King Saud University
College of Engineering
Department of Civil Engineering

FINAL EXAM

GE201 Statics – 1st Semester 1430- 31H

Wednesday, 12th SAFAR 1431 H – 27th January 2010
Time allowed: 3 hrs

Student name	
Student number	
Section / Instructor	

Attempt all questions

Questions	Maximum Marks	Marks obtained
Q # 1	10	
Q # 2	10	
Q # 3	14	
Q # 4	8	
Q # 5	8	
Total marks		_____ 50

Total marks obtained (in words):_____

Instructor's Signature

Student name		Marks obtained for Q 1	
Student number			

Question # 1 (3+3+4=10 points)

Course Learning Obj. #	*Percentage*
1	30
3	30
6	40

(a) Compute the combined moment of the two 400-N forces, shown in Figure 1, about: (i) point ***O***; and (ii) point ***A.***

$M_O = M_A = 400 \times 400 = 160000$ N.mm (C.W.)

Note: The given two forces are forming a couple, and couple moment is independent of moment centers.

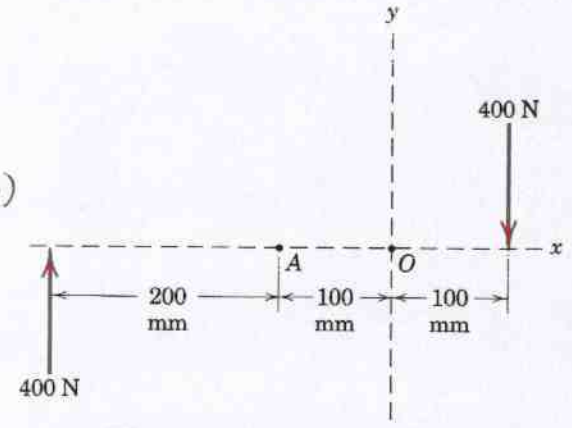
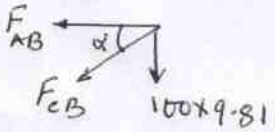


Figure 1

(b) Calculate the member forces in member *AB* and *CB* in a given truss, shown in Figure 2.

Apply method of joint at joint B.



$\sin\alpha = \frac{5}{13}$; $\cos\alpha = \frac{12}{13}$

$\rightarrow \Sigma F_x = 0 \quad F_{AB} - F_{CB}\cos\alpha = 0$ —— (i)

$+\uparrow \Sigma F_y = 0 \quad -F_{CB}\sin\alpha - 981 = 0$ —— (ii)

Solution yields:

$F_{AB} = 2355$ N (T) $\quad F_{CB} = -2551$ N or $F_{CB} = 2551$ N (C)

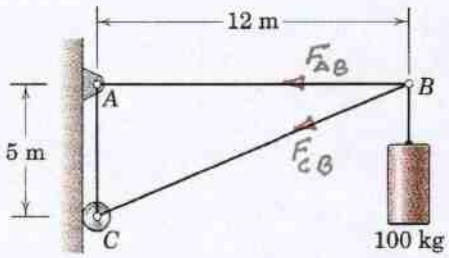


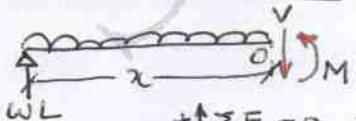
Figure 2

(c) Draw Shear Force diagram (SFD) and Bending Moment diagram (BMD) of simply supported beam as shown in Figure 3.

Reactions: From symmetry of loading:

$A_y = B_y = \frac{wL}{2}$

Shear and Moment: cut a section at a distance of x, say from A.



$+\uparrow \Sigma F_y = 0 \Rightarrow V = -wx + \frac{wL}{2}$ (Linear)

$\circlearrowleft \Sigma M_O = 0 \Rightarrow M = -\frac{wx^2}{2} + \frac{wL}{2}x$ (Parabolic)

x	0	L/2	L
V	$\frac{wL}{2}$	0	$-\frac{wL}{2}$
M	0	$wL^2/8$	0

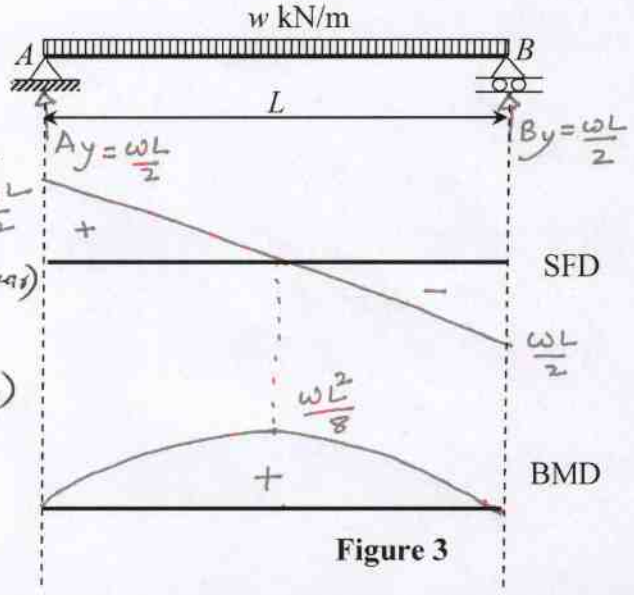


Figure 3

Student name		Marks obtained for Q 2	
Student number			

Question # 2 (10 points)

The turnbuckle, shown in Figure 4, is tightened until the tension in the cable *AB* equals 2.4 kN. **Determine:**

(a) The vector expression for the tension ***T*** as a force acting in the member *AD*.

(b) Magnitude of the moment about point ***O*** of the force acting on point ***A***.

(c) Value of the moment of the force acting on point ***A*** about the line ***OB***.

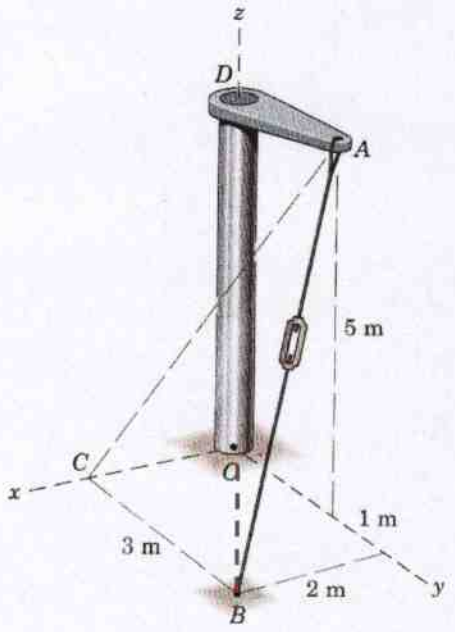


Figure 4

Course Learning Obj. #	*Percentage %*
1	100

A (0, 2, 5) ; B (2, 3, 0)

(a)

$$\vec{T}_{AB} = T\,n_{AB}$$

$$= 2.4\left[\frac{2i + j - 5k}{\sqrt{2^2 + 1^2 + 5^2}}\right]$$

$$\boxed{\vec{T} = 0.876\vec{i} + 0.438\vec{j} - 2.19\vec{k}}$$

(b)

$$M_O = r_{OB} \times T = \begin{vmatrix} i & j & k \\ 2 & 3 & 0 \\ 0.876 & 0.438 & -2.19 \end{vmatrix}$$

$$\boxed{\vec{M}_O = -6.57\vec{i} + 4.38\vec{j} - 1.75\vec{k}}$$

(c)

$$M_{OB} = M_O \cdot n_{OB}$$

$$= (-6.57i + 4.38j - 1.75k) \cdot \left[\frac{2i + 3k}{\sqrt{2^2 + 3^2}}\right]$$

$$= -3.61 + 3.61$$

$$= 0$$

[Note: Line OB is intersecting the point of application of force, hence the moment is ZERO.

Student name		Marks obtained for Q 3	
Student number			

Question # 3 (14 points)

For the channel section, shown in Figure 5:

(a) Locate the centroid $\bar{x}$ and $\bar{y}$ of the section;

(b) Determine the moments of inertia I_x and I_y about the x- and y-axes respectively.

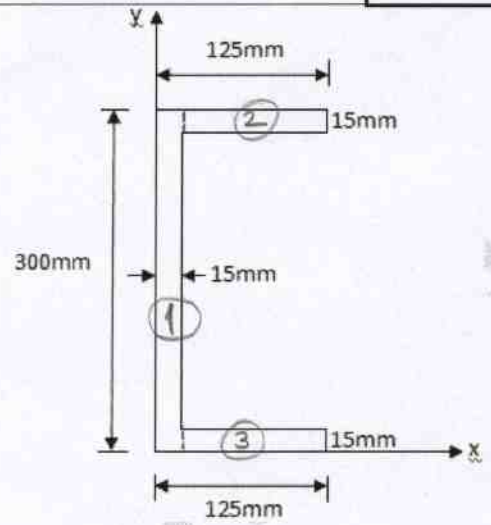


Figure 5

Course Learning Obj. #	*Percentage %*
5	**100**

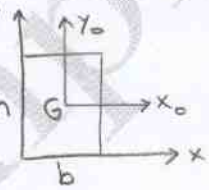
(a) Subdividing the given channel section as shown

Parts	$A(mm^2)$	$\bar{x}$(mm)	$\bar{y}$(mm)	$A\cdot\bar{x}\ (mm^3)$	$A\cdot\bar{y}\ (mm^3)$
1	4500	7.5	150	33750	675000
2	1650	70	292.5	115500	482625
3	1650	70	7.5	115500	12375
	7800			264750	1170000

$$\bar{x} = \frac{\Sigma A\bar{x}}{\Sigma A} = \frac{264750}{7800} = \boxed{33.94\,mm} \quad \text{and} \quad \bar{y} = \frac{\Sigma A\bar{y}}{\Sigma A} = \frac{1170000}{7800} = \boxed{150\,mm}$$

(b) Recalling that

G: Centroid



$$I_x = \frac{bh^3}{3}$$

$$I_{x_o} = \frac{bh^3}{12}$$

$$I_{x_1} = \frac{15(300)^3}{3} = 135000000\ mm^4$$

$$I_{x_2} = \frac{110(15)^3}{12} + (110)(15)(292.5)^2 = 141198750\ mm^4$$

$$I_{x_3} = \frac{110(15)^3}{3} = 123750\ mm^4$$

$$I_x = I_{x_1} + I_{x_2} + I_{x_3}$$

$$\boxed{I_x = 276322500\ mm^4}$$

$$I_{y_1} = \frac{300(15)^3}{3} = 337500\ mm^4$$

$$I_{y_2} = \frac{15(110)^3}{12} + (15)(110)(70)^2 = 9748750\ mm^4$$

$$I_{y_3} = I_{y_2} = 9748750\ mm^4$$

$$I_y = I_{y_1} + I_{y_2} + I_{y_3}$$

$$\boxed{I_y = 19835000\ mm^4}$$

Student name		Marks obtained for Q 4	
Student number			

Question # 4 (8 points)

In the loaded beam shown in Figure 6:

(a) Calculate the support reactions at ***A*** and ***B***.

(b) Determine the Shear Force and Bending Moment values at the point ***C***.

Assume the supports at *A* and *B* as pin and roller respectively.

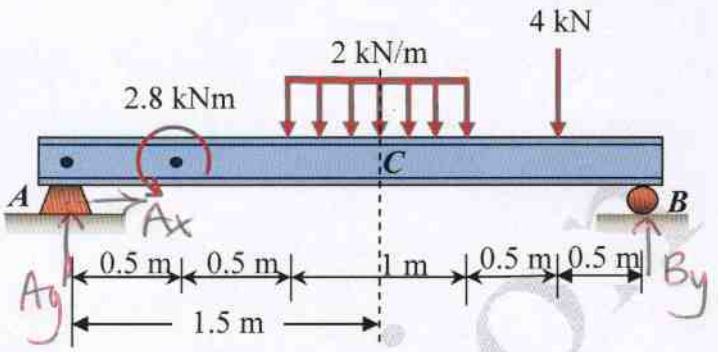


Figure 6

Course Learning Obj. #	*Percentage %*
6	100

a) Consider the whole system

$\xrightarrow{+} \sum F_x = 0 \Rightarrow A_x = 0$

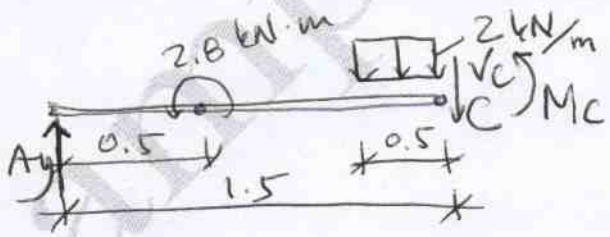
$+\circlearrowleft \sum M_A = 0 \Rightarrow 3B_y - 4(2.5) + 2.8 - 2(1)(1.5) = 0$

$B_y = \frac{10.2}{3} = 3.4\ kN$

$+\uparrow \sum F_x = 0 \Rightarrow A_y + B_y - 2(1) - 4 = 0$

$A_y = 2.6\ kN$

b) FBD (cut at C, look to the left)



$\uparrow \sum F_y = 0 \Rightarrow A_y - 2(0.5) - V_c = 0$

$V_c = A_y - 1 = 2.6 - 1 = 1.6\ kN$

$+\circlearrowleft \sum M_A = 0 \Rightarrow +M_c + 2.8 - 2(0.5)(1.25) - V_c \cdot 1.5 = 0$

$M_c = 1.25 + 1.6(1.5) - 2.8$

$= 0.85\ kN \cdot m$

Student name		Marks obtained for Q 5	
Student number			

Question #5 (8 points)

Determine the magnitude of force ***P*** needed to start moving the 40 kg block, shown in Figure 7.
The block is symmetric with uniform mass.
Take coefficient of static friction $\mu_s = 0.3$

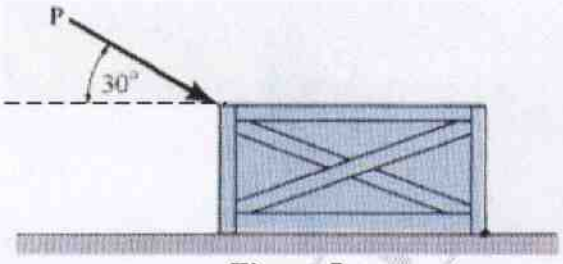
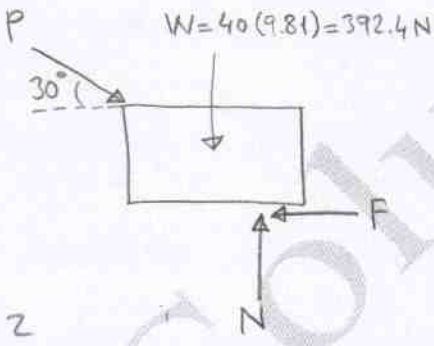


Figure 7

Course Learning Obj. #	*Percentage %*
7	**100**



$\Sigma F_x = 0$: $P\cos 30^\circ - F = 0$

$F = 0.866P$ 1

$\Sigma F_y = 0$: $-P\sin 30^\circ - 392.4 + N = 0$

$N = 0.5P + 392.4$ 2

F = Friction Force = $\mu_s N$ for impending motion

$F = 0.3(0.5P + 392.4)$ 3

Equating (1) and (3) yields that

$0.866P = 0.3(0.5P + 392.4)$

$0.716P = 117.72$

$P = 164.4\ N$