THE UNIVERSITY OF MANITOBA
Department of Civil and Geological Engineering

Date: December 4, 1997

Start Time: 9:00 a.m.

Course No. 23.135 (all sections)

Applied Mechanics 1A

FINAL EXAMINATION

PAGE NO:1 of 6

TIME: 2 HOURS

EXAMINER(S): D.Polyzois, N. Rajapakse, K. Dick

NAME:		
SIGNATURE:		
STUDENT NUMBER:		
QUESTIONS TO BE GRADED (CIRCLE ONLY FOUR)	**1**	
	2	
	3	
	4	
	5	

NOTE:

- **Attempt any FOUR questions out of five.**
- **All questions are of equal value.**
- **Calculators are permitted.**
- **No textbooks or other aids allowed.**

$$a^2 = b^2 + c^2 - 2bc\cos A$$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\mathbf{P} \times \mathbf{Q} = \begin{vmatrix} i & j & k \\ P_x & P_y & P_z \\ Q_x & Q_y & Q_z \end{vmatrix} = \mathbf{i}(P_yQ_z - P_zQ_y) - \mathbf{j}(P_xQ_z - P_zQ_x) + \mathbf{k}(P_xQ_y - P_yQ_x)$$

$$\mathbf{P} \cdot \mathbf{Q} = PQ\cos\theta$$

$$V = |V| = \sqrt{V_x^2 + V_y^2 + V_z^2}$$

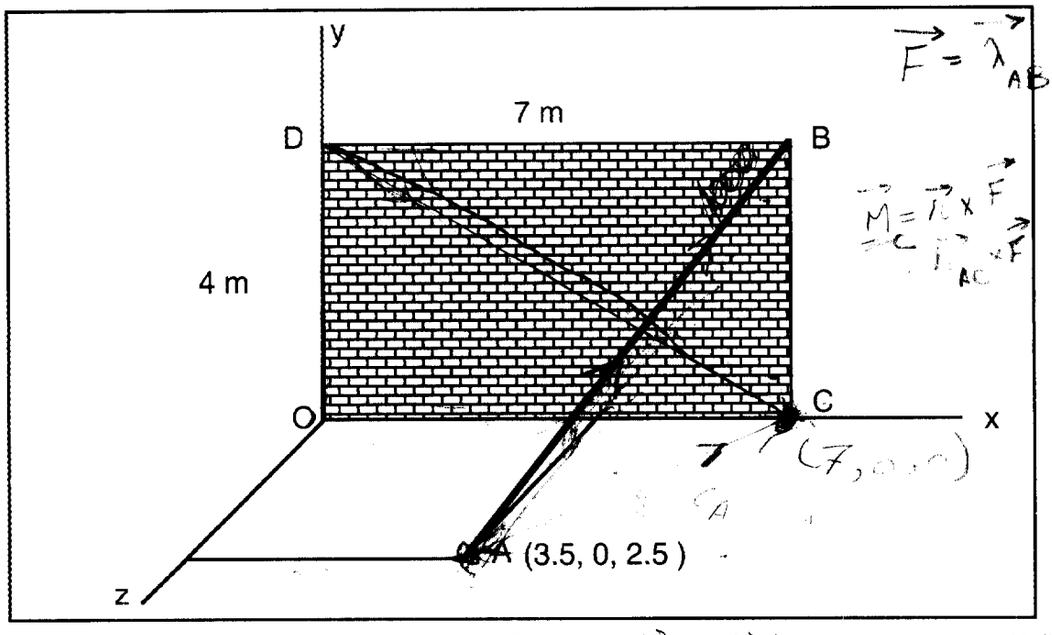
$$\cos\alpha = \frac{V_x}{V}, \cos\beta = \frac{V_y}{V}, \cos\gamma = \frac{V_z}{V}$$

$$\mathbf{M}_O = \mathbf{r} \times \mathbf{F}$$

$$M_{oL} = \lambda_{oL} \cdot M_O = \begin{vmatrix} \lambda_x & \lambda_y & \lambda_z \\ x & y & z \\ F_x & F_y & F_z \end{vmatrix}$$

continued ...

2) The force acting at A in cable AB is 1000 N.
Find the moment about CD due to the force in the cable.



$\vec{F} = \vec{\lambda}_{AB} \cdot |F|$

$\vec{M}_C = \vec{r}_{AC} \times \vec{F}$

$M_{CD} = \vec{\lambda}_{CD} \cdot (\vec{M}_C) = \vec{\lambda}_{CD} \cdot (\vec{CA} \times \vec{F})$

$M_{CD} = \vec{\lambda}_{CD} \cdot \vec{M}_C$

$\vec{M}_C = \vec{CA} \times \vec{F} = \vec{\lambda}_{CD} \cdot (\vec{CB} \times \vec{F})$

$\vec{\lambda}_{CD} = \dfrac{\vec{CD}}{|CD|}$

$\vec{CA}$:

$\vec{F} = ?$ $\quad \vec{M}_{CD} = ?$

$\vec{\lambda}_{CD} = ?$

$\vec{\lambda}_{CD} = \dfrac{\vec{CD}}{|CD|} = \dfrac{-7\vec{i} + 4\vec{j}}{\sqrt{7^2 + 4^2}} = -0.8682\,\vec{i} + 0.4\,\vec{j}$

$\vec{CA} = 3.5\,\vec{i} + 2\,\vec{k}$

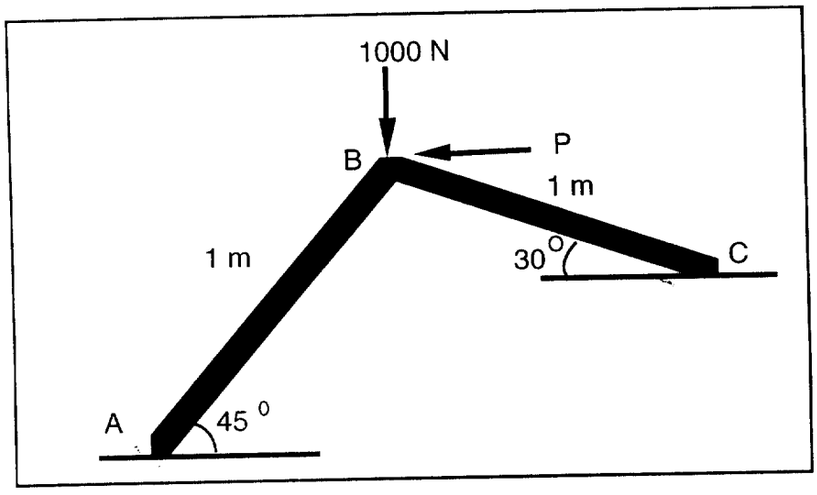
$\vec{F} = 1000\,\vec{\lambda}_{AB} = 1000N\,\dfrac{\vec{AB}}{AB} = 1000N\,\dfrac{3.5\vec{i} + 4\vec{j} - 2.5\vec{k}}{\sqrt{3.5^2 + 4^2 + 2.5^2}}$

$\vec{F} = 596\,\vec{i} + 681\,\vec{j} - 426\,\vec{k}$

$M_{CD} = \vec{\lambda}_{CD} \cdot (\vec{CA} \times \vec{F})$

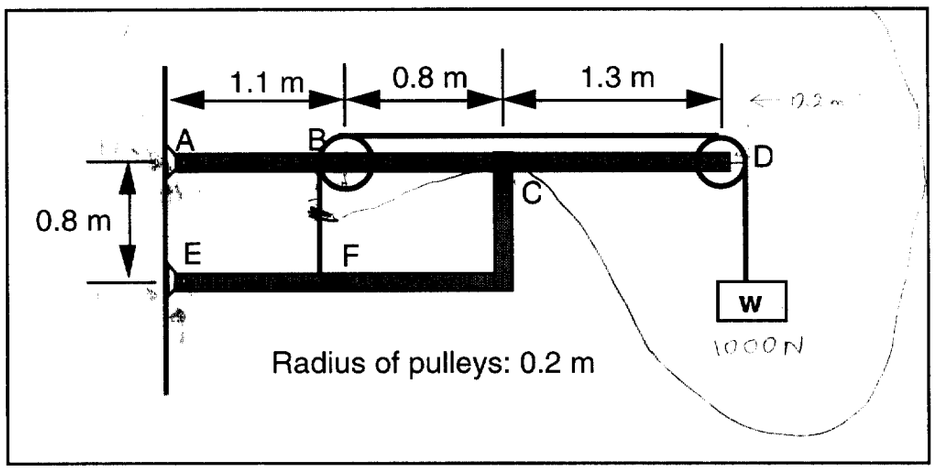
6K

3) Determine the minimum force P required to move the frame shown below. The coefficient of static friction between the frame and the ground is 0.25.



continued ...

4) Determine the forces in member ABCD if W = 1000 N. A, E, and C are pin connections.



$\Sigma F_x = A_x + E_x = 0$

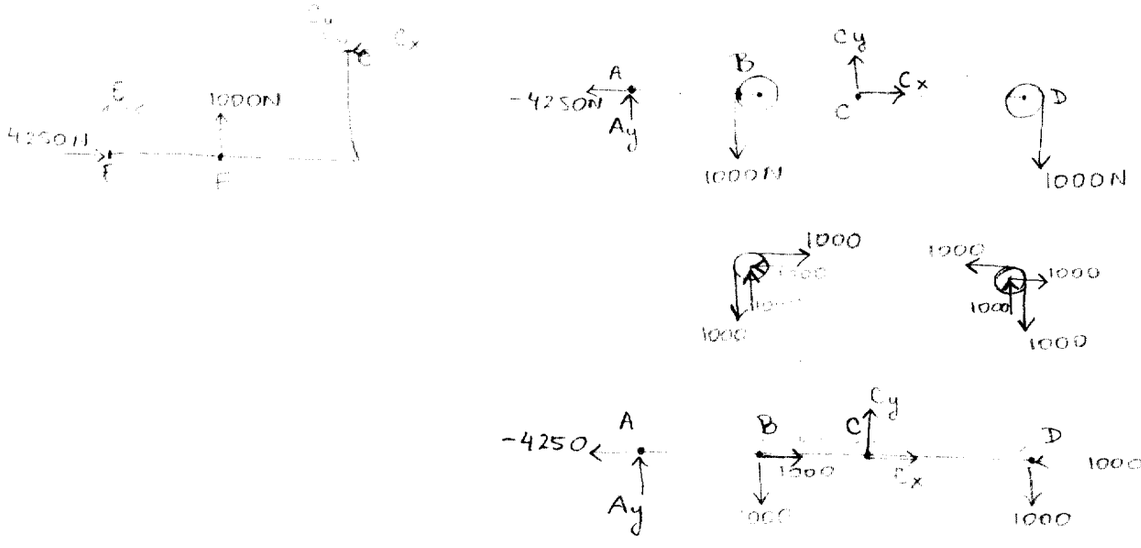
$\Sigma F_y = A_y + E_y - 1000N = 0$

$\Sigma M_c = (0.8)A_x - 3.4(1000N) = 0$ $\quad A_x = -4250N$

$E_x = 4250N$

Cannot determine A_y and E_y

Draw free body diagrams of indiv. members



$\rightarrow \Sigma F_x = -4250N + 000N + C_x - 1000N = 0$

$+\uparrow \Sigma F_y = A_y - 1000N + C_y - 1000N = 0$

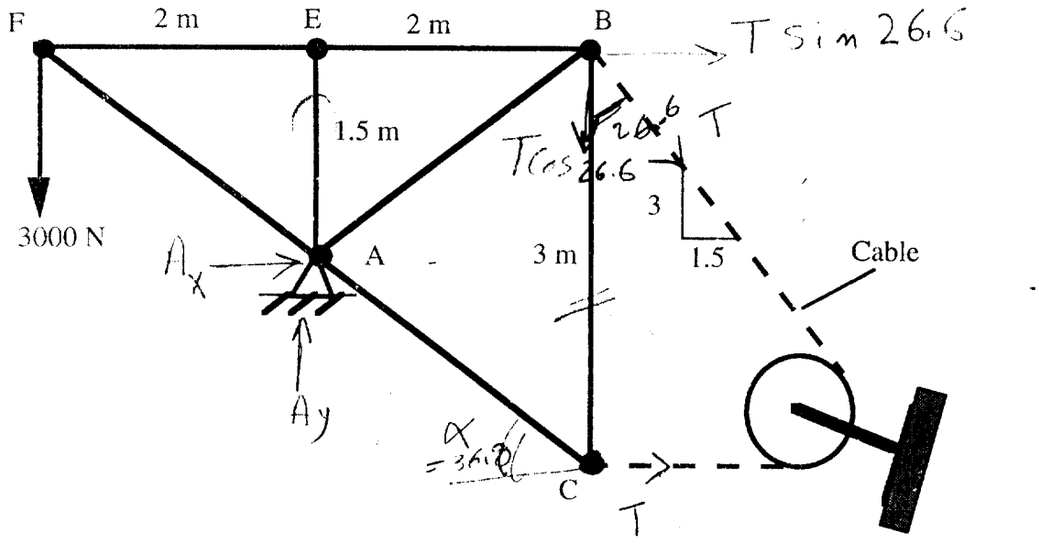
$+\circlearrowleft \Sigma M_A = -1000N(\quad) + C_y(1.9m) + (-1000N)(3.2m) = 0$

$C_y = 2262\,N$

$A_y = -263\,N$

continued ...

5) Find the force in Member BC



$\Sigma M_{@A} = 0$

$3000(2) + T(1.5) - T \sin 26.6 * 1.5$

$- T \cos 26.6 * 2 = 0$

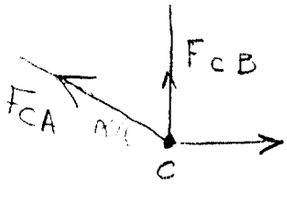
Solve for T = ←

$\Sigma F_x = 0 \Rightarrow A_x + T + T \sin 26.6 =$

Solve for Ax = ←

$\Sigma F_y = 0 \Rightarrow A_y - 3000 - T \cos 26.6 =$

Solve for Ay = ↑



Joint C

$\Sigma F_x = 0 \Rightarrow T - F_{AC} \cos 36.8 =$

Solve for FAC = ←

The End

$\Sigma F_y = 0$

$F_{CB} + F_{CA} * \sin 36.8 = 0$