UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2009/2010

SUBJECT	:	DYNAMICS
SUBJECT CODE	:	BDA 2013
COURSE	:	2 BDD
DATE	:	NOVEMBER 2009
DURATION	:	2 ½ HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** OUT OF **SIX (6)** QUESTIONS

THIS PAPER CONSISTS OF 8 PAGES

Q1 The large window in **Figure Q1** is opened using a hydraulic cylinder AB. The cylinder extends at a constant rate of 0.5 m/s.

(a) Relate the coordinate θ and s using the law of cosines.

(b) Determine the time derivatives of equation obtained in (a).

(c) At the instant $\theta = 40°$, find the value of s from the equation obtained in (a).

(d) Calculate the angular velocity, ω of the window at the instant $\theta = 40°$.

(e) Determine the time derivatives of equation obtained in (c).

(f) Calculate the angular acceleration, α of the window at the instant $\theta = 40°$

[25 marks]

Q2 The attached wheels roll without slipping on the plates A and B, which are moving in opposite directions as shown in **FIGURE Q2**. If v_A = *60 mm/*s to the right and v_B = *200 mm/s* to the left, determine;

(a) the velocity of the center O.

(b) the velocity of the point P.

[25 marks]

Q3 **FIGURE Q3** shows the slider A oscillates in the slot about the neutral position O with frequency of *2 cycles per second* and an amplitude x_{max} *of 50 mm* so that its displacement in millimeters may be written as $x = 50 \sin 4\pi t$ where t is the time in seconds. The disc, in turn, is set into angular oscillation about O with frequency of *4 cycles per second* and an amplitude $\theta_{max} = 0.2$ *rad*. The angular displacement is thus given by $\theta = 0.2 \sin 8\pi t$. Calculate the acceleration of A for the positions

(a) $x = 0$ with $\dot{x}$ positive.

(b) $x = 50$ mm.

[25 marks]

Q4 **FIGURE Q4** shows the pendulum which is suspended at point O and consists of two slender rod AB and OC. The slender rods have the mass of *4 kg/m*. The disk is fixed at the ends of slender rod OC and it has a density of *6000* kg/m^3 and a thickness of *15mm*. The disk has the radius of *300mm* while the hole has the radius of *150mm*. Determine;

(a) The moment inertia of rod OC and BC passing through the end point O.

(b) The moment inertia of the disk about the end point O.

(c) The pendulum moment of inertia about an axis passing through the pin at O.

(d) The location of y of the center of mass G of the pendulum.

(e) The pendulum moment of inertia about an axis passing through the mass center G of the pendulum.

[25 marks]

Q5 A plate shown in **FIGURE Q5** is suspended at A and B. Calculate,

(a) Mass of the plate.

(b) Location of the center of gravity of the plate.

(c) Mass moment of inertia of the plate about the center of gravity.

(d) Mass moment of inertia of the plate about the point of rotation at A.

When the string at B is immediately cut, determine,

(e) The angular acceleration of the plate.

(f) The horizontal and vertical components of the reaction at pin A.

[25 marks]

Q6 The double pulley shown in **FIGURE Q6** has a mass of *15 kg* and a centroidal radius of gyration of *165 mm*. Cylinder A and B are attached to the cords that are wrapped on the pulleys. The coefficient of kinetic friction between block B and the surface is *0.25*. Knowing that system is released from the position illustrated in FIGURE Q6, determine;

(a) The velocity of the cylinder A as it strikes the ground

(b) The total distance block B moves before coming to rest.
(*Hints: think about energy method to solve this problem*)

[25 marks]

FINAL EXAMINATION			
SEMESTER / SESSION :	SEMESTER 1 / 2009/10	COURSE	: 2 BDD
SUBJECT	: DYNAMICS	CODE SUBJECT	: BDA 2013

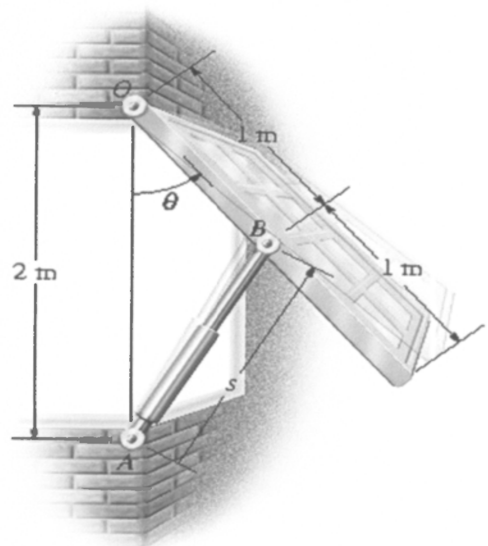


FIGURE Q1 – Hydraulic Window

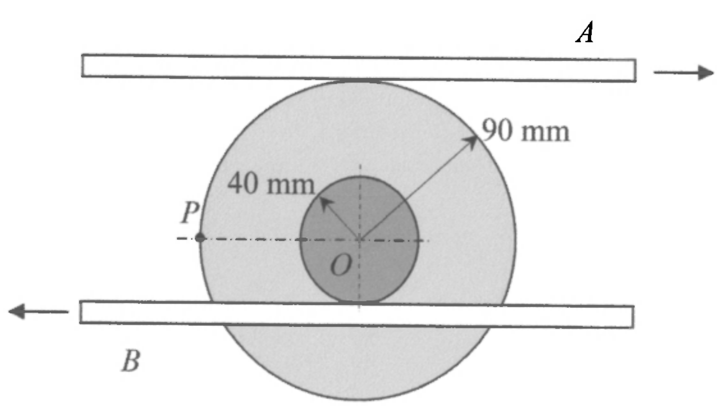


FIGURE Q2 – Rolling Wheel on the Plates

FINAL EXAMINATION			
SEMESTER / SESSION	: SEMESTER 1 / 2009/10	COURSE	: 2 BDD
SUBJECT	: DYNAMICS	CODE SUBJECT	: BDA 2013

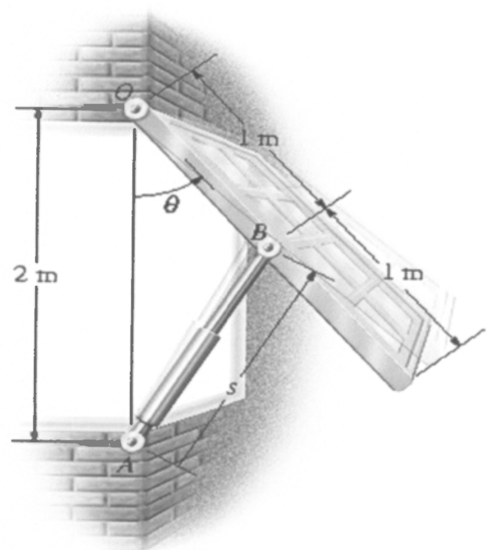


FIGURE O1 – Hydraulic Window

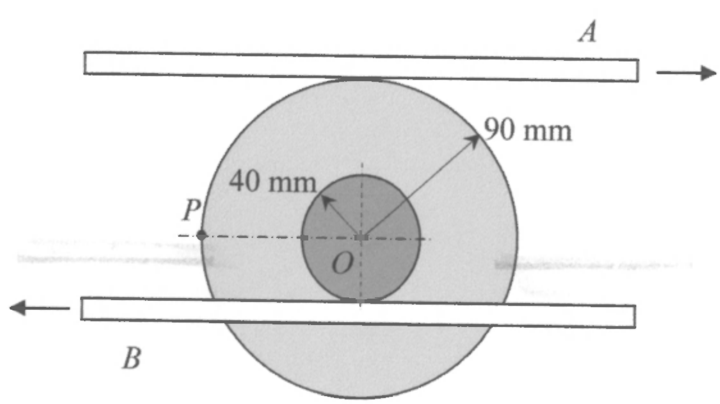


FIGURE O2 – Rolling Wheel on the Plates

FINAL EXAMINATION			
SEMESTER / SESSION	: SEMESTER 1 / 2009/10	COURSE	: 2 BDD
SUBJECT	: DYNAMICS	CODE SUBJECT	: BDA 2013

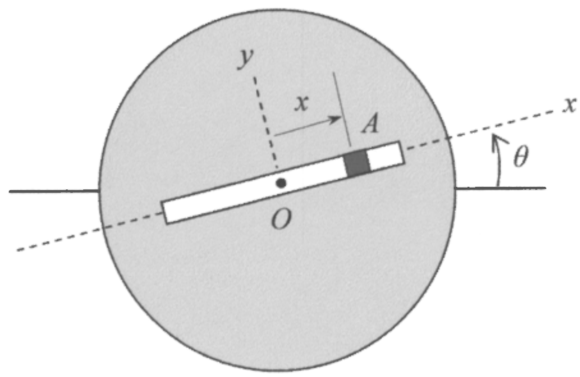


FIGURE Q3 – Slider 'A' and the Disc.

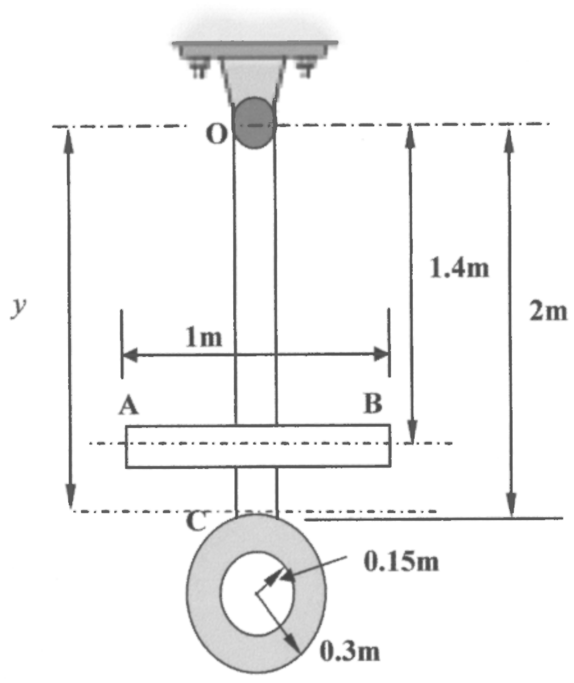


FIGURE Q4 – A Pendulum

FINAL EXAMINATION			
SEMESTER / SESSION	: SEMESTER 1 / 2009/10	COURSE	: 2 BDD
SUBJECT	: DYNAMICS	CODE SUBJECT	: BDA 2013

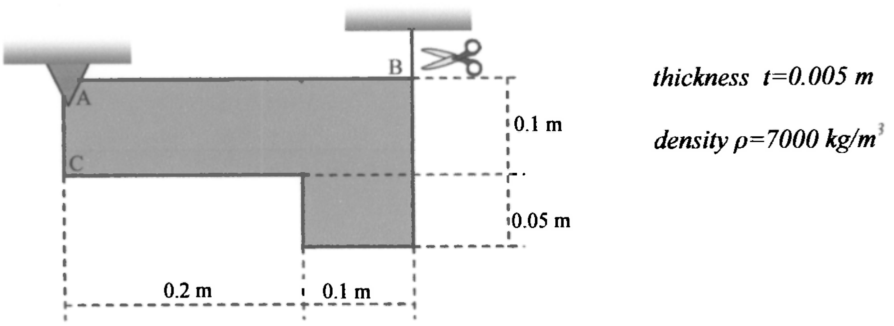


FIGURE Q5 – Hanging Plate

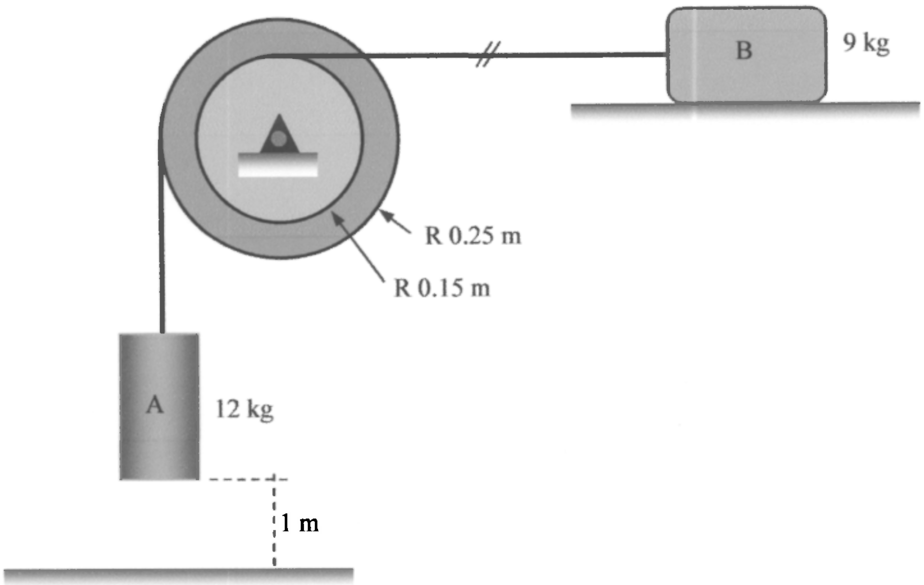


FIGURE Q6 – Double Pulley

FINAL EXAMINATION			
SEMESTER / SESSION :	SEMESTER 1 / 2009/10	COURSE	: 2 BDD
SUBJECT :	DYNAMICS	CODE SUBJECT	: BDA 2013

$$s = s_0 + v_0 t + \frac{1}{2}at^2$$

$$v = v_0 + at$$

$$v^2 = v_0^2 + 2as$$

$$\theta = \theta_0 + \omega t + \frac{1}{2}\alpha t^2$$

$$\omega = \omega_0 + \alpha t$$

$$\omega^2 = \omega_0^2 + 2\alpha s$$

$$\mathbf{v} = \mathbf{v}^r + \mathbf{v}^\theta$$

$$\mathbf{v}^\theta = r\omega \qquad \mathbf{v}^r = \dot{r}$$

$$\mathbf{a} = \mathbf{a}^r + \mathbf{a}^\theta$$

$$\mathbf{a}^r = \ddot{r} - \dot{\theta}^2 r$$

$$\mathbf{a}^\theta = \ddot{\theta}r + 2\dot{\theta}\dot{r}$$

$$\mathbf{a} = \mathbf{a}^n + \mathbf{a}^t$$

$$\mathbf{a}^n = r\omega^2 = \frac{v^2}{r}$$

$$\mathbf{a}^t = r\alpha$$

$$T_1 + U_{1\rightarrow 2} = T_2$$

$$T_1 + V_1 = T_2 + V_2$$

$$U = \Delta T + \Delta V_g + \Delta V_e$$

$$\Delta T = \frac{1}{2}m\left(v_2^2 - v_1^2\right) + \frac{1}{2}I_G\left(\omega_2^2 - \omega_1^2\right)$$

$$\Delta V_g = mg\left(h_2 - h_1\right)$$

$$\Delta V_e = \frac{1}{2}k\left(x_2^2 - x_1^2\right)$$

$$mv_1 + \sum\int_{t_1}^{t_2} F\,dt = mv_2$$

$$\left(H_0\right)_1 + \sum\int_{t_1}^{2} M_0\,dt = \left(H_0\right)_2$$

$$m_A\left(v_A\right)_1 + m_B\left(v_B\right)_1 = m_A\left(v_A\right)_2 + m_B\left(v_B\right)_2$$

$$I_G\omega_1 + m\left(v_G\right)_1 d_1 + \sum\int M_A\,dt = I_G\omega_2 + m\left(v_G\right)_2 d_2$$

$$e = -\frac{\left(v_B\right)_2^n - \left(v_A\right)_2^n}{\left(v_B\right)_1^n - \left(v_A\right)_1^n}$$

$$\left(v_A\right)_1^t = \left(v_A\right)_2^t$$

$$\sum M_G = I_G\alpha$$

$$\sum F = ma$$

$$\mathbf{v}_P = \mathbf{v}_{P'} + \mathbf{v}_{P/Oxy}$$

$$\mathbf{v}_P = (\dot{\mathbf{r}})_{OXY} = \Omega \times \mathbf{r} + (\dot{\mathbf{r}})_{Oxy}$$

$$\mathbf{a}_P = \mathbf{a}_{P'} + \mathbf{a}_{P/Oxy} + \mathbf{a}_C$$

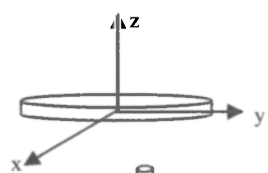
$$\mathbf{a}_P = \Omega \times (\Omega \times \mathbf{r}) + \dot{\Omega} \times \mathbf{r} + 2\left(\Omega \times (\dot{\mathbf{r}})_{Oxy}\right) + (\ddot{\mathbf{r}})_{Oxy}$$

$$I = mk_G^2$$

$$I = \int_m r^2\,dm$$

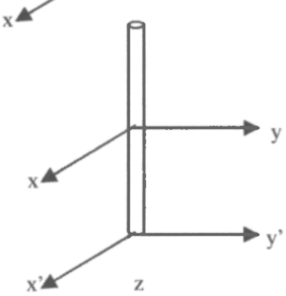
$$I_{XX} = I_{YY} = \frac{1}{4}mr^2$$

$$I_{ZZ} = \frac{1}{2}mr^2$$



$$I_{XX} = I_{YY} = \frac{1}{12}ml^2$$

$$I_{X'X'} = \frac{1}{3}ml^2$$



$$I_{XX} = \frac{1}{12}m\left(B^2 + C^2\right)$$

$$I_{YY} = \frac{1}{12}m\left(A^2 + B^2\right)$$

$$I_{ZZ} = \frac{1}{12}m\left(A^2 + C^2\right)$$