

"SOLUTIONS"

Your Name: _____

RUINA

Section day and time: _____

T&AM 202 Prelim 1

Tuesday March 6, 2001

Draft March 6, 2001

3 problems, 100 points, and 90+ minutes.

Please follow these directions to ease grading and to maximize your score.

- a) No calculators, books or notes allowed. A blank page for tentative scrap work is provided at the back. Ask for extra scrap paper if you need it.
- b) Full credit if
- ↖ ↗ → free body diagrams ← are drawn whenever force or moment balance is used;
 - correct vector notation is used, when appropriate;
 - ↑ → any dimensions, coordinates, variables and base vectors that you add are clearly defined;
 - ± all signs and directions are well defined with sketches and/or words;
 - reasonable justification, enough to distinguish an informed answer from a guess, is given;
 - * you clearly state any reasonable assumptions if a problem seems *poorly defined*;
 - work is I.) neat,
II.) clear, and
III.) well organized;
 - your answers are TIDILY REDUCED (Don't leave simplifiable algebraic expressions.);
 - your answers are boxed in; and
 - » unless otherwise stated, you will get full credit for, instead of doing a calculation, presenting Matlab code that would generate the desired answer. To ease grading and save space, your Matlab code can use shortcut notation like " $\dot{\theta}_7 = 18$ " instead of, say, " $\text{theta7dot} = 18$ ".
- c) Substantial partial credit if your answer is in terms of well defined variables and you have not substituted in the numerical values. Substantial partial credit if you reduce the problem to a clearly defined set of equations to solve.

Problem 1: _____/_____

Problem 2: _____/_____

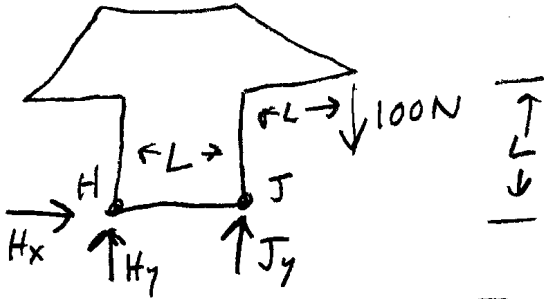
Problem 3: _____/_____

TOTAL: _____/100

1) (35 pt) Truss. For the truss shown, please find:

- (15 pt) The reaction at H.
- (10 pt) The bar force in EC (tension or compression).
- (10 pt) All the zero-force members.

FBD of whole structure:



$$\left\{ \sum \underline{F} = \underline{0} \right\} \cdot \underline{i} \Rightarrow \boxed{H_x = 0}$$

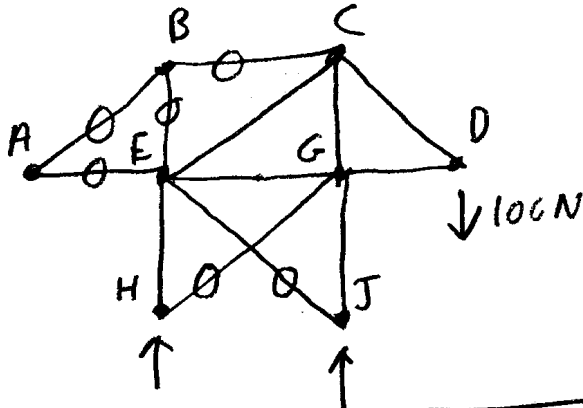
$\sum F_y = 0$

$$\sum \underline{M}_H = \underline{0} \Rightarrow L J_y - 2L \cdot 100N = 0$$

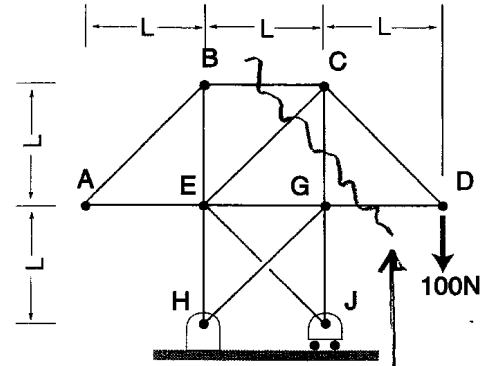
$$\Rightarrow \boxed{J_y = 200N}$$

$$\left\{ \sum \underline{F} = \underline{0} \right\} \cdot \underline{j} \Rightarrow \boxed{H_y = -100N}$$

Find zero force members

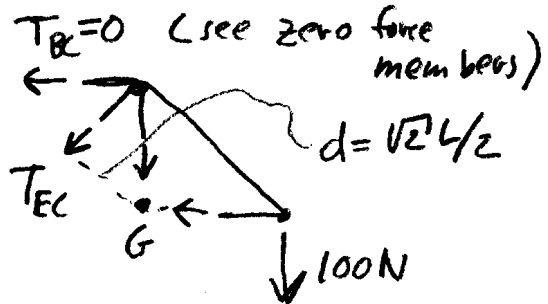


HG, AE, AB, BE, BC, JE
6 zero force members



Take section cut

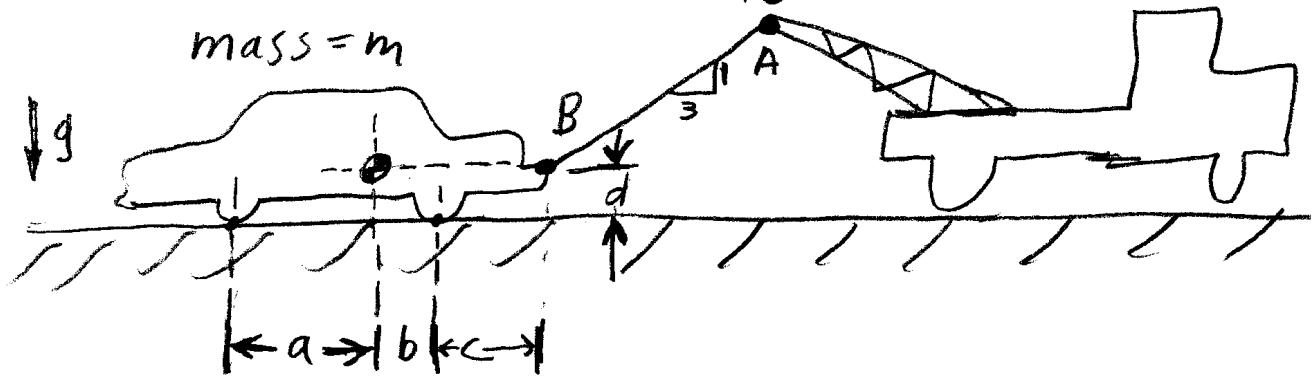
Draw FBD



$$\sum \underline{M}_G = \underline{0} \Rightarrow -L \cdot 100N + \frac{\sqrt{2}}{2} L T_{EC} = 0$$

$$\Rightarrow \boxed{T_{EC} = \sqrt{2} \cdot 100N \approx 141N}$$

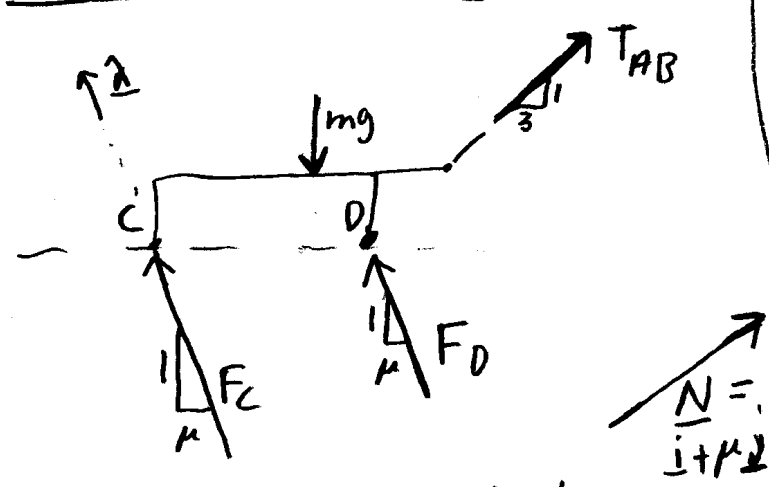
2) A car is being towed. Unfortunately all the wheels are locked and skidding with friction coefficient μ . In terms of a, b, c, d, m, g & μ , find the tension in the tow cable AB.



a) $T_{AB} = ?$

b) (5pts) Extra credit: Instead of an angle w/ slope = $1/3$, what should the cable angle be to minimize the tension?

FBD: $\hat{j} \uparrow, \hat{i} \rightarrow$



define \underline{N} = a vector \perp to friction forces. ($\Rightarrow \underline{\lambda} \cdot \underline{N} = 0$)

$\left\{ \sum \underline{F} = \underline{0} \right\} \cdot \underline{N}$

$$\left\{ \begin{aligned} &((F_c + F_d)\underline{\lambda} - mg\underline{j} \\ &+ \frac{(3\underline{i} + \underline{j})}{\sqrt{10}} T_{AB} \end{aligned} \right\} \cdot \underline{N} = 0$$

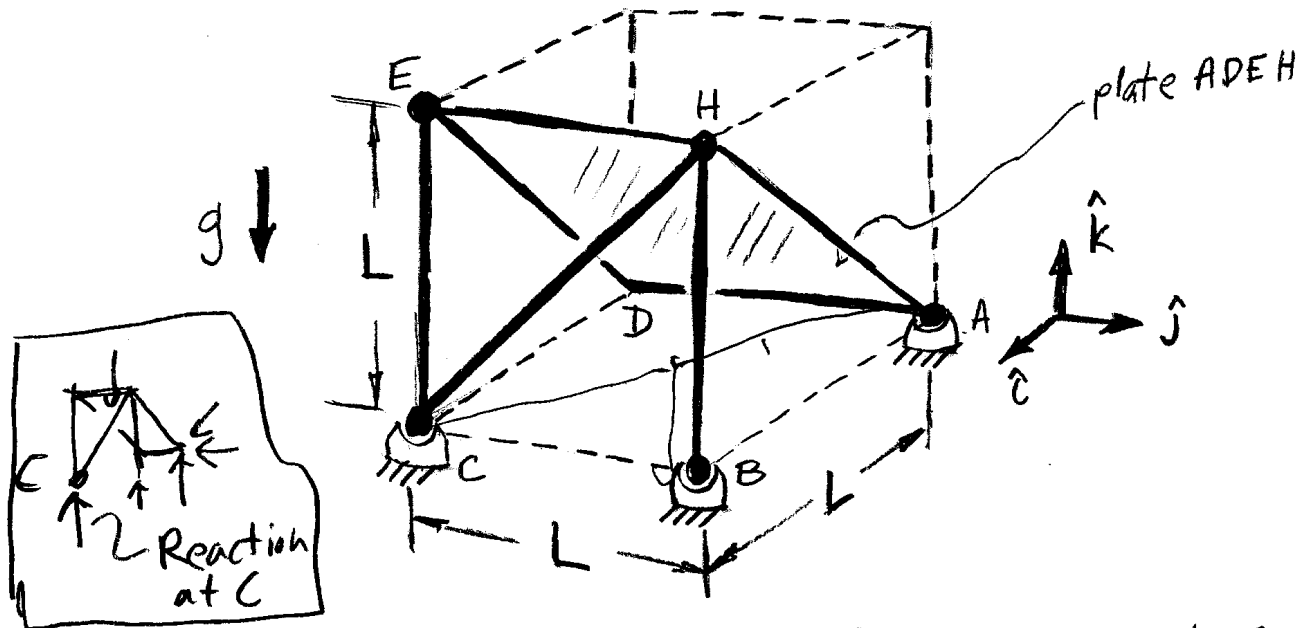
$$-mg\underline{j} \cdot (i + \mu\underline{j}) + \frac{3i + j}{\sqrt{10}} (i + \mu\underline{j}) T_{AB} = 0$$

$$-\mu mg + \frac{3 + \mu}{\sqrt{10}} T_{AB} = 0$$

$$\Rightarrow T_{AB} = \frac{\sqrt{10}}{3 + \mu} \mu mg$$

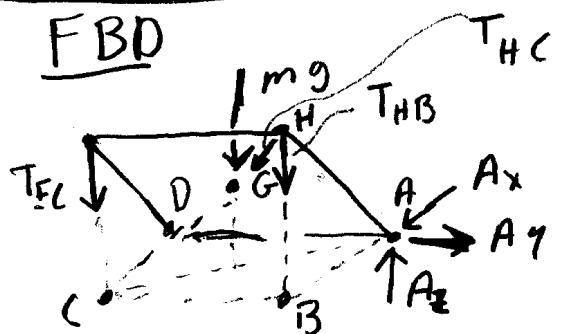
b) Minimized if cable is in \underline{N} direction

3) Uniform plate. mass = m , Ball & socket at A. Bars CE, CH & BH.



Find T_{CH} , T_{BH} , T_{CE} & reactions at C.

(Hint: several of these are zero)



$$(\sum \underline{M}/A) \cdot \underline{k} = 0 \Rightarrow \boxed{T_{HC} = 0}$$

(only T_{HC} contributes)

$$\sum M_{AC} = 0 \Rightarrow \boxed{T_{HB} = 0}$$

(only T_{HB} contributes)

$$\{\sum \underline{F}_i = 0\} \cdot \underline{i} \Rightarrow \boxed{A_x = 0}$$

$$\{\sum \underline{F}_i = 0\} \cdot \underline{j} \Rightarrow \boxed{A_y = 0}$$

$$\{\sum \underline{F}_i = 0\} \cdot \underline{k} \Rightarrow \underbrace{A_z - T_{EC} - mg}_{(1)} = 0$$

$$\sum M_{OB} = 0 \Rightarrow A_z + T_{EC} = 0 \quad (2)$$

$$(1) \& (2) \Rightarrow \boxed{A_z = mg/2}$$

$$\boxed{T_{EC} = -mg/2}$$

$$\boxed{A \text{ \& } C \text{ reaction is } mg/2 \underline{k}}$$