King Saud University
College of Engineering
Department of Civil Engineering

GE201 Statics
First Semester 1432-33 H
Monday: 25-12-1432
Time: 90 Min

FIRST MID TERM EXAM
SOLUTION

Name (in Arabic) : ……………………………….....

Student No.: ………………………………………..

Section / Instructor: ……………………….........

Q.	Max. Marks	Obtained
1	10	
2	10	
3	10	
Total	**30**	

Question # 1 (10 points)

(a) – (4 points)

i) Moment produced by a force about an axis intersecting the line of action of the force is ....

a) Positive *b) Negative* *c) **Zero***

ii) For a coplanar and collinear force system, number of independent equilibrium equations is ....

*a) **One*** *b) Two* *c) Three*

iii) The forces whose lines of action meet at a common point are called ……………..… forces.

a) Parallel *b) Collinear* *c) **Concurrent***

iv) The magnitude of projection of force **F** on ***line AB*** is equal to $\vec{F}.\vec{n}_{AB}$

(b) – (2 points)

The tension force in the cable is **100 N** as shown in Figure 1, determine force ***T***.

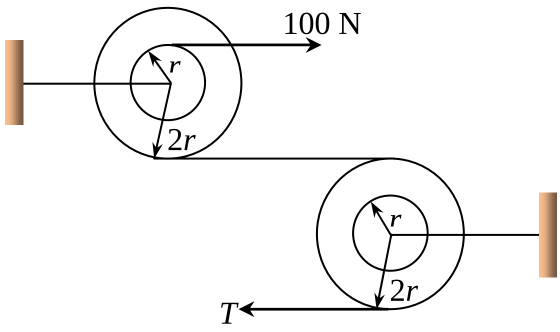
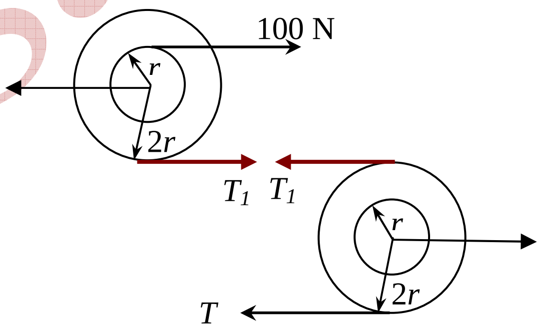


Figure 1

Solution:



Taking the moment of the forces about the center of the pulleys, and equating them to zero, we have

$$-100\times r + T_1 \times 2r = 0 \quad \Rightarrow T_1 = 50\text{ N}$$

$$-T\times 2r + T_1\times 2r = 0 \Rightarrow T = T_1 = 50\text{ N} \qquad \textit{Ans.}$$

Student name		Marks obtained for Q1	
Student number			

(c) – (4 points)

Calculate the magnitude of the force supported by the pin at **B** and the roller at **A** for the bell crank loaded as shown in Figure 2.

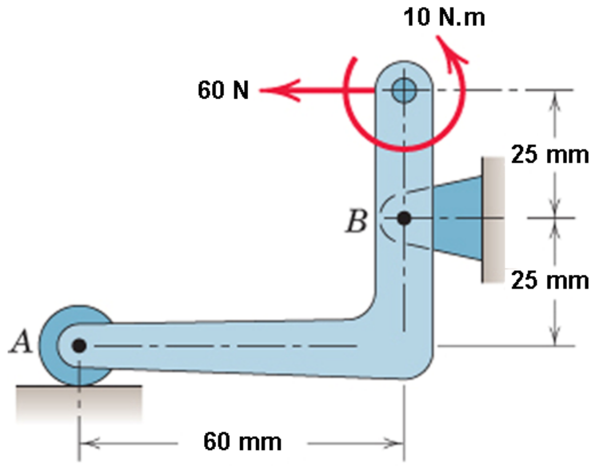
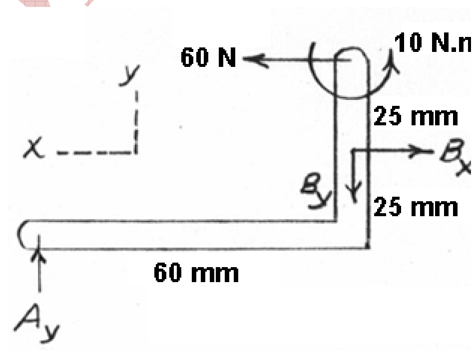


Figure 2

Solution:



$$\sum M_B = 0:$$
$$60 \times 0.025 + 10 - 0.06 A_y = 0 \Rightarrow A_y = 191.67\ \text{N}$$
$$\sum F_y = 0:$$
$$B_y = A_y = 191.67\ \text{N}$$
$$\sum F_x = 0:$$
$$B_x = 60\ \text{N}$$

Then $B = \sqrt{B_x^2 + B_y^2} = \sqrt{60^2 + 191.67^2} = 200.84\ \text{N}$ *Ans.*

Question ≠ 2 (10 points)

For the loaded system shown in Figure 3:

a) Replace the three forces and a couple by a single force ***R*** and moment ***M*** about point ***O.***

b) Determine the direction of ***R***.

c) Sketch the resultant force ***R*** that represents the force-couple system alone and find its intersection with the *x*-axis.

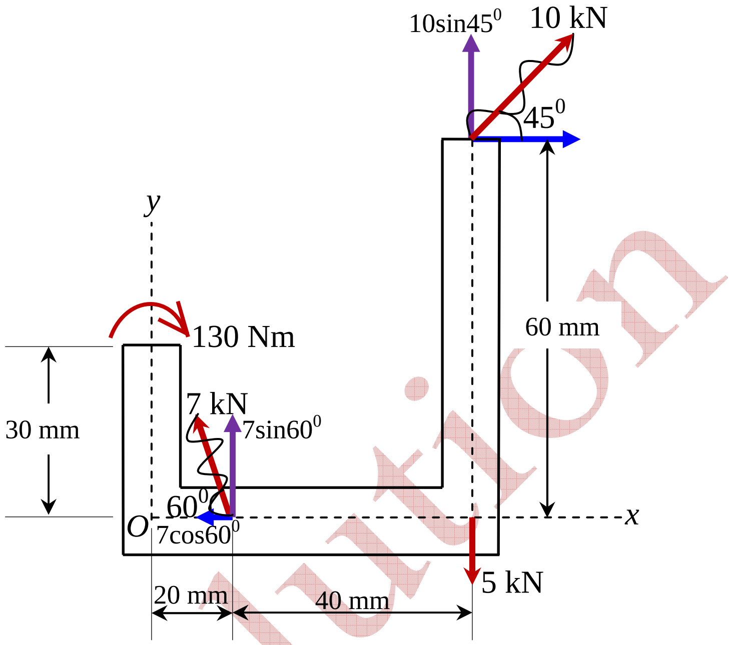


Figure 3

Solution

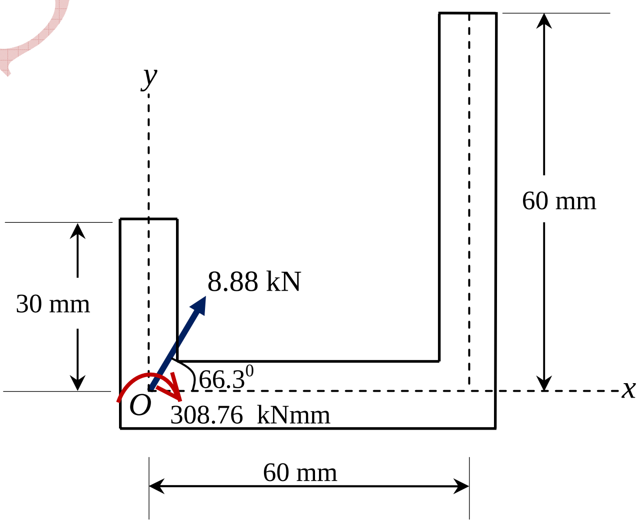
(a)

$$\overset{+}{\rightarrow} R_x = \Sigma F_x = 10\cos 45^0 - 7\cos 60^0 = 3.57 \text{ kN} \rightarrow$$

$$\overset{+}{\uparrow} R_y = \Sigma F_y = 10\sin 45^\circ + 7\sin 60^0 - 5 = 8.13 \text{ kN} \uparrow$$

$$R = \sqrt{R_x^2 + R_y^2} = \sqrt{3.57^2 + (8.13)^2} = 8.88 \text{ kN} \qquad Ans.$$

$$CCW(+)M_0 = \Sigma Fd = -130 + 7\sin 60^\circ \times 20 - 5 \times 60$$
$$+10\sin 45^\circ \times 60 - 10\cos 45^\circ \times 60 = -308.76 \text{ kN.mm}$$
$$\Rightarrow M_0 = 308.76 \text{ kN.mm (CW)} \qquad Ans.$$



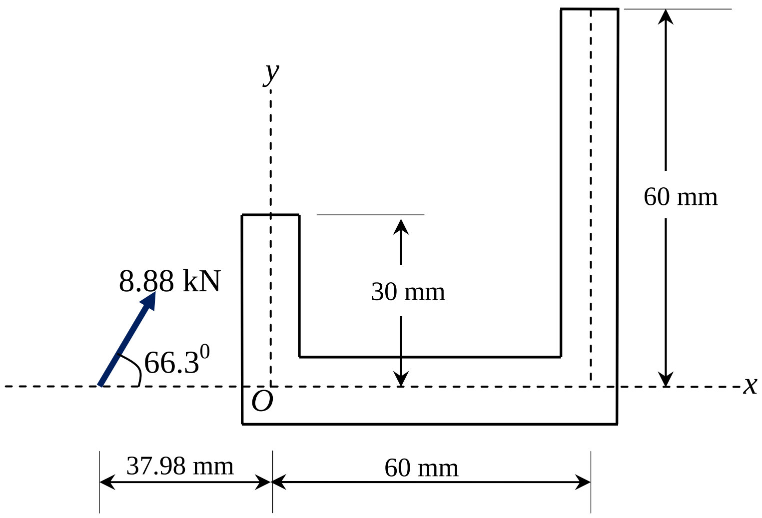
(Note : 1 kN.mm = 1 N.m)

(b) Direction of Resultant *R*

$$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right) = \tan^{-1}\left(\frac{8.13}{3.57}\right) = 66.3^\circ \; Ans.$$

(c) *x*-Intercept:

$$x = \frac{M_o}{R_y} = \frac{-308.76}{8.13} = -37.98 \text{ mm} \qquad Ans.$$



Student name		Marks obtained for Q3	page 4/4
Student number			

Question # 3 (10 points)

For the force system shown in Fig. 4, determine the following:

(i) the moment about point ***B*** **(M_B)**.

(ii) the moment about ***line CD*** ***(M_{CD})***.

Note that point **A** lies in the y-z plane.

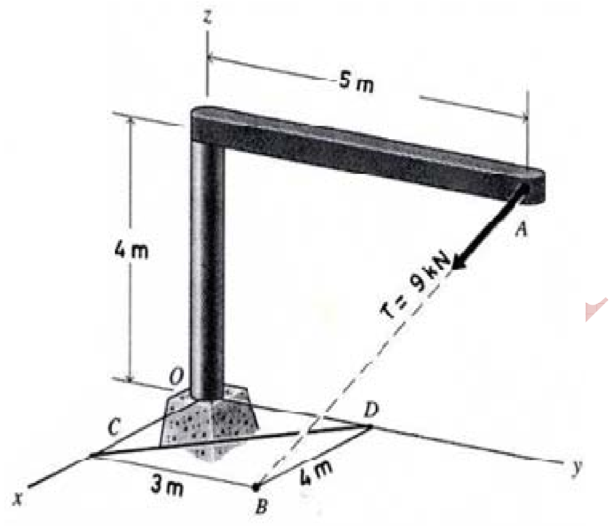


Figure 4

Solution:

(i)

As the line of action of 9 kN force is passing through *B*, the force will not produce any moment about point *B*.

That is $\vec{M}_B = 0$ *Ans.*

(ii)

Coordinates : A (0,5,4) , B (4,3,0) , C (4,0,0) and D (0,3,0)

$$\vec{T} = 9\vec{n}_{AB} = 9[l\vec{i} + m\vec{j} + n\vec{k}]$$

$$= 9\left[\frac{(4-0)\vec{i} + (3-5)\vec{j} + (0-4)\vec{k}}{\sqrt{(4-0)^2 + (3-5)^2 + (0-4)^2}}\right] = 9\left[\frac{2}{3}\vec{i} - \frac{1}{3}\vec{j} - \frac{2}{3}\vec{k}\right]$$

$$= 6\vec{i} - 3\vec{j} - 6\vec{k}$$

$$\vec{M}_c = \vec{r}_{cB} \times \vec{T} = 3\vec{j} \times [6\vec{i} - 3\vec{j} - 6\vec{k}] \Rightarrow \vec{M}_c = -18\vec{i} - 18\vec{k}$$

$$\vec{n}_{CD} = [l\vec{i} + m\vec{j} + n\vec{k}]$$

$$\vec{n}_{CD} = \left[\frac{-4\vec{i} + 3\vec{j}}{\sqrt{(16+9)}}\right] = -0.8\vec{i} + 0.6\vec{j}$$

$$\vec{M}_{CD} = (\vec{M}_C . \vec{n}_{CD})\vec{n}_{CD} = M_{CD}\vec{n}_{CD}$$

$$\Rightarrow \vec{M}_{CD} = [(-18\vec{i} - 18\vec{k}).(-0.8\vec{i} + 0.6\vec{j})](-0.8\vec{i} + 0.6\vec{j})$$

$$\Rightarrow \vec{M}_{CD} = 14.4(-0.8\vec{i} + 0.6\vec{j})$$

$$\Rightarrow \vec{M}_{CD} = -11.52\vec{i} + 8.64\vec{j} \qquad \textit{Ans.}$$