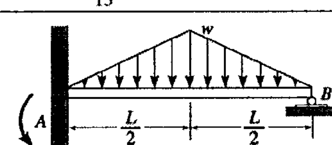
$(FEM)_{AB} = \frac{wL^2}{20}$ $(FEM)_{BA} = \frac{wL^2}{30}$



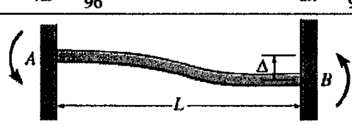
$(FEM)'_{AB} = \frac{wL^2}{15}$



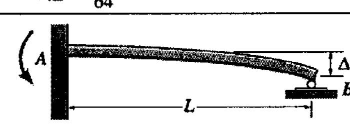
$(FEM)_{AB} = \frac{5wL^2}{96}$ $(FEM)_{BA} = \frac{5wL^2}{96}$



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



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



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