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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2019/2020

COURSE NAME	:	DYNAMICS
COURSE CODE	:	BDA 20103
PROGRAMME	:	BDD
EXAMINATION DATE	:	JULY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	PART A: ANSWER **ALL** QUESTIONS PART B: ANSWER **THREE (3)** QUESTIONS **ONLY** **OPEN BOOK EXAMINATION**

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

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PART A (COMPULSORY):
Answer **ALL** questions.

Q1. In **Figure Q1**, balls are thrown to the inclined plane with a velocity, v_o. The location of origin of the x y coordinate system is at ground level, Point O.

(a) Determine the time, t of balls at Points B and C.
(15 marks)

(b) Determine the range of values of v_o if the balls are to land between Points B and C.
(5 marks)

Q2. In **Figure Q2,** crates A and B have masses of 50 kg and 30 kg, respectively. The coefficient of kinetic friction, μ_k between the crates and the ground is 0.25. If they start from rest,

(a) Draw the kinetic diagram for crates A and B.
(6 marks)

(b) Determine their speed when time, t is 5s.
(12 marks)

(c) Determine the force exerted by crate A on crate B during the motion.
(2 marks)

PART B (OPTIONAL):
Answer **THREE (3)** questions **ONLY**.

Q3. (a) Explain the approach in absolute motion analysis.
(8 marks)

(b) In **Figure Q3 (b)**, crank AB rotates in counter-clockwise direction with an angular velocity and angular acceleration of 12 rad/s and 4 rad/s^2, respectively.

(i). Determine the magnitude and direction of velocity of the slider block C.
(6 marks)

(ii). Determine the magnitude and direction of acceleration of the slider block C.
(6 marks)

Q4 The rod AB has an angular motion (counterclockwise) as shown in **Figure Q4**. The slider C is moving down the incline plane as shown. By considering on the above circumstances;

(a). Determine the velocity of point B at the instant.
(3 marks)

(b). Find the velocity and angular velocity of slider block C at the instant.
(7 marks)

(c). Find the acceleration of point B at the instant.
(3 marks)

(d). Calculate the acceleration and angular acceleration of slider block C at the instant.
(7 marks)

Q5. **Figure Q5** shows the pendulum which is suspended at point A and consists of a thin rod having a mass of 6 kg. A rectangular thin plate with the hollow section is welded at the end of slender rod AB with a mass of 8 kg/m^2. By examining on the above situation;

(a) Calculate moment of inertia of the pendulum about point A, $I_{A(pendulum)}$.

(7 marks)

(b) Determine the location of $\bar{y}$ of the mass center, G of the pendulum.

(4 marks)

(c) Determine the mass moment of inertia, I_G about the axis of rotation, A.

(4 marks)

(d) If the velocity of its mass centre of pendulum is 3 m/s, find the translational and rotational kinetic energy of the pendulum.

(5 marks)

Q6 (a) The bar shown in **Figure Q6 (a)** has a mass of 15 kg and is subjected to a couple moment of $M = 80$ Nm and a force $P = 120$ N applied to the end of the bar.

(i) Draw the free body diagram of the bar to account for all the forces that act on it.

(3 marks)

(ii) Determine the total work done by all the forces acting on the bar when it has rotated downward from $\theta = 0°$ to $\theta = 70°$.

(7 marks)

(b) The 12 kg rod shown in **Figure Q6 (b)** is constrained so that its end of slider block B move along the fixed guide. The rod is initially at rest when $\theta = 0°$. If the slider block B is acted upon by a horizontal force $P = 70$ N;

(i) Draw kinematic diagram of the rod at $\theta = 0°$ and $\theta = 30°$ respectively.

(2 marks)

(ii) Determine the initial and final kinetic energy.

(4 marks)

(ii) Calculate the angular velocity of the rod at the instant $\theta = 30°$

(4 marks)

-END OF QUESTION-

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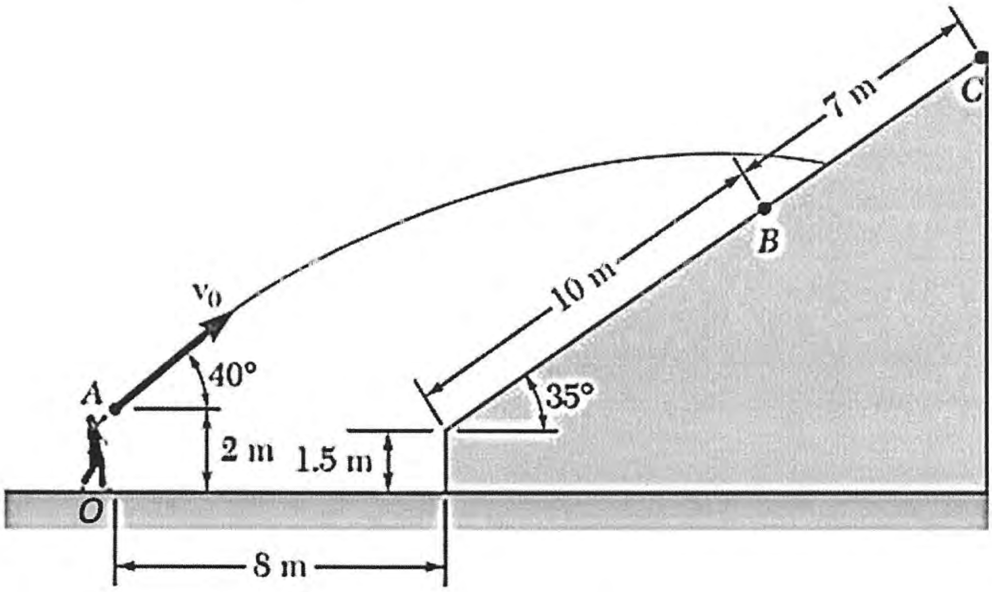

Figure Q1

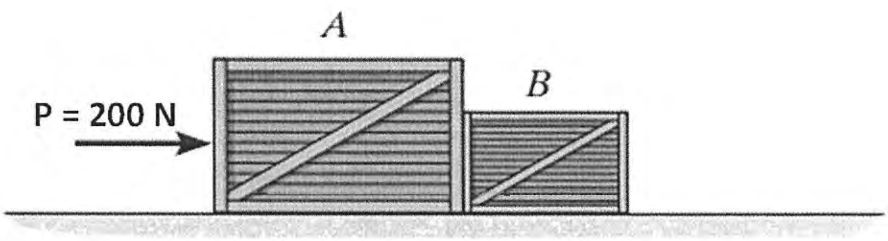

Figure Q2

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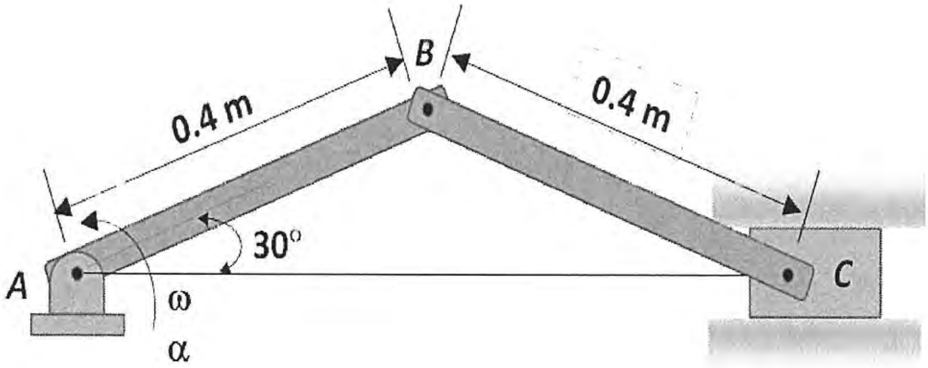

Figure Q3 (b)

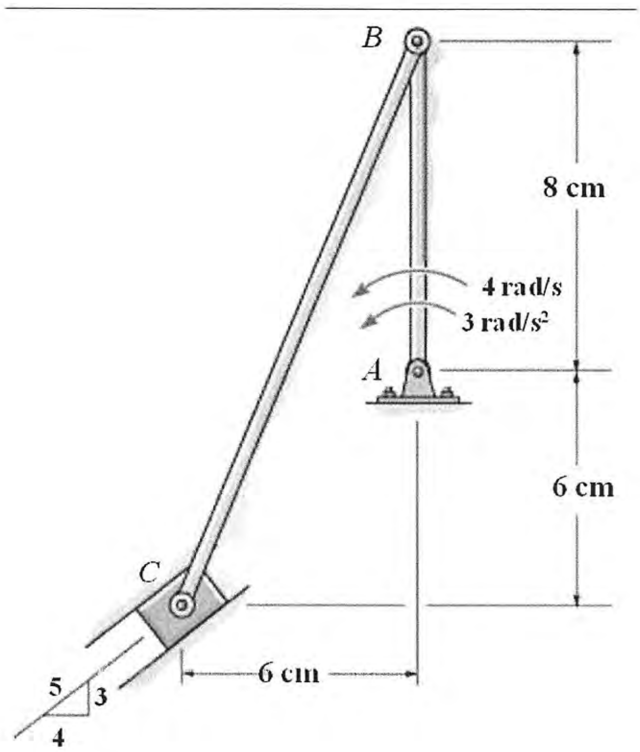

Figure Q4

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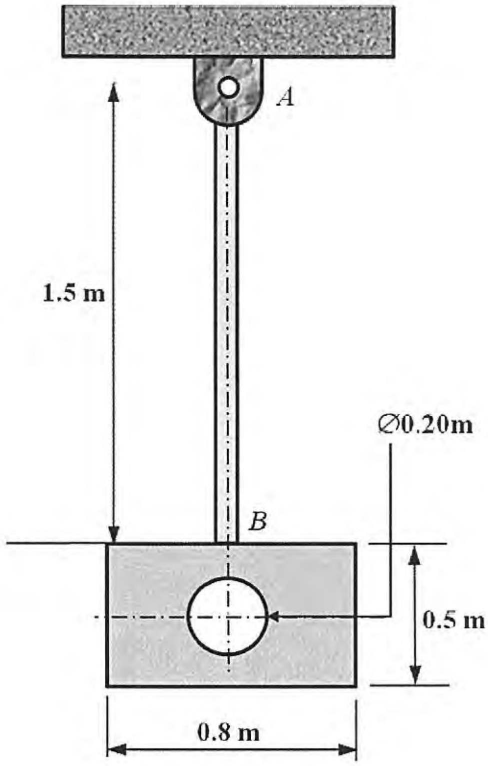

Figure Q5

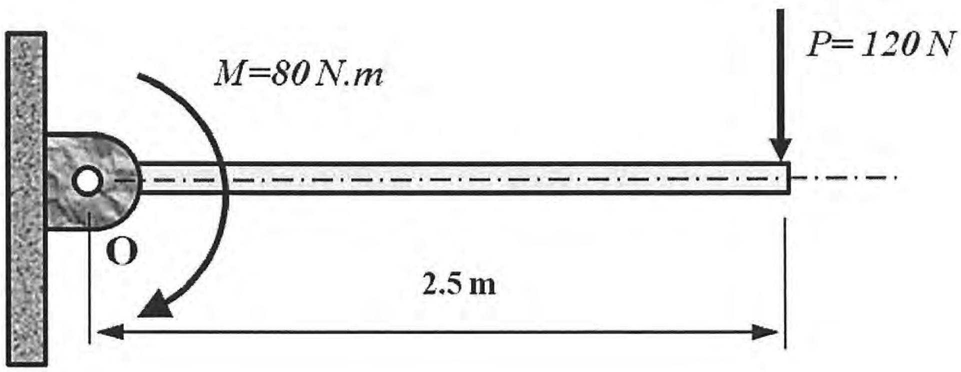

Figure Q6 (a)

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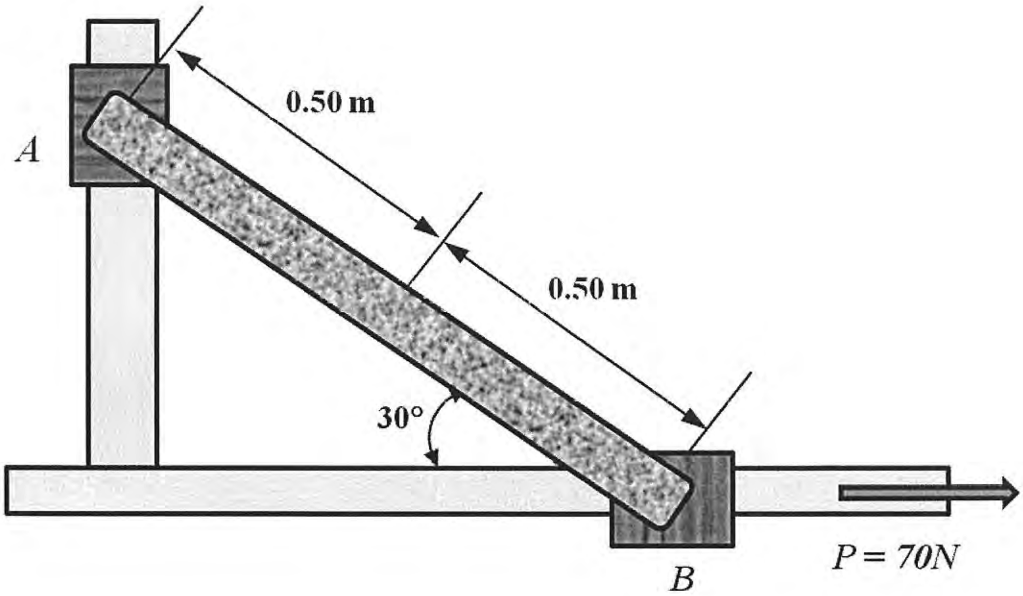

Figure Q6 (b)

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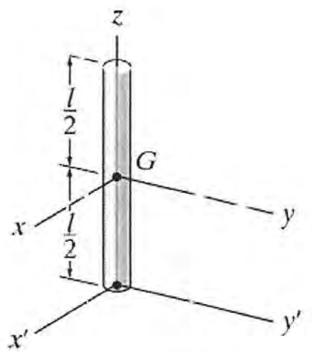
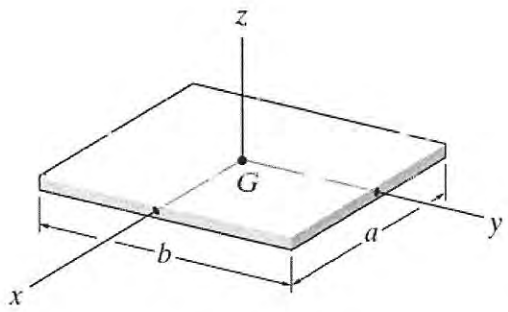


Slender Rod

$$I_{xx} = I_{yy} = \frac{1}{12} ml^2$$

$$I_{x'x'} - I_{y'y'} - \frac{1}{3} ml^2$$

$$I_{zz} = 0$$

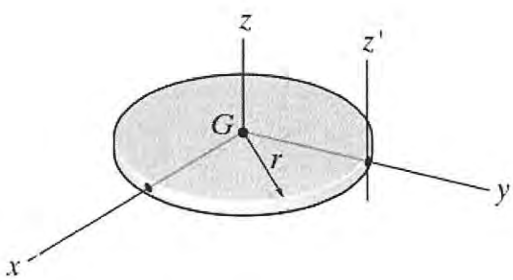


Thin plate

$$I_{xx} = \frac{1}{12} mb^2$$

$$I_{yy} = \frac{1}{12} ma^2$$

$$I_{zz} = \frac{1}{12} m(a^2 + b^2)$$



Thin Circular disk

$$I_{xx} = I_{yy} = \frac{1}{4} mr^2$$

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

$$I_{z'z'} = \frac{3}{2} mr^2$$

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KINEMATICS

Particle Rectilinear Motion

Variable a	*Constant* $a = a_c$
$a = dv/dt$	$v = v_0 + a_c t$
$v = ds/dt$	$s = s_0 + v_0 t + 0.5 a_c t^2$
$a\,ds = v\,dv$	$v^2 = v_0^{\ 2} + 2a_c(s - s_0)$

Particle Curvilinear Motion

x, y, z Coordinates		*r, θ, z Coordinates*	
$v_x = \dot{x}$	$a_x = \ddot{x}$	$v_r = \dot{r}$	$a_r = \ddot{r} - r\dot{\theta}^2$
$v_y = \dot{y}$	$a_y = \ddot{y}$	$v_\theta = r\dot{\theta}$	$a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta}$
$v_z = \dot{z}$	$a_z = \ddot{z}$	$v_z = \dot{z}$	$a_z = \ddot{z}$

n, t, b Coordinates

$v = \dot{s}$ $\quad a_t = \dot{v} = v\dfrac{dv}{ds}$

$$a_n = \frac{v^2}{\rho} \qquad \rho = \frac{\left[1 + (dy/dx)^2\right]^{3/2}}{\left|d^2y/dx^2\right|}$$

Relative Motion

$v_B = v_A + v_{B/A}$ $\qquad a_B = a_A + a_{B/A}$

Rigid Body Motion About a Fixed Axis

Variable a	*Constant* $a = a_c$
$\alpha = d\omega/dt$	$\omega = \omega_0 + \alpha_c t$
$\omega = d\theta/dt$	$\theta = \theta_0 + \theta_0 t + 0.5\alpha_c t^2$
$\omega\,d\omega = \alpha\,d\theta$	$\omega^2 = \omega_0^{\ 2} + 2\alpha_c(\theta - \theta_0)$

For Point P

$s = \theta r \qquad \upsilon = \omega r \qquad a_t = \alpha r \qquad a_n = \omega^2 r$

Relative General Plane Motion – Translating Axis

$v_B = v_A + v_{B/A(pin)} \qquad a_B = a_A + a_{B/A(pin)}$

Relative General Plane Motion – Trans. & Rot. Axis

$v_B = v_A + \Omega \times r_{B/A} + (v_{B/A})_{xyz}$

$$a_B = a_A + \dot{\Omega} \times r_{B/A} + \Omega \times (\Omega \times r_{B/A}) + 2\Omega \times (v_{B/A})_{xyz} \times (a_{B/A})_{xyz}$$

KINETICS

Mass Moment of Inertia $\quad I = \int r^2 dm$

Parallel-Axis Theorem $\quad I = I_G + md^2$

Radius of Gyration $\quad k = \sqrt{I/m}$

Equations of Motion

Particle	$\sum F = ma$
Rigid Body (Plane Motion)	$\sum F_x = m(a_G)_x \quad \sum F_y = m(a_G)_y$ $\sum M_G = I_G\alpha$ or $\sum M_P = \sum(\mu_k)_P$

Principle of Work and Energy : $T_1 + U_{1-2} = T_2$

Kinetic Energy

Particle	$T = (1/2)mv^2$
Rigid Body (Plane Motion)	$T = (1/2)mv_G^2 + (1/2)I_G\omega^2$

Work

Variable force	$U_F = \int F\cos\theta\,ds$
Constant force	$U_F = (F_c\cos\theta)\Delta s$
Weight	$U_W = -W\,\Delta y$
Spring	$U_s = -\left(0.5ks_2^2 - 0.5ks_1^2\right)$
Couple moment	$U_M = M\,\Delta\theta$

Power and Efficiency

$P = dU/dt = F.v \qquad \varepsilon = P_{out}/P_{in} = U_{out}/U_{in}$

Conservation of Energy Theorem

$T_1 + V_1 = T_2 + V_2$

Potential Energy

$V = V_g + V_e$ where $V_g = \pm Wy, V_e = +0.5ks^2$

Principle of Linear Impulse and Momentum

Particle	$mv_1 + \sum\int F dt = mv_2$
Rigid Body	$m(v_G)_1 + \sum\int F dt = m(v_G)_2$

Conservation of Linear Momentum

$\sum(\text{syst. } mv)_1 = \sum(\text{syst. } mv)_2$

Coefficient of Restitution $\quad e = \dfrac{(v_B)_2 - (v_A)_2}{(v_A)_1 - (v_B)_1}$