

ENCE353: Introduction to Structural Analysis
Midterm #1

Name: Solution

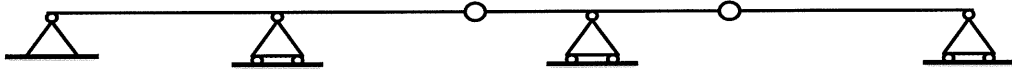
CSI 2117: 9:00-9:50AM, October 10, 2012
Closed book, closed notes, one sheet of notes allowed
Show all work

Problem	Points	Score
1	10	10
2	15	15
3	25	25
Total	50	50

Problem 1 (10 Points)

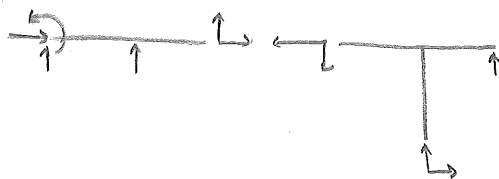
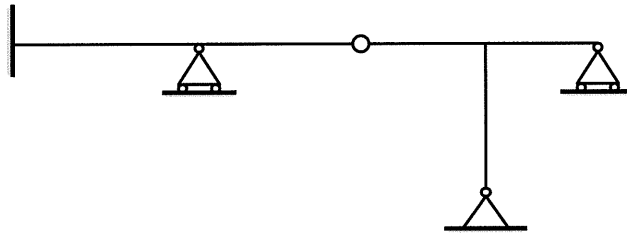
Classify each of the structures as statically determinate, statically indeterminate, or unstable. If indeterminate, specify the degree of indeterminacy.

Part A (5 Points)



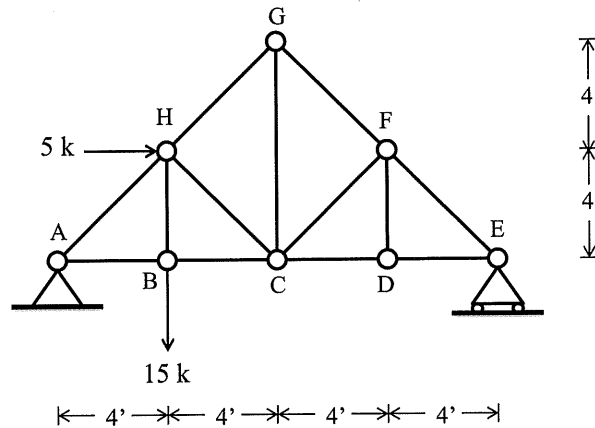
$$\begin{aligned}
 n &= 3 \\
 r &= 9 \\
 r &= 3n \\
 9 &= 9 \Rightarrow \text{statically determinate}
 \end{aligned}$$

Part B (5 Points)

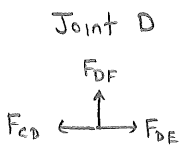


$$\begin{aligned}
 n &= 2 \\
 r &= 9 \\
 9 &> 3(2) \Rightarrow \text{statically indeterminate} \\
 &\quad \text{to the 3rd degree}
 \end{aligned}$$

Problem 2 (15 Points)



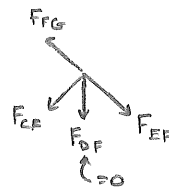
Part A: Determine all zero-force members (5 Points)



$$+\uparrow \sum F_y = 0$$

$$\Rightarrow F_{DF} = 0$$

Joint F



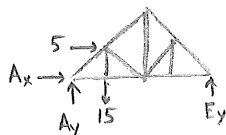
$$+\nearrow \sum F_y = 0$$

$$\Rightarrow F_{CF} = 0$$

CF
DF

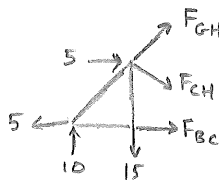
Part B: Determine forces in members BC, CH, GH. State whether forces are in tension or compression (10 Points)

Determine support reactions



$$\begin{aligned} \sum F_x = 0; & \quad A_x + 5 = 0 & \quad A_x = -5 \text{ k} \\ \sum F_y = 0; & \quad A_y - 15 + E_y = 0 & \quad \Rightarrow A_y = 10 \text{ k} \\ \sum M_A = 0; & \quad -15(4) - 5(4) + E_y(16) = 0 & \quad E_y = 5 \text{ k} \end{aligned}$$

Method of Section



$$\begin{aligned} \sum F_x = 0; & \quad -5 + 5 + F_{BC} + F_{CH} \cos 45 + F_{GH} \cos 45 = 0 \\ \sum F_y = 0; & \quad 10 - 15 - F_{CH} \sin 45 + F_{GH} \sin 45 = 0 \\ \sum M_H = 0; & \quad -5(4) - 10(4) + F_{BC}(4) = 0 \end{aligned}$$

$$\Rightarrow \begin{aligned} F_{BC} &= 15 \text{ k} \\ F_{CH} &= -10\sqrt{2} \text{ k} \\ F_{GH} &= -5\sqrt{2} \text{ k} \end{aligned}$$

$F_{BC} = 15 \text{ k (T)}$
 $F_{CH} = 14.14 \text{ k (C)}$
 $F_{GH} = 7.07 \text{ k (C)}$

Problem 3 (25 Points)

Part A: Determine support reactions (8 Points)

Part B: Determine shear and moment equations as functions of length for BCD (8 Points)

Part C: Draw axial, shear, and moment diagrams (8 Points)

State whether in tension or compression for axial, positive or negative for shear, and show curvature for moment

Label maximum and minimum values and their locations

Part D: Draw the deflected shape of the entire structure (1 Points)

Ⓐ

$\frac{1}{2}(5)(1.5) = 3.75$
 $\sum M_C = 0$
 $3.75(\frac{1}{3} \cdot 5) - A_y(5) = 0$
 $\Rightarrow A_y = 1.25 \text{ k}$

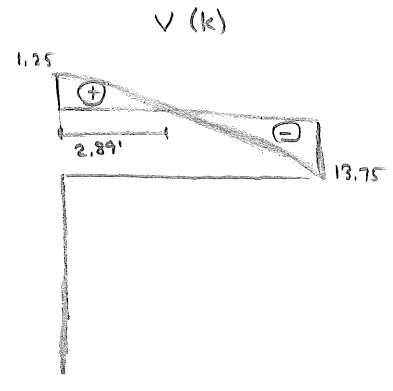
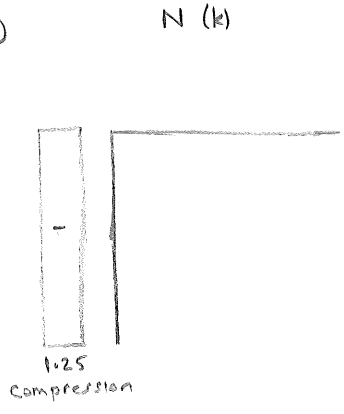
$\frac{1}{2}(10)(3) = 15$
 $\sum F_x = 0: D_x = 0$
 $\sum F_y = 0: 1.25 - 15 + D_y = 0$
 $\sum M_D = 0: -1.25(10) + 15(\frac{10}{3}) + M_D = 0$
 $\Rightarrow D_x = 0$
 $D_y = 13.75 \text{ k}$
 $M_D = -37.5 \text{ k}\cdot\text{ft}$

Ⓑ

$\frac{1}{2}(x)(\frac{3}{10}x)$
 $\sum F_y = 0: 1.25 - \frac{3}{20}x^2 - V = 0$
 $\sum M_0 = 0: -1.25(x) + \frac{3}{20}x^2(\frac{x}{3}) + M = 0$
 $\Rightarrow V = 1.25 - \frac{3}{20}x^2$
 $M = 1.25x - \frac{1}{20}x^3$

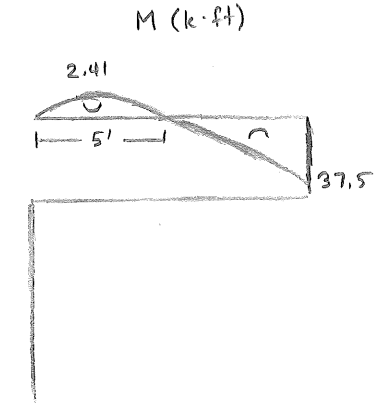
Problem 3 (Continued)

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$$V = 1.25 - \frac{3}{20}x^2 = 0$$

$$\Rightarrow x = 2.89$$



M_{max} at $V=0$, $x=2.89$

$$M = 1.25(2.89) - \frac{1}{20}(2.89)^3 = 2.41$$

$M=0$ at hinge, $x=5$

$$M = 1.25(5) - \frac{1}{20}(5)^3 = 0 \quad \checkmark$$

Ⓓ

