| Menoufiya University		Dept.: Production Engineering
Faculty of Engineering		Year : First
Shebin El- Kom		Subject: Applied Mechanics
Final First Term Examination		Code : PRE 113
Academic Year: 2015-2016		Time Allowed: 3 hours
Date: 14/1/2016	Minufiya University	Total Marks : 120 Marks

Examiner: Dr/ Mohamed Hesham Belal + Dr/ Mamdouh El-Elamy
Allowed Tables and Charts: None -   (take $g_0 = 9.8$ m/s^2)

Answer All the Following Questions:

Part I: Statics

Question (1):   (30 Marks)

Draw the normal force (if any), shear force and the bending moment diagrams for the hinged beam shown in Fig. (1).

Fig.(1)
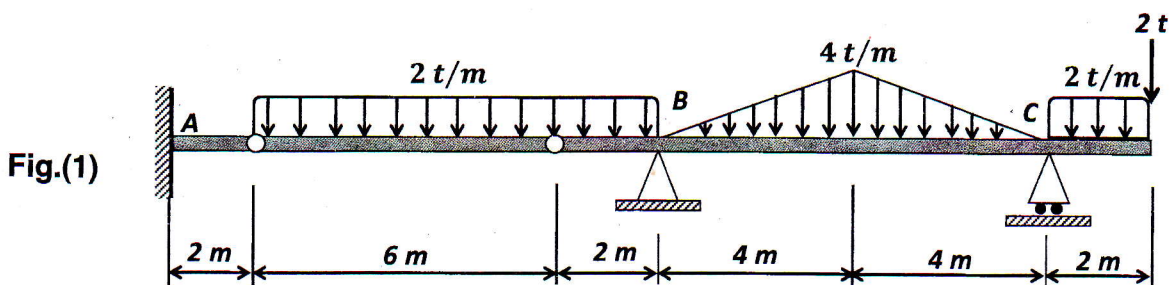
Question (2):   (2*15 = 30 Marks)

(a) – Determine the area moment of inertia of the area shown in Fig. (2), with respect to the central axis, and also find the area moment of inertia with respect to A-A axis.

Take area moment of inertia of circular $I_y = I_x = \dfrac{\pi R^4}{4}$, semicircular $I_y = I_x = \dfrac{\pi R^4}{8}$

(b)- Determine the mass moment of inertia and radius of gyration of the steel flywheel shown in Fig. (3) with respect to the axis of rotation. The web of the flywheel consists of a solid plate *2 cm* thick. (Density of steel $\rho = 7850$ kg/m^3). Take the moment of inertia $\dfrac{1}{2}m(R_2^2 - R_1^2)$
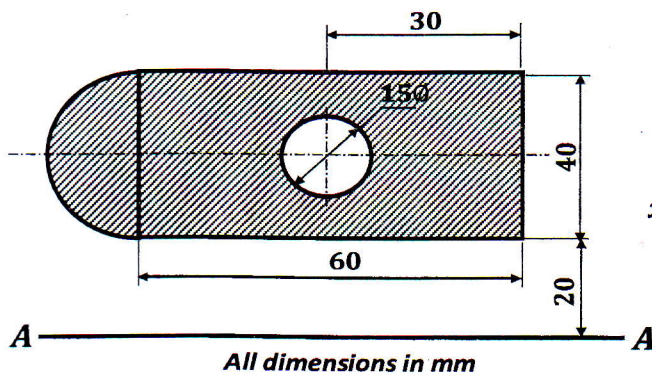

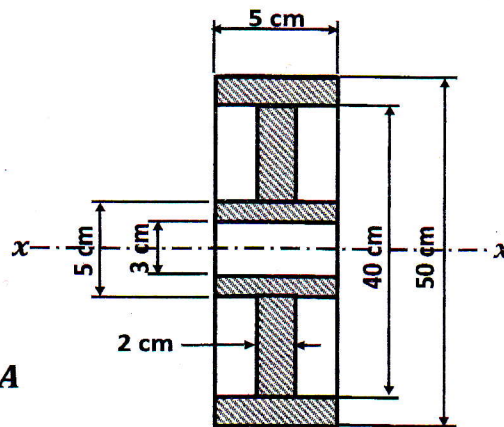All dimensions in mm

Fig.(2)

Fig.(3)

This exam measure the following ILOs											
Question No.	Q1	Q2-a	Q3-a	Q4-a	Q2-b	Q3-b	Q4-a	Q4-b	Q2-a	Q3-c	Q4-a	Q4-b
	a-1	a-5	a-19	a-3	b-1	b-16	b-17	b-1	c-1	c-5	c-22	c-16
Skills	Knowledge & Understand				Intellectual				Professional			

With our best wishes

Part II: Dynamics
Question (3): (3*10 = 30 Marks)

(a) – Fig.(4) shows a steel ball of mass $m_1 = 1$ kg is released with initial velocity 3.06 m/s from position A along smooth path (H=R= 0.4 m) to strike another mass $m_2 = 2$kg resting at position B and attached with a spring of constant k = 320 kN/m. If the coefficient of restitution e = 0.2, *Determine:* (1)- the separation velocities u_1 and u_2, (2)- the deflection of the spring (Δ) after impact, and (3)- the percentage loss of kinetic energy during impact.

(b) –An artificial satellite is launched in a direction parallel to the surface of the earth from a position (A) at an altitude h_0. The trajectory of the satellite is elliptical orbit with maximum altitude h_1 at the position (B) as shown in Fig.(5). At the position (B) set of auxiliary rockets are fired to increase its velocity and set it in a parabolic orbit. *Given:* $h_0 = 1.6 \times 10^6$ m, $h_1 = 25.6 \times 10^6$ m, R = 6.4×10^6 m. *Calculate:* (1)- the eccentricity , the semi latus rectum and the periodic time of the elliptical orbit, (2)- the velocity of the satellite in the elliptical orbit at the position (C), and (3)- the work done by the auxiliary rockets at B, if the satellite mass m = 10 kg.

(c) – The water flow enters the offset nozzle through the fixed pipe joint at *A* with a rate of 0.2 m³/s and static gauge pressure 100 kPa. The flow issues from the nozzle outlet at *B* with a velocity u in the direction inclined on the horizontal with $\theta = 30^0$ as shown in Fig.(6). The water-filled nozzle has a mass of 20 kg and the center of mass at *C*. *Given:* $d_i = 0.2$ m, $d_o = 0.1$ m and the density of water is 1 Mg/m³. *Determine* the horizontal and vertical force reactions and the moment reaction on the fixed pipe joint at *A* during operation.

Question (4): (2*15 = 30 Marks)

(a) – The vibratory system shown in Fig.(7) has the following data: $J_0 = 6.4$ kg.m², $m_1 = 10$ kg, $m_2 = 16$ kg, a = 40 cm, b = 80 cm, $K_1= 2K_2$. When the system was displaced and released, the amplitude of any cycle decreases to 0.25 of the value of previous cycle.
(1)- *Find* the values of the unknown C, K_1 and K_2, (2)- *Find* the periodic time,
(3)- *Write down* the equation of motion of the system with reference to x and *Determine* the steady state response if the mass m_1 is subjected to a force: F(t) = 540 sin 60t N.

(b) – A thin circular disc of mass m = 1.5 kg and of radius r =10 cm rotates uniformly about the axis z with spinning velocity $\omega_2 = 200$ rad/s. The frame carrying the disc rotates about the fixed axis Z with constant precession velocity $\omega_1 = 20$ rad/s as shown in Fig.(8). Axis of spinning z has the momentary orientation with Y axis by $\Psi = 60^0$ in the plane X-Y.
Determine: (1)- the angular velocity and angular acceleration of the disc,
(2)- the velocity and acceleration of the point A on the rim of the disc, and
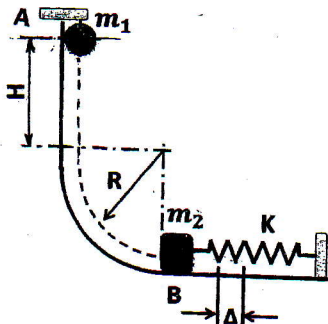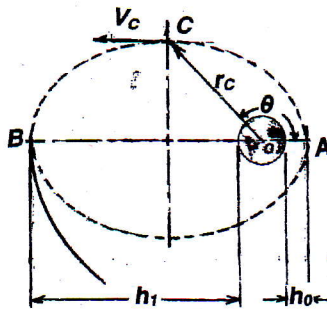(3)- the reactions at C and D due to gyroscopic moment when $\Psi = 0^0$ if L= 30 cm.
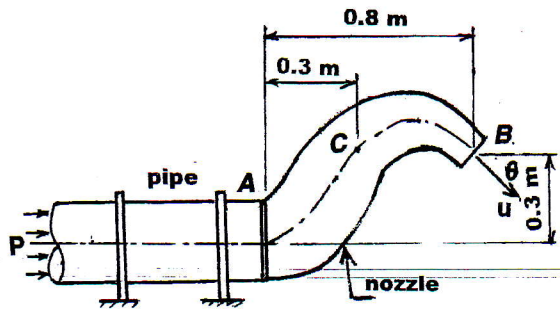

Fig.(4)   Fig.(5)   Fig.(6)
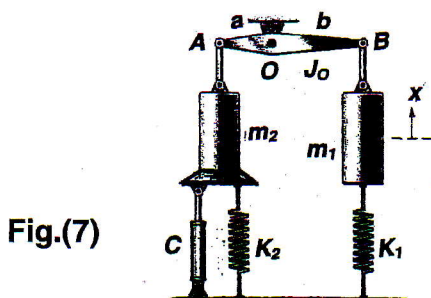
Fig.(7)   Fig.(8)