UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER 2
SESSION 2010/2011

NAME OF COURSE	:	DYNAMICS
COURSE CODE	:	BDA 20103 / BDA 2013
PROGRAM	:	BACHELOR OF MECHANICAL ENGINEERING WITH HONOURS
DATE OF EXAMINATION	:	APRIL / MAY 2011
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS.

THIS PAPER CONSISTS OF NINE (9) PAGES

Q1 **(a)** **Figure Q1(a)** shows a diagram of a rigid body which is undergoing rotation about a fixed axis. Derive the equations which represent the magnitude of velocity and acceleration of point P by using the *x-y* coordinate system.

[5 marks]

(b) A large window AB is closed by using the power window system through the application of cable as shown in **Figure Q1(b)**. The window has the width of 3 m and the roller which connect the window and the wall is positioned at 1.5m from point A. If the cable is pulled by the force F with a constant speed of 0.8 m/s at the instant theta is equal to 55 degrees ($\theta = 55°$) ;

(i) Determine the position coordinate equation which represents the motion of the system.

(ii) Find the distance x at the instant $\theta = 55°$.

(iii) Calculate the angular velocity of the large window AB.

(iv) Find the angular acceleration of the large window AB.

[15 marks]

Q2 **(a)** The link shown in **Figure Q2 (a)** is guided by two block A and B, which move in the fixed slots. The velocity of block A is 4 m/s downward.

(i) Draw kinematics diagram of the body.

(ii) Determine the magnitudes v_B and ω using the velocity equation of $v_B = v_A + v_{B/A}$ to points *A* and *B*.

[6 marks]

(b) The connecting rod ABD is fixed at A and the length of rod AB and BD is 0.8 m respectively. Block D shown in **Figure Q2 (b)** moves with a speed of 6 m/s.

(i) Show the location of the instantaneous center (IC) on the kinematics diagram of link BD.

(ii) Determine the angular velocity of link BD.

(iii) Determine the velocity of B.

(iv) Draw the kinematics diagram of link AB.

(v) Determine the angular velocity of AB.

[14 marks]

Q3 **Figure Q3** shows that pin A is fixed on bar DC. At the position shown, the bar DC is rotating counterclockwise at the constant rate, $\omega_{DC} = 2$ rad/s. Pin A can only slide along the slotted plate EBO. Assume P be a point on EBO coincident with A. At this instant,

(a) Determine the angular velocity of EBO, ω_{EBO} rad/s.

[7marks]

(b) Determine the angular acceleration of EBO, α_{EBO} rad/s^2.

[8 marks]

(c) Draw the velocity and acceleration diagrams

[5 marks]

Q4 A plate structure as seen in **Figure Q4** has a pin rotation at O and simply supported at A. This plate structure is made of material with the density of 7800kg/m^3. The thickness of the plate is 5mm.

(a) Find the location of the center of mass (center of gravity) of the plate structure, measured from the pin rotation O.

[8 marks]

(b) Calculate the reaction force at the support A.

[5 marks]

(c) If the plate structure has only pin support O without another support at A, Find the moment at O to hold the plate structure at still.

[7 marks]

Q5 A 3.5 kg slender bar AB rotates (clockwise direction) about the pivot rotation at O starting at vertical position with initial angular velocity of 2 rad/s as shown in **Figure Q5**. A soft spring with a constant of 200 N/m is attached at the initial position. The original length of the spring is 120mm.

(a) Determine the inertia of the slender bar about the point of rotation (point O).

[5 marks]

(b) Calculate the change of kinetic energy after the slender bar has rotated 90°.

[5 marks]

(c) Calculate the change of total potential energy after the slender bar has rotated 90°.

[5 marks]

(d) Find the angular velocity of the slender bar about the pivot of rotation O.

[5 marks]

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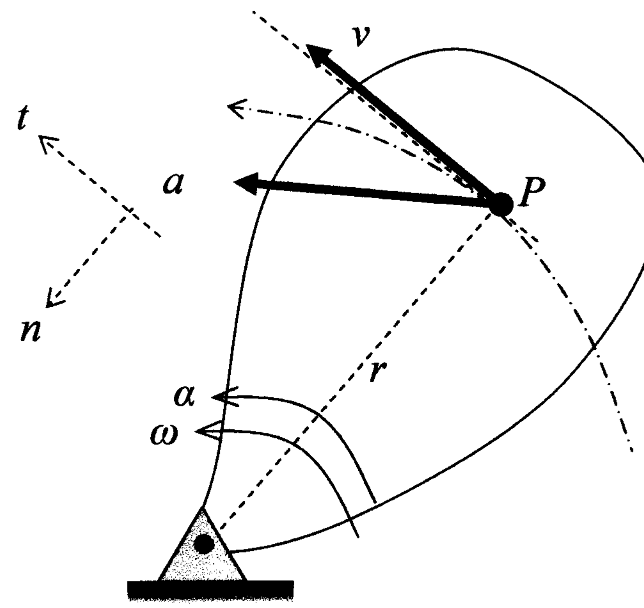

Figure Q1(a): Fixed Axis Rotation

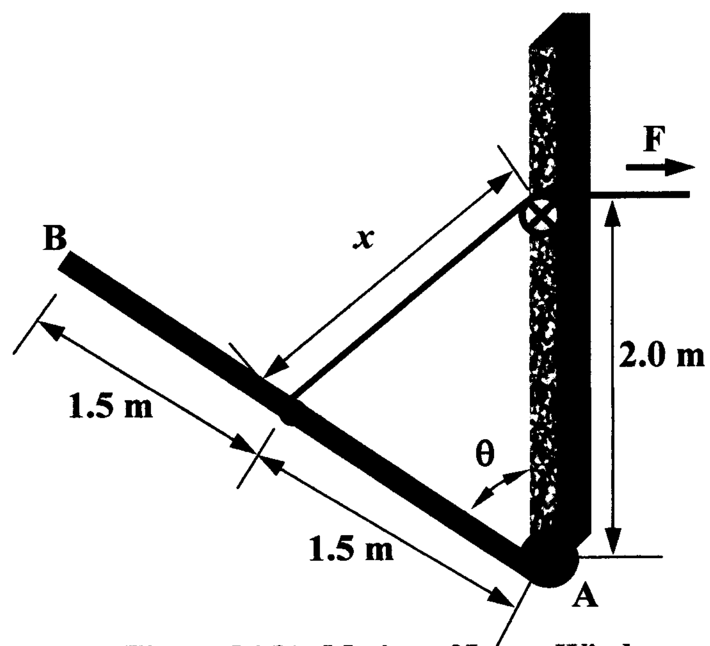

Figure Q1(b): Motion of Large Window

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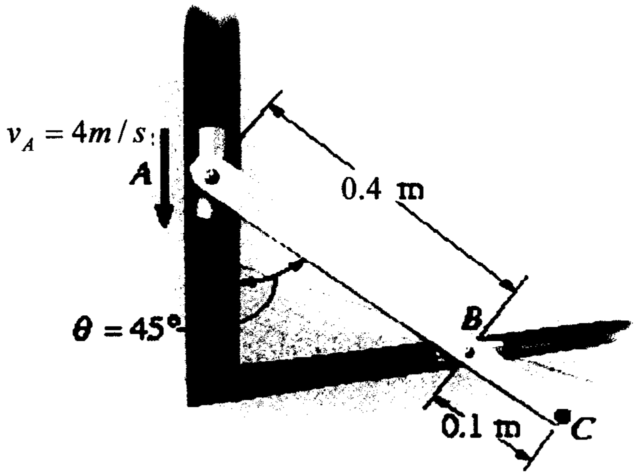

Figure Q2(a): Link on the Fixed Slot

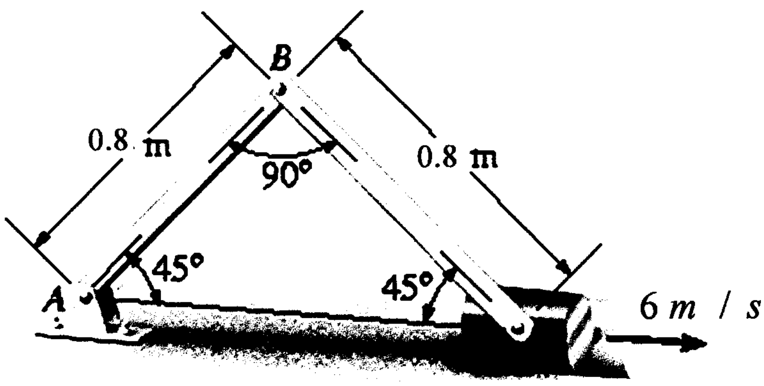

Figure Q2(b): Connecting Rod and Block D

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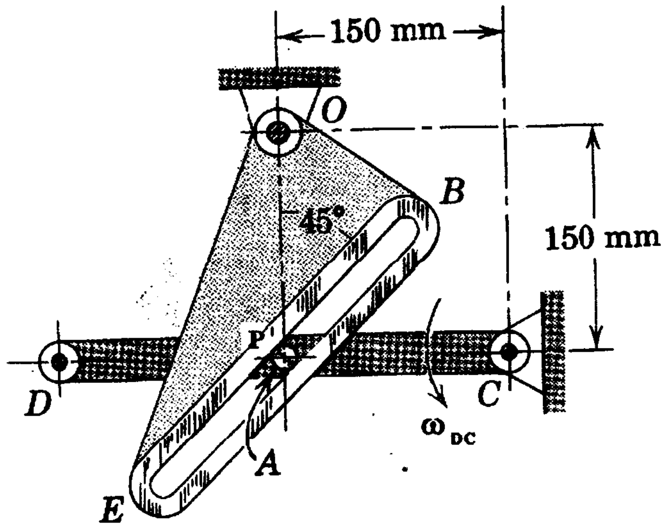

Figure Q3:Bar and Slotted Plate

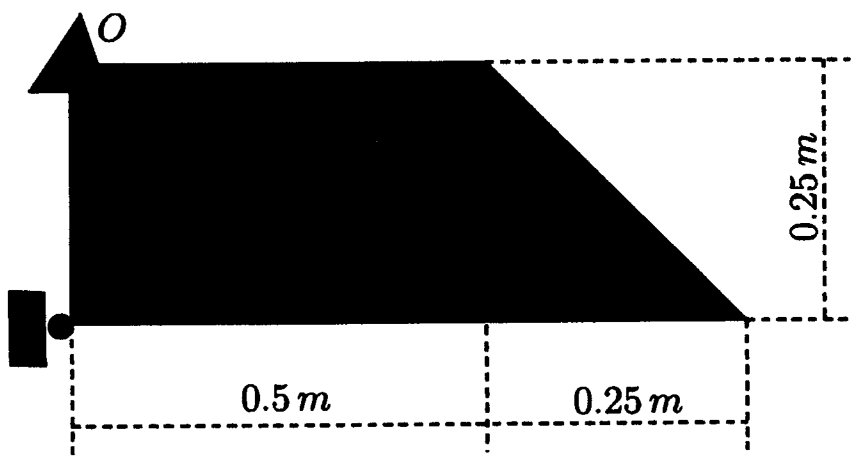

Figure Q4: Plate Structure

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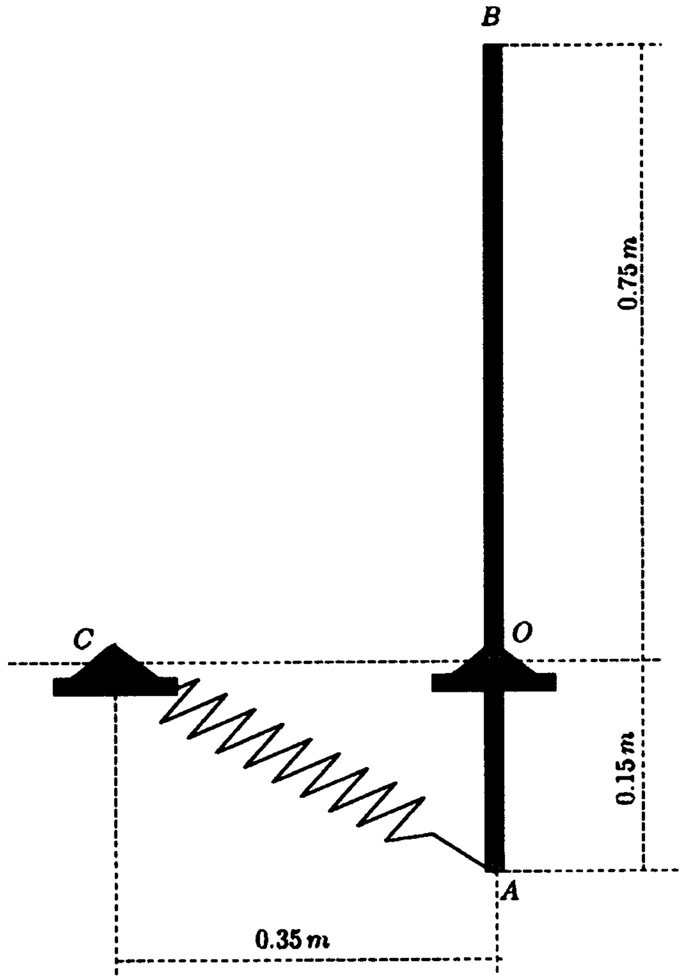

Figure Q5: Rotating Slender Bar

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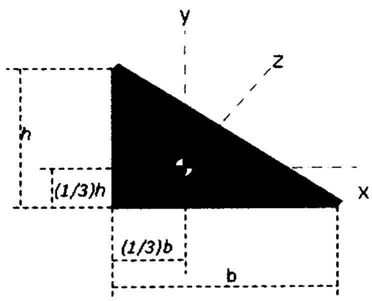
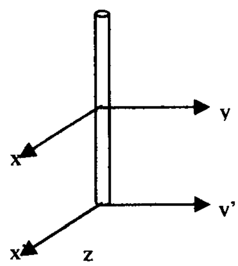
$$s = s_0 + v_0 t + \frac{1}{2}at^2$$
$$v = v_0 + at$$
$$v^2 = v_0^2 + 2as$$
$$\theta = \theta_0 + \omega t + \frac{1}{2}\alpha t^2$$
$$\omega = \omega_0 + \alpha t$$
$$\omega^2 = \omega_0^2 + 2\alpha s$$
$$\mathbf{v} = \mathbf{v}^r + \mathbf{v}^\theta$$
$$\mathbf{v}^\theta = r\omega \qquad \mathbf{v}^r = \dot{r}$$
$$\mathbf{a} = \mathbf{a}^r + \mathbf{a}^\theta$$
$$\mathbf{a}^r = \ddot{r} - \dot{\theta}^2 r$$
$$\mathbf{a}^\theta = \ddot{\theta}r + 2\dot{\theta}\dot{r}$$
$$\mathbf{a} = \mathbf{a}^n + \mathbf{a}^t$$
$$\mathbf{a}^n = r\omega^2 = \frac{v^2}{r}$$
$$\mathbf{a}^t = r\alpha$$
$$T_1 + U_{1\to 2} = T_2$$
$$T_1 + V_1 = T_2 + V_2$$
$$U = \Delta T + \Delta V_g + \Delta V_e$$
$$\Delta T = \frac{1}{2}m\left(v_2^2 - v_1^2\right) + \frac{1}{2}I_G\left(\omega_2^2 - \omega_1^2\right)$$
$$\Delta V_g = mg\left(h_2 - h_1\right)$$
$$\Delta V_e = \frac{1}{2}k\left(x_2^2 - x_1^2\right)$$
$$mv_1 + \sum\int_{t_1}^{t_2} F\,dt = mv_2$$
$$\left(H_0\right)_1 + \sum\int_{t_1}^{t_2} M_0\,dt = \left(H_0\right)_2$$

$$m_A\left(v_A\right)_1 + m_B\left(v_B\right)_1 = m_A\left(v_A\right)_2 + m_B\left(v_B\right)_2$$
$$I_G\omega_1 + m\left(v_G\right)_1 d_1 + \sum\int M_A dt = I_G\omega_2 + m\left(v_G\right)_2 d_2$$
$$e = -\frac{\left(v_B\right)_2^n - \left(v_A\right)_2^n}{\left(v_B\right)_1^n - \left(v_A\right)_1^n}$$
$$\left(v_A\right)_1^t = \left(v_A\right)_2^t$$
$$\sum M_G = I_G\alpha$$
$$\sum F = ma$$
$$\mathbf{v}_P = \mathbf{v}_{P'} + \mathbf{v}_{P/Oxy}$$
$$\mathbf{v}_P = (\dot{\mathbf{r}})_{OXY} = \boldsymbol{\Omega}\times\mathbf{r} + (\dot{\mathbf{r}})_{Oxy}$$
$$\mathbf{a}_P = \mathbf{a}_{P'} + \mathbf{a}_{P/Oxy} + \mathbf{a}_C$$
$$\mathbf{a}_P = \boldsymbol{\Omega}\times\left(\boldsymbol{\Omega}\times\mathbf{r}\right) + \dot{\boldsymbol{\Omega}}\times\mathbf{r} + 2\left(\boldsymbol{\Omega}\times(\dot{\mathbf{r}})_{Oxy}\right) + (\ddot{\mathbf{r}})_{Oxy}$$
$$I = mk_G^{\,2}$$
$$I = \int_m r^2 dm$$

$$I_x = \frac{1}{18}mh^2$$
$$I_y = \frac{1}{18}mb^2$$
$$I_z = \frac{1}{18}m(b^2 + h^2)$$



$$I_{XX} = I_{YY} = \frac{1}{12}ml^2$$
$$I_{X'X'} = \frac{1}{3}ml^2$$



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