King Saud University
College of Engineering
Department of Civil Engineering

GE 201 Statics
Second Semester 1433-34 H
Monday: 12-6-1434
Time: 90 Min

SECOND MID TERM EXAM
(SOLUTION)

Name (in Arabic): ……..

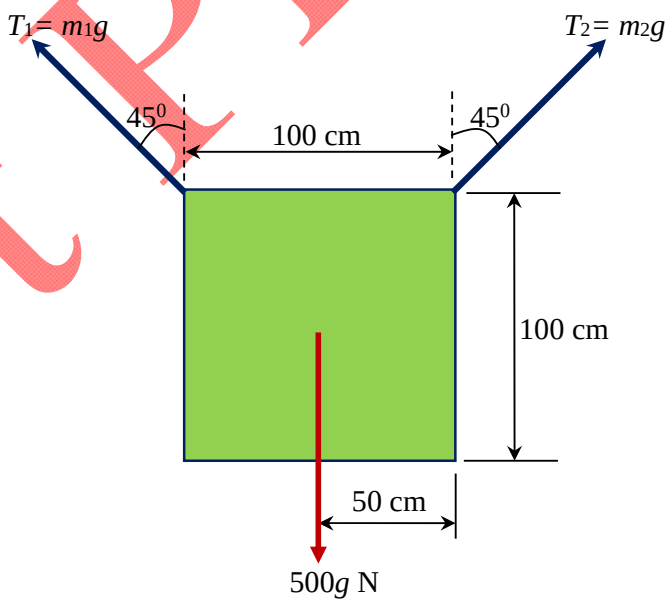
Student No.: ……..

Section / Instructor: ……..

Q. No.	Max. Marks	Marks Obtained
1	10	
2	10	
3	10	
Total	30	

Question # 1(a) 2.5 Marks)

A 500 kg uniform plate is hanging as shown in the figure. Calculate the values of the two masses (m_1 and m_2) for the equilibrium of the plate.



Solution

Applying the equilibrium equations, we have

$$\overset{+}{\rightarrow}\Sigma F_x = 0 \Rightarrow -T_1 \sin 45^\circ + T_2 \sin 45^\circ = 0$$

$$\Rightarrow T_1 = T_2 \Rightarrow m_1 g = m_2 g \Rightarrow m_1 = m_2$$

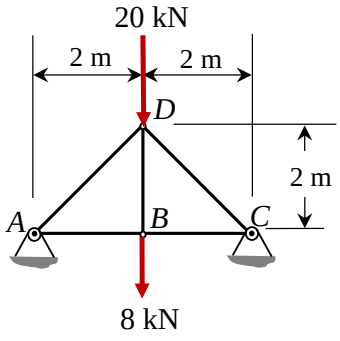
$$\overset{+}{\uparrow}\Sigma F_y = 0 \Rightarrow T_1 \cos 45^\circ + T_2 \cos 45^\circ - 500g = 0$$

$$\Rightarrow 2T_1 \frac{1}{\sqrt{2}} = 500\text{g} \Rightarrow T_1 = \frac{500}{\sqrt{2}} g \Rightarrow m_1\text{g} = \frac{500}{\sqrt{2}} g$$

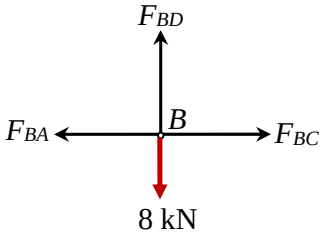
$$\underline{\underline{m_1 = m_2 = 353.5\text{kg}}} \quad Ans.$$

Question # 1(b) (2.5 Marks)

For the truss shown in the figure, calculate the force in member ***DB***.



Solution



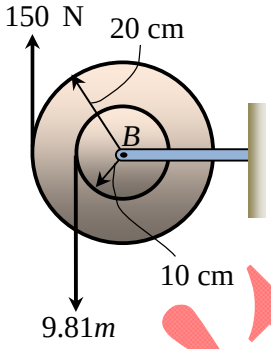
$\overset{+}{\uparrow}\Sigma F_y = 0 \Rightarrow F_{BD} - 8 = 0 \Rightarrow \underline{\underline{F_{BD} = 8\,\text{kN}}}$ *Ans.*

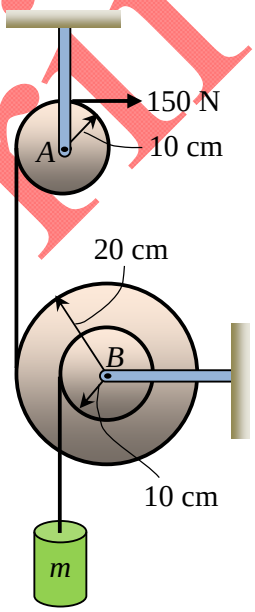
Student name		**Marks obtained for Q.1**	page 2/4
Student number			

Question # 1(c) (2.5 Marks)

If the pulley system is in equilibrium, calculate the mass (m) of the hanging cylinder.

Solution





$CCW(+)\Sigma M_B = 0 \Rightarrow 9.81m \times 10 - 150 \times 20 = 0$

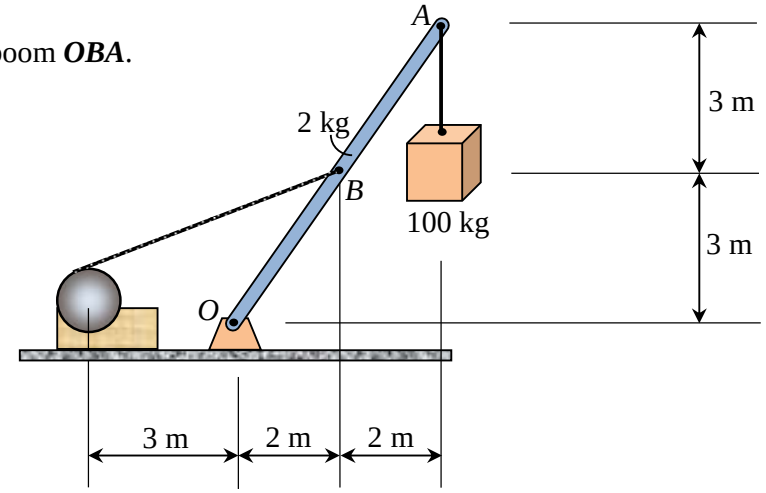
$\Rightarrow \underline{\underline{m = 30.6\,\text{kg}}}$ *Ans.*

Question # 1(d) (2.5 Marks)

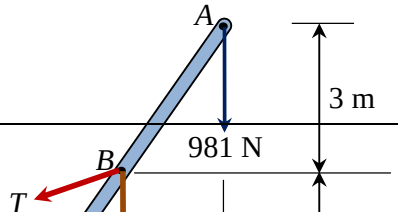
Draw the free body diagram (***FBD***) of 2kg-boom ***OBA***.

(Show the correct directions of all forces)

Solution



Free body diagram of 2kg-boom *OBA*:



Student name		**Marks obtained for Q.2**	page 3/4
Student number			

Question # 2 (10 Marks)

For the truss and loading shown in the figure:

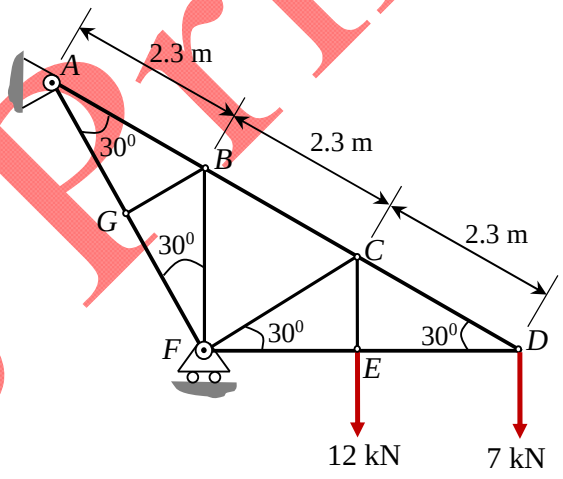
a) Calculate the support reactions at pin ***A*** and roller ***F***.

b) Identify the all zero-force members.

c) Calculate the forces in members ***AB*** and ***AG*** by using method of joints

d) Calculate the forces in members ***CB***, ***CF*** and ***EF*** by using method of sections

(*Specify whether* ***Tension*** *or* ***Compression***)



Solution

a) *Reactions:*

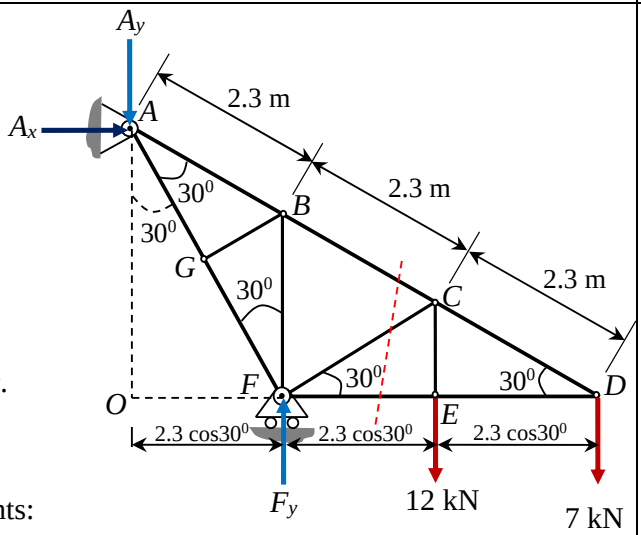
$\overset{+}{\rightarrow} \Sigma F_x = 0 \Rightarrow A_x = 0$ *Ans.*

$CCW(+) \Sigma M_A = 0$

$\Rightarrow F_y \times 2.3\cos 30^\circ - 12 \times 4.6\cos 30^\circ - 7 \times 6.9\cos 30^\circ = 0$

$\Rightarrow F_y = 45\ \text{kN} \uparrow$ *Ans.*

$\overset{+}{\uparrow} \Sigma F_y = 0 \Rightarrow -A_y + 45 - 12 - 7 = 0 \Rightarrow A_y = 26\ \text{kN} \downarrow$ *Ans.*



b) *Zero force members*: *BG* and *BF*

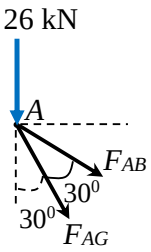
c) Forces in the members *AB* and *AG* using method of joints:

$+\uparrow \Sigma F_y = 0 \Rightarrow -F_{AG}\cos 30^\circ - F_{AB}\cos 60^\circ - 26 = 0 \Rightarrow F_{AG} = -(0.58F_{AB} + 30)$

$+\rightarrow \Sigma F_x = 0 \Rightarrow F_{AB}\sin 60^\circ + F_{AG}\sin 30^\circ = 0 \Rightarrow F_{AB}\sin 60^\circ - (0.58F_{AB} + 30)\sin 30^\circ = 0$

$F_{AB}(\sin 60^\circ - 0.58\sin 30^\circ) - 15 = 0 \Rightarrow \underline{\underline{F_{AB} = 26 \text{ kN (T)}}}$ *Ans.*

$\therefore F_{AG} = -(0.58 \times 26 + 30) = -45 \text{ kN} \Rightarrow \underline{\underline{F_{AG} = -45 \text{ kN (C)}}}$ *Ans.*



d) Forces in the members *CB*, *CF* and *EF* using method of sections:

Cut the truss into two parts through the section shown above, and consider the right part of the truss.

$EC = 2.3\sin 30^\circ = 1.15 \text{ m}$

$CCW(+)\Sigma M_D = 0 \Rightarrow F_{CF}\cos 30^\circ \times 1.15 + F_{CF}\sin 30^\circ \times 2.3\cos 30^\circ + 12 \times 2.3\cos 30^\circ$

$\Rightarrow \underline{\underline{F_{CF} = -12 \text{ kN (C)}}}$ *Ans.*

$+\uparrow \Sigma F_y = 0 \Rightarrow F_{CB}\sin 30^\circ - (-12)\sin 30^\circ - 12 - 7 = 0 \Rightarrow \underline{\underline{F_{CB} = 26 \text{ kN (T)}}}$ *Ans.*

$+\rightarrow \Sigma F_x = 0 \Rightarrow -F_{EF} - 26\cos 30^\circ - (-12)\cos 30^\circ = 0 \Rightarrow \underline{\underline{F_{EF} = -12.1 \text{ kN (C)}}}$ *Ans.*

Student name		**Marks obtained for Q.3**	page 4/4
Student number			

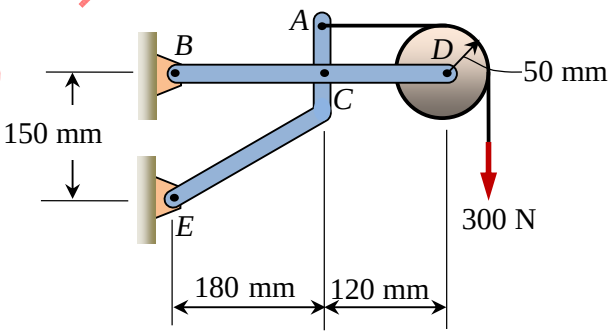
Question # 3 (10 Marks)

For the frame shown in the figure:

a) Find the reactions at the pin supports ***B*** and ***E*** respectively.

b) Draw the free body diagrams (***FBD***) for each member.

c) Determine the horizontal and vertical components of force at ***C***.



Solution

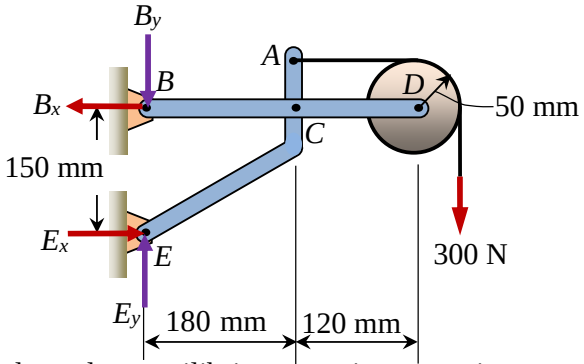
a) *Reactions:*

$CCW(+)\Sigma M_E = 0 \Rightarrow$

$B_x \times 150 - 300 \times 350 = 0 \Rightarrow \underline{\underline{B_x = 700 \text{ N}}}$ $\leftarrow$ *Ans.*

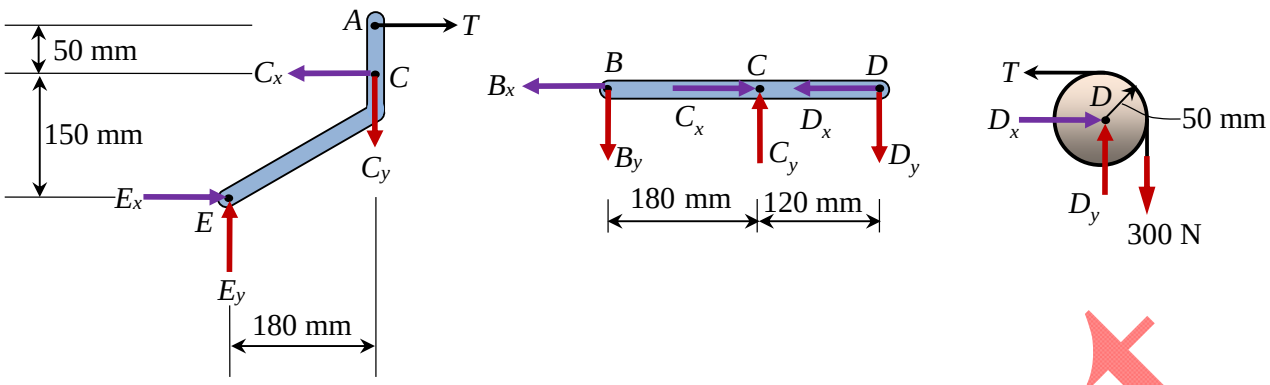
$+\rightarrow \Sigma F_x = 0 \Rightarrow E_x - 700 = 0 \Rightarrow \underline{\underline{E_x = 700 \text{ N}}}$ $\rightarrow$ *Ans.*

$+\uparrow \Sigma F_y = 0 \Rightarrow E_y - B_y - 300 = 0 \Rightarrow B_y = E_y - 300$



As the number of unknowns are more than the numbers of independent equilibrium equations, reaction components E_y and B_y will be obtained from the free body diagrams of individual members in part (c).

b) *Free Body Diagrams:*



a – Contd.) *Remaining reaction components*: From member *ECA*

$CCW(+)\Sigma M_C = 0 \Rightarrow 700\times150 - E_y \times180 - 300\times50 = 0 \Rightarrow E_y = 500\text{ N}$ *Ans.*

$\therefore B_y = E_y - 300 = 500 - 300 \Rightarrow B_y = 200\text{ N}$ *Ans.*

(c) Horizontal and vertical components of the force at *C*: From member *ECA*

$\overset{+}{\rightarrow}\Sigma F_x = 0 \Rightarrow -C_x + E_x + T = 0 \Rightarrow -C_x + 700 + 300 = 0 \Rightarrow C_x = 1000\text{ N}$ *Ans.*

$\overset{+}{\uparrow}\Sigma F_y = 0 \Rightarrow -C_y + E_y = 0 \Rightarrow -C_y + 500 = 0 \Rightarrow C_y = 500\text{ N}$ *Ans.*