الجامعة التكنولوجية

قسم هندسة البناء والإنشاءات

المرحلة الأولى

العـدد : ٢٤٩

التاريخ : ٢٥/ ٥/ 2016

الى / السيد معاون رئيس القسم

م/ الاجابة النموذجية لمادة (الميكانيك الهندسي 2)

تحية طيبة .....

نرفق لكم طياً نسخة من الأسئلة الخاصة بمادة الميكانيك الهندسي 2 و للإمتحان النهائي للفصل الدراسي الثاني – الدور الأول و للعام الدراسي 2015 – 2016 و الذي تم اجراءه بتاريخ 2016/5/24 مع الاجابة النموذجية الخاصة بها.

مع التقدير

أ.م.د. قيس جواد فريح

مسؤول المرحلة الأولى

٢٥/ ٥/ 2016

نسخة منه الى/

- ملف اللجنة الامتحانية

University of Technology
Building and Construction Engineering Department
Final Exam. - First Attempt - 2015-2016

Subject: Engineering Mechanics II **Date: 24 / 05 /2016**
Class: 1st **Time: 3 hrs.**

Note: Answer **FOUR** questions only.

Q1/ Determine the Centroid Coordinates of the shaded area shown in Fig. (1).

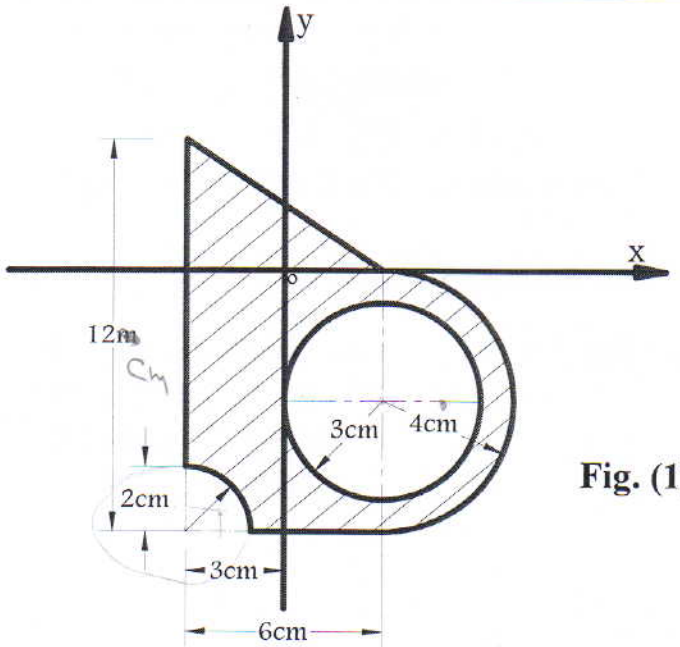

Fig. (1)

Q2/ A particle is moving along a horizontal line. It has an initial velocity of **3 m/sec** to the right and an acceleration of **1 m/sec^2** to the right for the first **6 seconds**. The particle is then moves with an acceleration of **2 m/sec^2** to the left for **5 seconds**. Then it moves for **4 seconds** with acceleration to the right, the velocity of the particle at the end of this time interval is **5 m/sec** to the right. Determine:

1- The acceleration of the particle for the last **4 seconds**.
2- The total distance travelled by the particle.
3- The displacement of the particle during the first **13 seconds**.

Note: solve using velocity-time diagram (V-t diagram)

Q3/ The shaded area shown in Fig.(2) has a radius of gyration with respect to **x-axis** of **3.04 cm**. Determine the minimum and maximum moment of inertia of the shaded area with respect to axes through the origin.

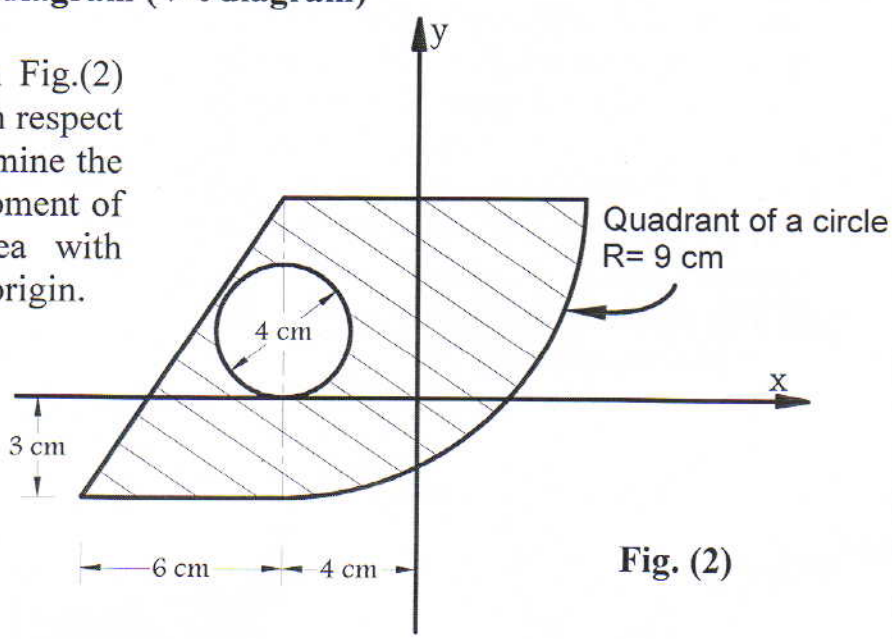

Fig. (2)

Q4/ Body **(A)** shown in Fig.(3) weighs **1000 N** and slides on the horizontal plane. The weight of body **(B)** is **500 N** and its velocity changes from **2 m/sec** download to **4 m/sec** download while its moves **6 m**. Determine the tension in the cord and the coefficient of friction between body **(A)** and the Plane.

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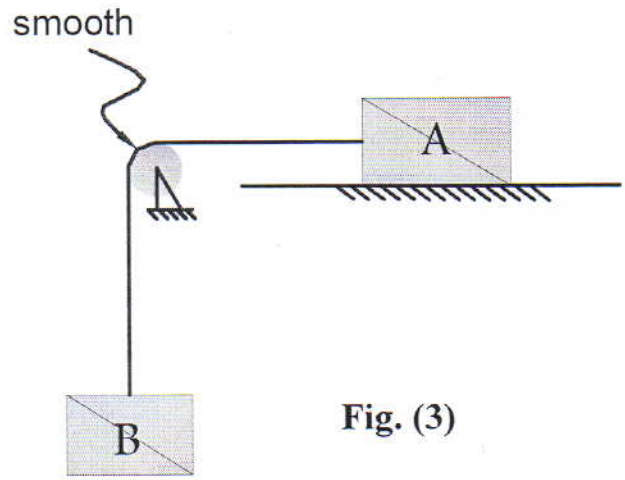

Fig. (3)

Q5/ Answer one of the following:

A) For the shaded area shown in Fig.(4), determine the moment of Inertia with respect to axis passing through the centroid and parallel to x-axis.

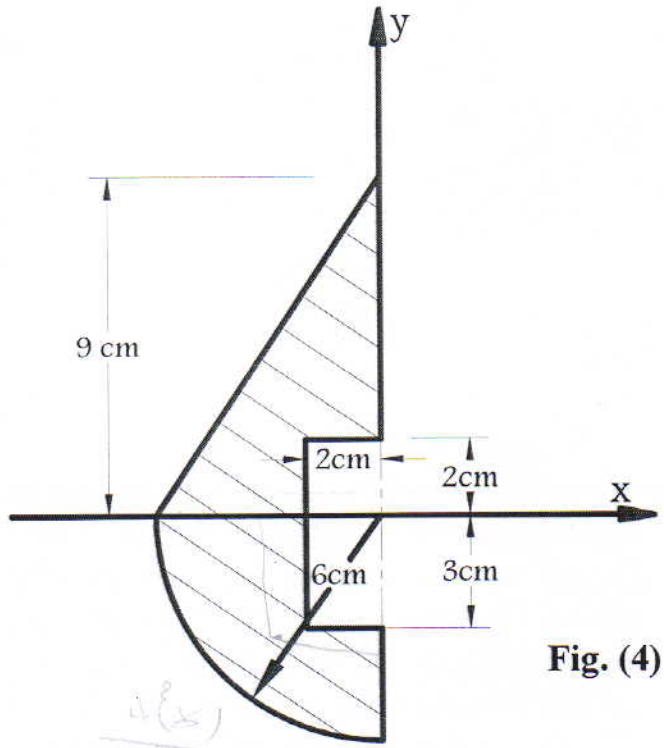

Fig. (4)

B) Bar AB rotates about a fixed horizontal axis through **(A)** with initial angular velocity of **2 rad/sec** counterclockwise and angular acceleration of **0.5 rad/sec^2** clockwise during **6 seconds**. During this time interval, the angular velocity reverses direction. At the end of this time interval, the bar is in the position shown in Fig.(5), determine:

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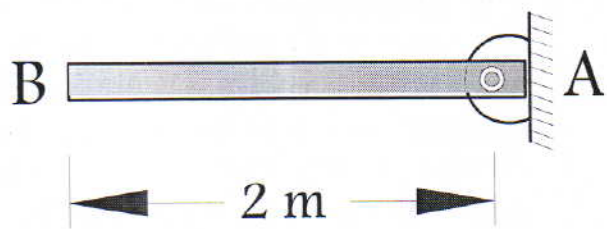

Fig. (5)

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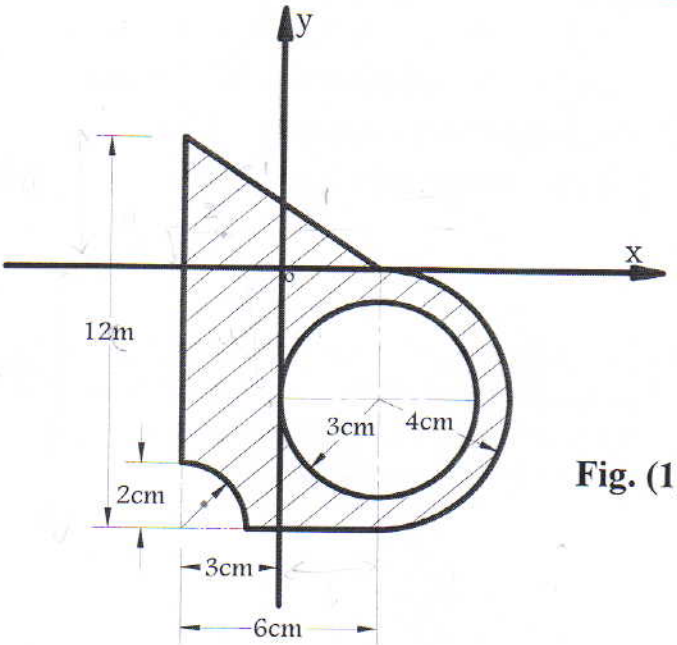

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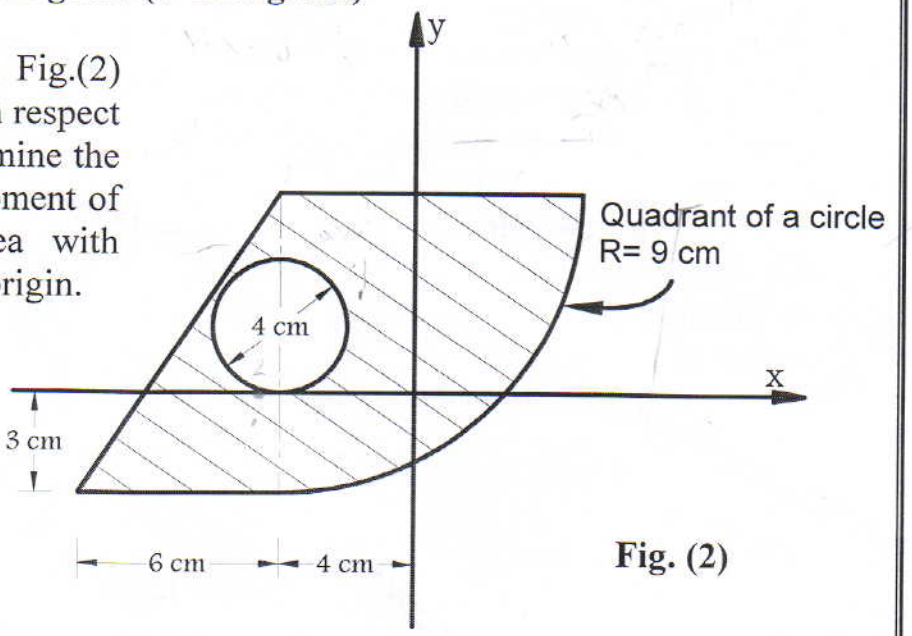

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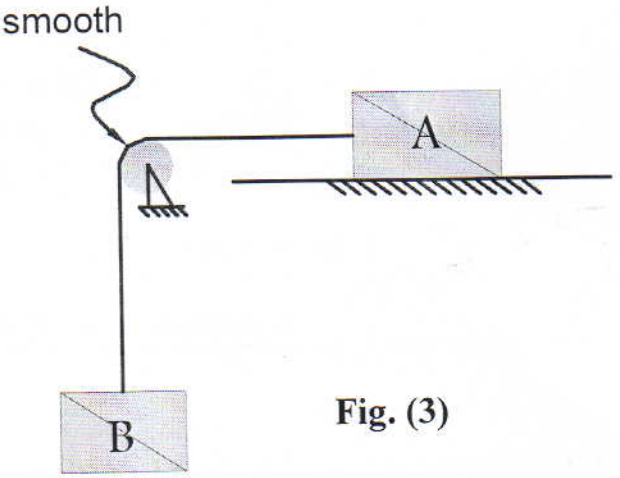

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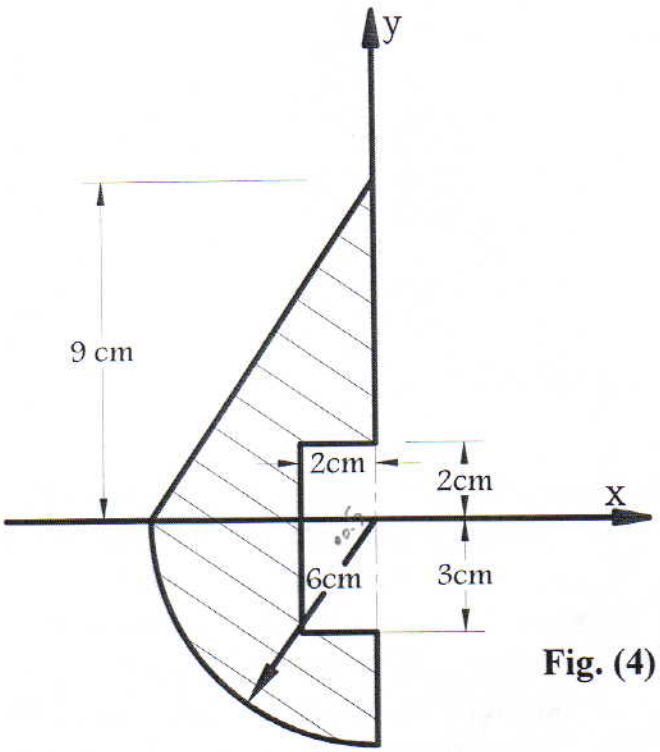

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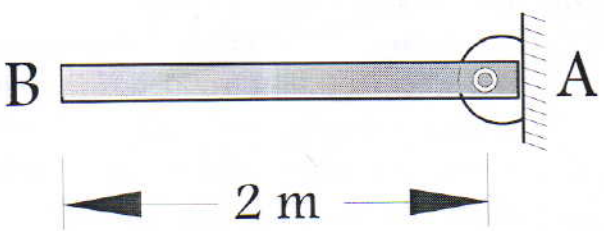

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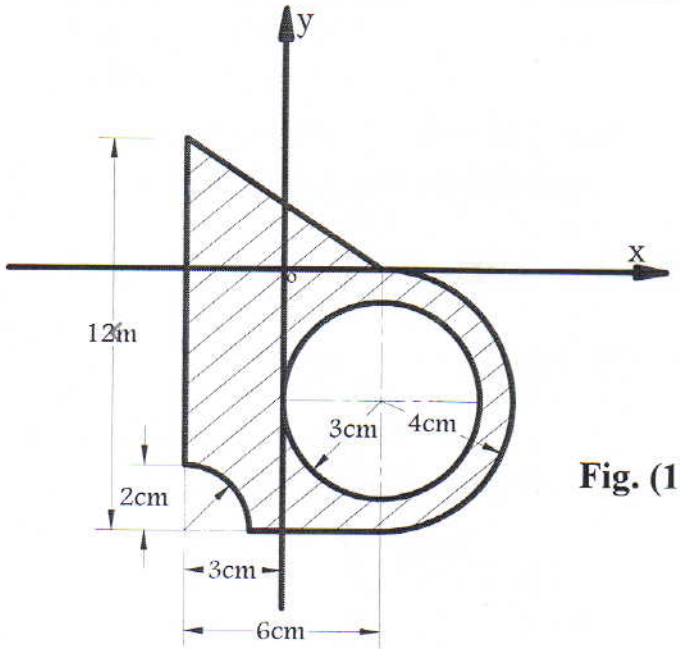

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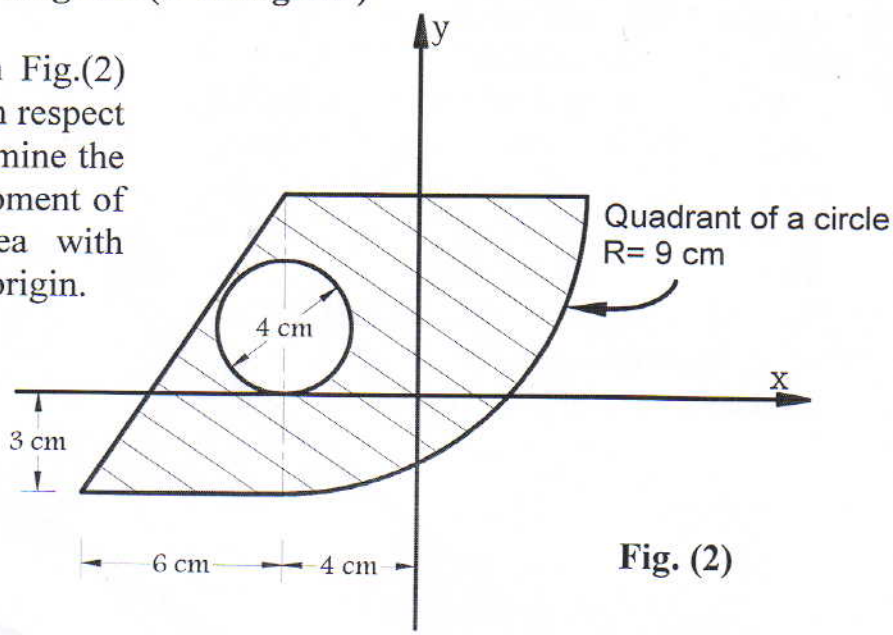

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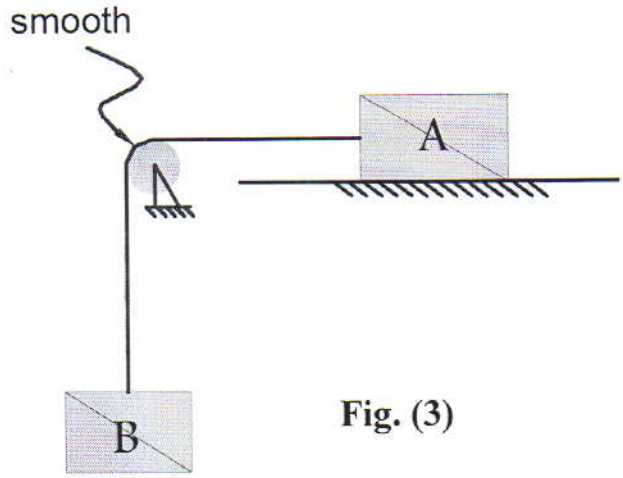

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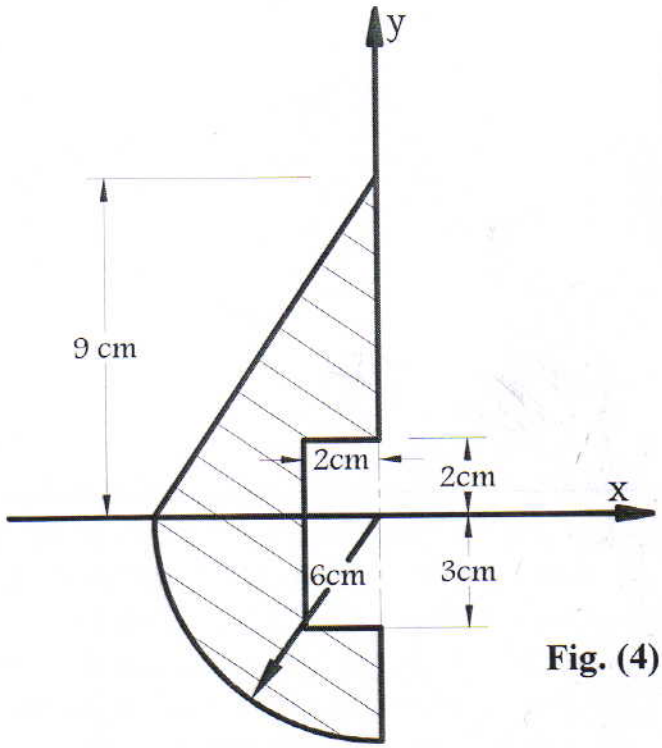

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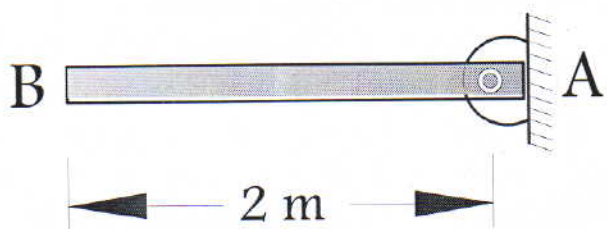
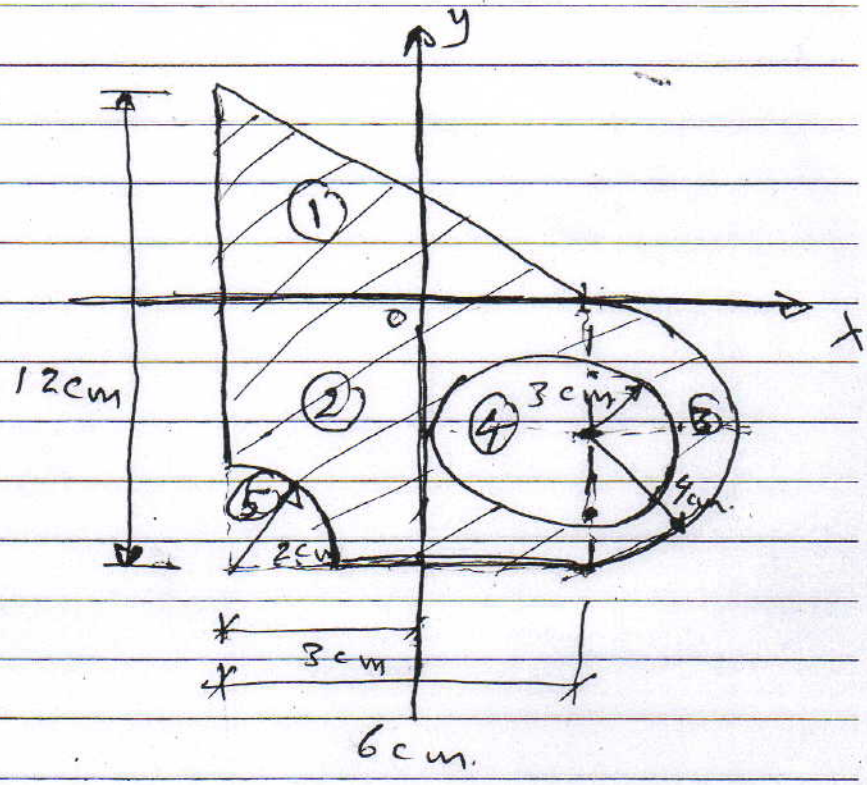


Fig. (5)

Good Luck

Q.1

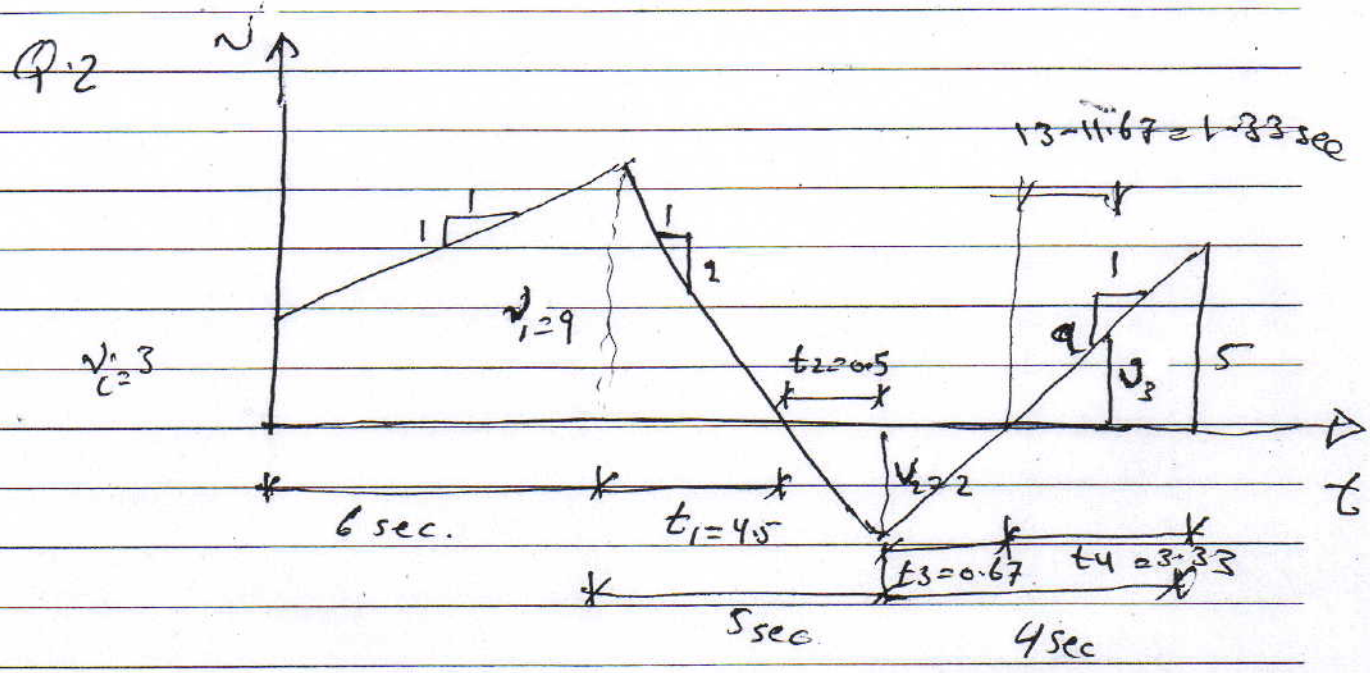


Symbol	Area cm^2	x-Coord. cm	M_y cm^3	y-Coord. cm	M_x cm^3
(1)	$\frac{4\times6}{2}=12$	-1	-12	$\frac{4}{3}=1.33$	15.96
(2)	$6\times8=48$	0	0	-4	-192
(3)	$\frac{4^2\pi}{2}=25.12$	$\left[3+\frac{4\times4}{3\pi}\right]=4.7$	118.06	-4	-100.48
(4)	$-3^2\pi=-28.26$	3	-84.78	-4	113.04
(5)	$-\frac{2^2\pi}{4}=-3.14$	$-\left[3-\frac{4\times2}{3\pi}\right]=-2.15$	6.75	$-\left[8-\frac{4\times2}{3\pi}\right]=-7.15$	22.45
Total	53.72		28.03		-141.03

$$\bar{x}=\frac{M_{y_{total}}}{A_{total}}=\frac{28.03}{53.72}=0.52\ cm$$

$$\bar{y}=\frac{M_{x_{total}}}{A_{total}}=\frac{-141.03}{53.72}=-2.63\ cm$$

Q.2



a) $\frac{1}{1} = \frac{v_1 - 3}{6}$, $v_1 = 9$ m/sec $\rightarrow$

$\frac{-2}{1} = \frac{v_2 - 9}{5}$, $v_2 = 1$ m/sec $\leftarrow$

$\frac{2}{1} = \frac{9}{t_1}$, $t_1 = 4.5$ sec

$\therefore t_2 = 5 - 4.5 = 0.5$ sec

$\frac{q}{1} = \frac{5-(-1)}{4}$, $q = 1.5$ m/sec^2 $\rightarrow$

$\frac{1.5}{1} = \frac{1}{t_3} \Rightarrow t_3 = 0.67$ sec.

$\therefore t_4 = 4 - 0.67 = 3.33$ sec.

b) $Q = \left[\frac{3+9}{2} * 6\right] + \left(\frac{9*4.5}{2}\right) + \left(\frac{1*0.5}{2}\right) + \left(\frac{1*0.67}{2}\right) + \left(\frac{3.33*5}{2}\right)$

$Q = 36 + 20.25 + 0.25 + 0.335 + 8.325$

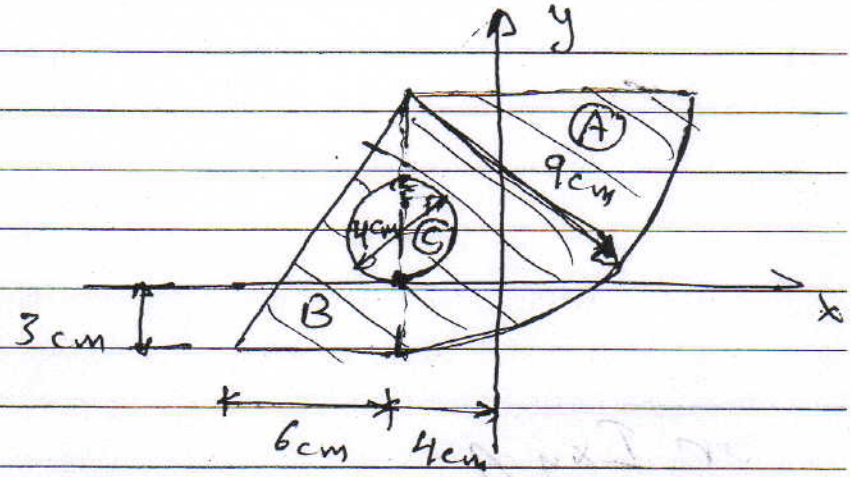
$Q = 65.16$ m

c) $\frac{1.5}{1} = \frac{v_3}{1.33}$, $v_3 = 2$ m/sec $\rightarrow$

$q = \left[\frac{3+9}{2} * 6\right] + \left(\frac{9*4.5}{2}\right) - \left(\frac{1*0.5}{2}\right) - \left(\frac{1*0.67}{2}\right) + \left(\frac{2*1.33}{2}\right)$

$q_{\text{at } 13\text{sec}} = 36 + 20.25 - 0.25 - 0.335 + 1.33 = 57$ m $\rightarrow$

Q.3



$$A = \frac{9^2 * \pi}{4} + \frac{6*9}{2} - \frac{2^2\pi}{2} = 63.585 + 27 - 12.56$$

$$A = 78.03 \text{ cm}^2$$

$$K_x = \sqrt{\frac{I_{x\,total}}{A_{total}}}, \quad I_{x\,total} = K_x^2 * A$$

$$I_{x\,total} = 3.04^2 * 78.03 = 721.1 \text{ cm}^4$$

$$I_{y_A} = 0.0549(9^4) + \frac{9^2\pi}{4}\left[-\left(4 - \frac{4*9}{3\pi}\right)\right]^2$$

$$= 360.2 + 63.585(0.18)^2 = 362.26 \text{ cm}^4$$

$$I_{y_B} = I_c + Ad^2 = \frac{9*6^3}{36} + \frac{9*6}{2}(-6)^2$$

$$= 54 + 972 = 1026 \text{ cm}^4$$

$$I_{y_C} = \frac{\pi(2)^4}{4} + 2^2\pi(-4)^2 = 12.56 + 200.96$$

$$= 213.52 \text{ cm}^4$$

$$\therefore I_{y_{total}} = 362.26 + 1026 - 213.52 = 1174.74 \text{ cm}^4$$

$$I_{xy_A} = I_{x'y'} + A x_c y_c$$

$$I_{xy_A} = 0.01645(9)^4 + \frac{9^2\pi}{4}\left[-0.18\right]\left[6 - \frac{4(9)}{3\pi}\right]$$

$$I_{xy_A} = 107.9 - 24.93 = 83 \text{ cm}^4$$

$$I_{xy_B} = \frac{(6^2)(9)^2}{72} + \left(\frac{6*9}{2}\right)(-6)(6) = 40.5 \text{ cm}^4$$

$$I_{xy_C} = 0 + (2^2\pi)(-4)(3) = -100.48 \text{ cm}^4$$

Q.3

$$I_{xy\,total} = 83 + 40.5 - (-100.48) = 223.98\ cm^4$$

$$I_{max\atop min} = \frac{I_x + I_y}{2} \pm \sqrt{\left(\frac{I_x - I_y}{2}\right)^2 + I_{xy}^2}$$

$$= \frac{721.1 + 1174.74}{2} \pm \sqrt{\left(\frac{721.1 - 1174.74}{2}\right)^2 + (223.98)^2}$$

$$= 947.92 \pm \sqrt{51447.31 + 50167}$$

$$= 947.92 \pm \sqrt{101614.35} = 947.92 \pm 318.77$$

$I_{max} = 1266.7\ cm^4$

$I_{min} = 629.15\ cm^4$

Q.4

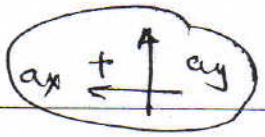
From F.B.D.2

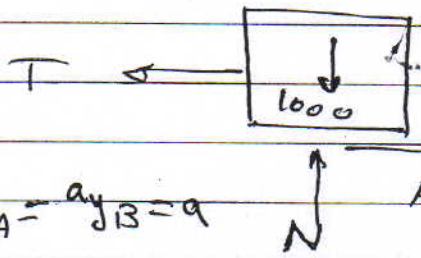
$\Sigma F_y = m a_y$

$500 - T = \frac{500}{10} * a_{yB}$

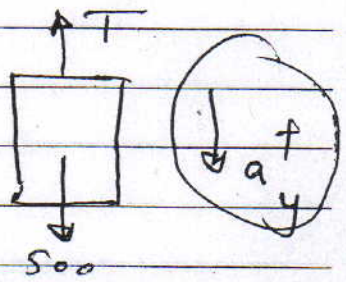
$500 - T = 50 * 1$

$T = 450\ N$





F.B.D.1



F.B.D.2

F.B.D.1

$\Sigma F_y = m a_{y_A}^{\nearrow 0}$

$N - 1000 = 0$

$N = 1000\ N \uparrow$

$a_{x_A} = a_{yB} = a = 1$

$\Sigma F_x = m a_{x_A}$

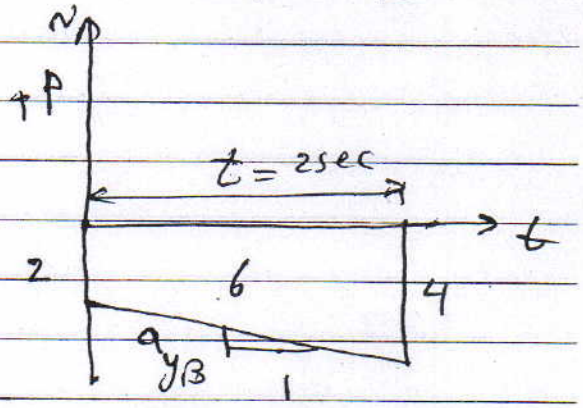
$\Sigma F_x = m a$

$T - \mu * 1000 = \frac{1000}{10} * 1$

$450 - 1000\mu = 100$

$350 = 1000\mu$

$\therefore \mu = \frac{350}{1000} = 0.35$

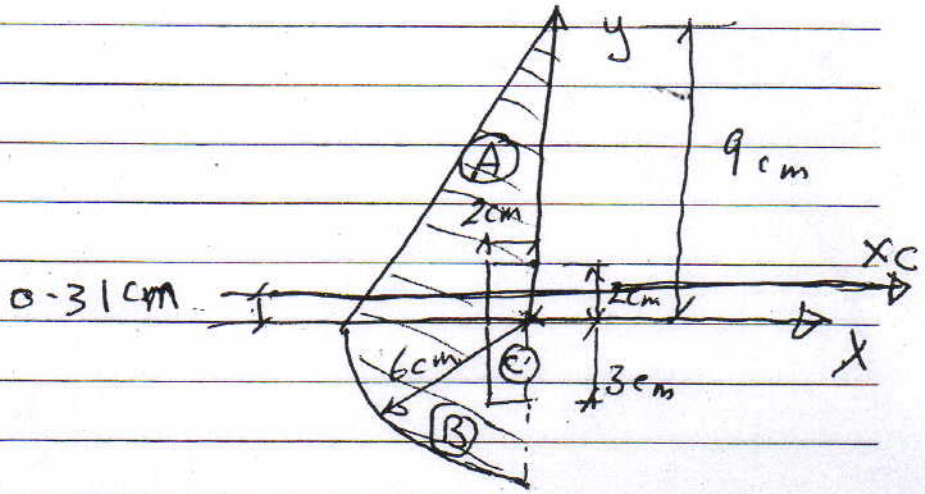


$6 = \frac{2+4}{2} * t$, $t = 2sec$

$\frac{a_{yB}}{1} = \frac{4-2}{2}$

$a_{yB} = 1\ m/sec^2 \downarrow$

Q.5) A.



Symbol	Area cm^2	y-Coord. cm	M_x cm^3
A	$\frac{9*6}{2} = 27$	3	81
B	$\frac{6^2\pi}{4} = 28.26$	$\frac{-4*6}{3\pi} = -2.55$	-72.1
C	$-(5*2) = -10$	-0.5	5
total	45.26		13.9

$$\therefore \bar{y} = \frac{M_{x_{total}}}{A_{total}} = \frac{13.9}{45.26} = 0.31 \text{ cm}$$

For area (A)

$$I_{xcA} = I_c + Ad^2 = \frac{6*9^3}{36} + \frac{6*9}{2}(3-0.31)^2 = 121.5 + 195.37 = 316.87 \text{ cm}^4$$

For area (B)

$$I_{xcB} = I_c + Ad^2 = 0.0549(6)^4 + \pi\frac{(6^2)}{4}\left[-\left(\frac{4*6}{3\pi} + 0.31\right)\right]^2$$

$$= 71.2 + 230.8 = 301.95 \text{ cm}^4$$

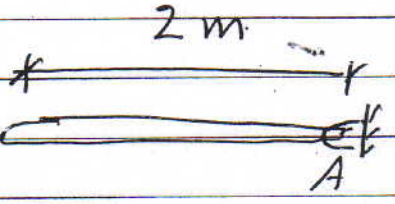
For area (C)

$$I_{xcC} = I_c + Ad^2 = \frac{2*(5)^3}{12} + (2*5)\left[-(0.5+0.31)\right]^2$$

$$= 20.83 + 6.56 = 27.4 \text{ cm}^4$$

$$I_{xc_{total}} = I_{xcA} + I_{xcB} - I_{xc^C} = 316.87 + 301.95 - 27.4 = 591.42 \text{ cm}^4$$

Q.5 B



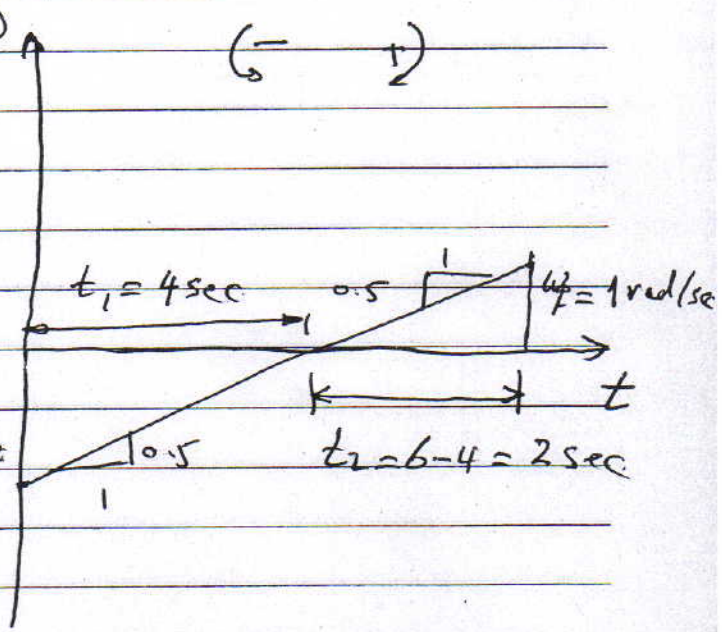
$\frac{0.5}{1} = \frac{2}{t_1}$

$t_1 = 4\ sec$

$\therefore t_2 = 6 - 4 = 2 sec$

$\frac{0.5}{1} = \frac{w_f}{2}$

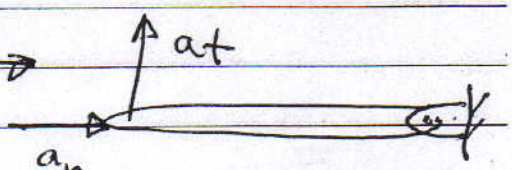
$w_f = 1\ rad/sec$ ↺



$a_t = r\alpha$

$= 2(0.5) = 1\ m/sec^2$ ↑

$a_n = r\omega^2 = 2(1)^2 = 2\ m/sec^2$ →



(or)

$v = r\omega = 2 * 1 = 2\ m/sec$

$a_n = \frac{v^2}{r} = \frac{4}{2} = 2\ m/sec^2$ →

$a = \sqrt{a_t^2 + a_n^2} = \sqrt{5} = 2.24\ m/sec^2$ ∠ 1/2

b) $\phi = \left(\frac{2*4}{2}\right) + \left(\frac{1}{2} * 1 * 2\right) = 4 + 1 = 5\ rad.$