Midterm 1- 2022 Solution w marking scheme

Mechanical Analysis (Concordia University)

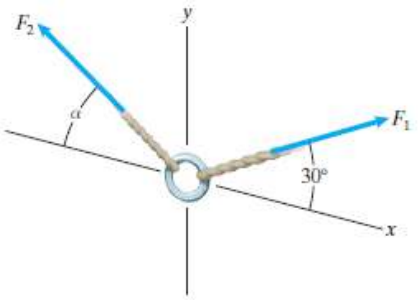
CONCORDIA UNIVERSITY GINA CODY SCHOOL OF ENGINEERING and COMPUTER SCIENCE

ENGR 245 – T (MECHANICAL ANALYSIS)

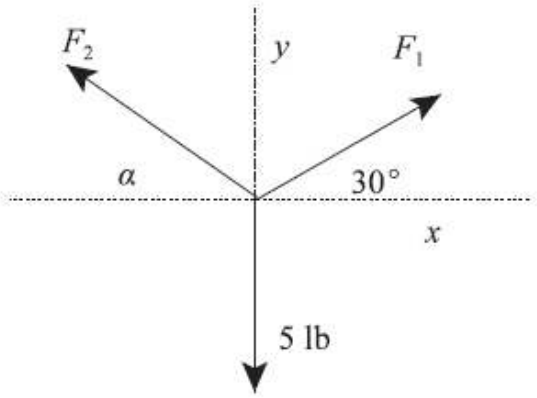
MIDTERM # 1

Attempt all questions. Only calculators permitted. Time – 60 minutes

1) The ring weighs 5 lb and is in equilibrium. The force F1 = 4.5 lb. Determine the force **F2** and the angle **α**.
MARKS 6



Solution: The free-body diagram is shown below the drawing. The equilibrium equations are



$\sum F_x : F_1 \cos 30^\circ - F_2 \cos\alpha = 0$ 1

$\sum F_y : F_1 \sin 30^\circ + F_2 \sin\alpha - 5\ \text{lb} = 0$ 1

We can write these equations as

$F_2 \sin\alpha = 5\ \text{lb} - F_1 \sin 30^\circ$

$F_2 \cos\alpha = F_1 \cos 30^\circ$ 1

Dividing these equations and using the known value for F_1 we have.

$$\tan\alpha = \frac{5\ \text{lb} - (4.5\ \text{lb}) \sin 30^\circ}{(4.5\ \text{lb}) \cos 30^\circ} = 0.706 \Rightarrow \alpha = 35.2^\circ$$

1 for answer
1 for correct answer

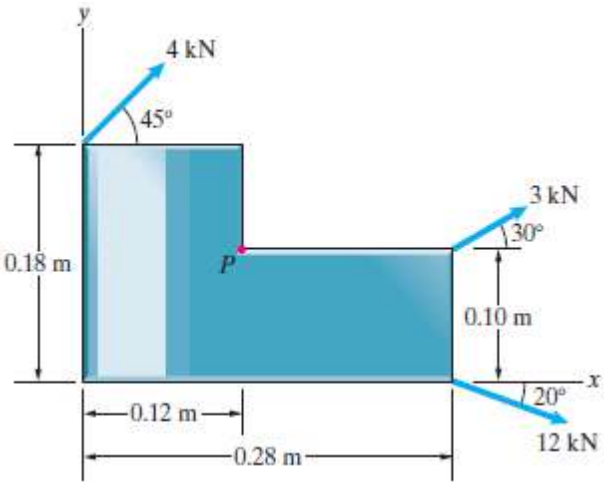
$$F_2 = \frac{(4.5\ \text{lb}) \cos 30^\circ}{\cos\alpha} = 4.77\ \text{lb}$$

$F_2 = 4.77$ lb, $\alpha = 35.2^\circ$

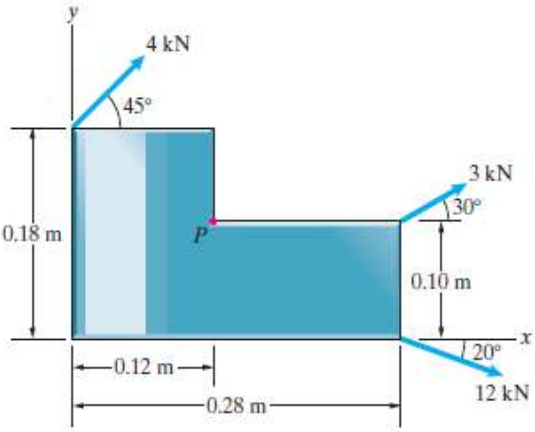
1 for answer
1 for correct answer

2) Three forces act on the plate. Determine the sum of the moments of the three forces about point P.

MARKS 7



Problem 4.53 Three forces act on the plate. Use Eq. (4.2) to determine the sum of the moments of the three forces about point P.



Solution:

1.5 $\mathbf{r}_1 = (-0.12\mathbf{i} + 0.08\mathbf{j})$ m, $\mathbf{F}_1 = (4\cos 45^\circ\mathbf{i} + 4\sin 45^\circ\mathbf{j})$ kN

1.5 $\mathbf{r}_2 = (0.16\mathbf{i})$ m, $\mathbf{F}_2 = (3\cos 30^\circ\mathbf{i} + 3\sin 30^\circ\mathbf{j})$ kN

1.5 $\mathbf{r}_3 = (0.16\mathbf{i} - 0.1\mathbf{j})$ m, $\mathbf{F}_3 = (12\cos 20^\circ\mathbf{i} - 12\sin 20^\circ\mathbf{j})$ kN

1.5 $\mathbf{M}_P = \mathbf{r}_1 \times \mathbf{F}_1 + \mathbf{r}_2 \times \mathbf{F}_2 + \mathbf{r}_3 \times \mathbf{F}_3$

$$\mathbf{M}_P = (0.145 \text{ kN-m})\mathbf{k} = (145 \text{ N-m})\mathbf{k}$$

0.5 for the answer

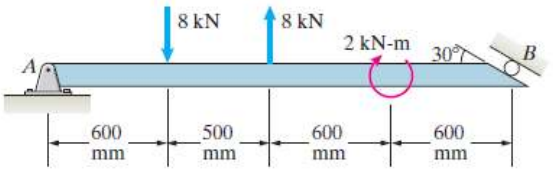
1 for correct answer

3) (a) Draw the free-body diagram of the beam. (b) Determine the reactions at the pin support A and at the roller B.

MARKS 7

Problem 5.12 (a) Draw the free-body diagram of the beam.

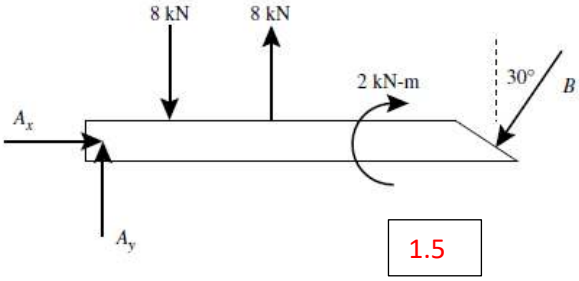
(b) Determine the reactions at the pin support A.



Solution:

(a) The FBD

(b) The equilibrium equations



1.5

1.5

1.5

$$\sum M_A : -(8\text{ kN})(0.6\text{ m}) + (8\text{ kN})(1.1\text{ m}) - 2\text{ kNm} - B\cos 30^\circ (2.3\text{ m}) = 0$$

$$\sum F_x : A_x - B\sin 30^\circ = 0$$

$$\sum F_y : A_y - 8\text{ kN} + 8\text{ kN} - B\cos 30^\circ = 0$$

Solving

$$A_x = 0.502\text{ kN},\ A_y = 0.870\text{ kN},\ B = 1.004\text{ kN}$$

0.5 for the answer

1 for correct answer