UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	:	DYNAMICS
COURSE CODE	:	BDA20103/ BDA2013
PROGRAMME	:	BACHELOR OF MECHANICAL ENGINEERING WITH HONOURS
EXAMINATION DATE	:	JUNE 2013
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER ONLY **FIVE** QUESTIONS

THIS PAPER CONTAINS ELEVEN (11) PRINTED PAGES

ANSWER ONLY FIVE QUESTIONS

Q1 (a) Define two conditions of any object to be considered as a particle.

(4 marks)

(b) **FIGURE Q1** shows A1 Circuit used by car A and car B for preparation before the actual championship. Car B is moving along the curved lap with a velocity $18\ \mathrm{ms^{-1}}$, at the same time decelerating at $2\ \mathrm{ms^{-2}}$. In front of this car, car A is travelling along the straight part of the circuit with a velocity $35\ \mathrm{ms^{-1}}$, while decelerating at $5\ \mathrm{ms^{-2}}$ due to sudden transmission issue. At this instant, determine:

(i) the velocity of car B relative to car A, $v_{B/A}$.

(8 marks)

(ii) the acceleration of car B with respect to car A, $a_{B/A}$.

(8 marks)

Q2 **FIGURE Q2** shows a cannonball A, B and C of mass 80 kg, 40 kg and 60 kg respectively. Cannonball A travels with a velocity $20\ \mathrm{ms^{-1}}$ just before it strikes cannonball B, which is rest horizontally. The collision causing cannonball B to hits stationary cannonball C, which then makes it move further towards the anvil wall. Suppose the restitution coefficient for collision between cannonballs A and B is 0.3 and the restitution coefficient for collision between cannonballs B and car C is 0.8, determine:

(a) the velocity of cannonball B, v_B when it hits the cannonball C.

(7 marks)

(b) the velocity of cannonball C, v_C at which it strikes the anvil wall.

(7 marks)

(c) the velocity of cannonball C, v_C when it rebounds from the anvil wall if restitution coefficient between them is 0.75.

(6 marks)

Q3 A wooden crate is lifted from the floor by using three pulleys system as shown in **FIGURE Q3**. The crate is connected to a pulley C by an inextensible cable. The motion of the crate, pulleys A, B and C is controlled by a cable D which move with a constant acceleration, a_D = 2 m/s^2 and an initial velocity, $(V_O)_D$ = 4 m/s, in the direction as shown. Pulleys A and B are of double pulley type. At time, t = 10 seconds, determine:

(a) the numbers of revolution, N rpm executed by the pulley A.

(4 marks)

(b) the angular velocity of the pulley B, ω_B rad/s.

(4 marks)

(c) the magnitude and direction of acceleration of point E at pulley B, a_E m/s^2.

(4 marks)

(d) the velocity, v m/s and the distance, S meter of the crate moved.

(8 marks)

Q4 (a) The bar AB of the linkage shown in **FIGURE Q4(a)** has a clockwise angular velocity, ω = 30 rad/s when θ = 60°. Using the instantaneous centers of zero velocity, determine the angular velocities, ω (magnitude and direction) of members BC and the wheel CD at this instant.

(5 marks)

(b) At the instant shown in **FIGURE Q4(b)**, link AB has an angular velocity, ω_{AB} = 2 rad/s and an angular acceleration, α_{AB} = 6 rad/s^2. At instant θ = 60°, determine:

(i) the magnitude and direction of acceleration at pin B, a_B m/s^2.

(2 marks)

(ii) the angular velocity of link BC, ω_{BC} rad/s and link CD, ω_{CD} rad/s.

(4 marks)

(iii) the angular acceleration of link CB, α_{CB} rad/s^2.

(5 marks)

(iv) the angular acceleration of link CD, α_{CD} rad/s^2.

(4 marks)

Q5 Two homogenous steel slender rod and thin plate are welded together to form a pendulum as shown in **FIGURE Q5**. The density of the slender rod is 1.5 kg/m and the thin plate is 10 kg/m^2. Determine:

(a) the mass of the slender rod and the thin plate.

(4 marks)

(b) the location of the center of mass, G of the pendulum.

(4 marks)

(c) the moment of inertia of the pendulum about an axis perpendicular to the page and passing through G.

(6 marks)

(d) the moment of inertia of the pendulum about an axis perpendicular to the page and passing through O.

(6 marks)

Q6 A spring having a stiffness of k = 600 N/m is attached to the point B of the 6 kg rod, with an unstretched length of 300 mm as shown in **FIGURE Q6**. If the rod is released from rest at $\theta = 30°$ to $\theta = 0°$;

(a) draw the diagram of the rod, when it is located at its initial ($\theta = 30°$) and final ($\theta = 0°$) positions.

(4 marks)

(b) calculate the total potential energy at the initial and final positions.

(8 marks)

(d) determine the angular velocity, ω of the rod at the instant $\theta = 0°$.

(8 marks)

JAWAB LIMA SOALAN SAHAJA

S1 (a) Terangkan dua keadaan yang membolehkan sesuatu objek dianggap sebagai zarah.

(4 markah)

(b) **RAJAH S1** menunjukkan sirkit perlumbaan A1 yang digunakan oleh kereta A dan kereta B sebagai persediaan sebelum kejohanan sebenar. Kelihatan kereta B sedang bergerak di sepanjang selekoh dengan kelajuan $18\,ms^{-1}$, pada waktu yang sama mengalami penurunan halaju sebanyak $2\,ms^{-2}$. Manakala di hadapan kereta ini, kereta A sedang bergerak di sepanjang laluan tegak dengan kelajuan $35\,ms^{-1}$, dan turut mengalami penurunan halaju sebanyak $5\,ms^{-2}$ disebabkan masalah enjin. Pada ketika ini, tentukan:

(i) halaju kereta B terhadap kereta A, $v_{B/A}$.

(8 markah)

(ii) pecutan kereta B terhadap kereta A, $a_{B/A}$.

(8 markah)

S2 **RAJAH S2** menunjukkan peluru meriam A, B dan C dengan masing-masing berjisim 80 kg, 40 kg dan 60 kg. Peluru A bergerak dengan halaju $20\,ms^{-1}$ sejurus sebelum melanggar peluru B yang berada dalam keadaan pegun. Perlanggaran ini mengakibatkan peluru B melanggar peluru C yang juga dalam keadaan rehat, dan seterusnya menyebabkan peluru C bergerak ke arah dinding tegar. Jika 'pekali pengembalian' untuk perlanggaran di antara peluru A dan B ialah 0.3, dan sebanyak 0.8 bagi perlanggaran di antara peluru B dan C, tentukan:

(a) halaju peluru meriam B, v_B apabila ia melanggar peluru meriam C.

(7 markah)

(b) halaju peluru meriam C, v_C ketika ia melanggar dinding tegar.

(7 markah)

(c) halaju peluru meriam C, v_C apabila ia melantun dari dinding tegar jika 'pekali pengembalian' di antara keduanya adalah 0.75.

(6 markah)

S3 Sebuah kotak kayu diangkat dari lantai dengan menggunakan sistem tiga takal seperti dalam **RAJAH S3.** Kotak ini disambung ke takal C dengan kabel yang tidak memanjang. Pergerakan kotak, takal A, takal B dan takal C dikawal oleh kabel D yang bergerak dengan pecutan malar, $a_D = 2$ m/s^2 dan halaju awal, $(V_O)_D = 4$ m/s, pada arah yang ditunjuk. Takal A dan takal B adalah dari jenis dwi takal. Pada masa, $t = 10$ saat, tentukan:

(a) bilangan pusingan, *N* ppm dari takal A.

(4 markah)

(b) halaju sudut takal B, ω_B rad/s.

(4 markah)

(c) magnitude dan arah pecutan titik E pada takal B, a_E m/s^2.

(4 markah)

(d) halaju, *v* m/s dan jarak, *S* meter kotak ini bergerak.

(8 markah)

S4 (a) Bar AB pada sambungan yang ditunjuk dalam **RAJAH S4(a)** berpusing pada arah putaran jam dengan halaju sudut, $\omega = 30$ rad/s apabila $\theta = 60°$. Dengan menggunakan kaedah pusat seketika halaju sifar, tentukan halaju sudut, ω (magnitude dan arah) anggota BC dan roda CD pada ketika ini.

(5 markah)

(b) Pada ketika yang ditunjuk dalam **RAJAH S4(b)**, sambungan AB berpusing dengan halaju sudut, $\omega_{AB} = 2$ rad/s dan pecutan sudut, $\alpha_{AB} = 6$ rad/s^2. Pada ketika, $\theta = 60°$, tentukan:

(i) magnitud dan arah pecutan pada pin B, a_B m/s^2.

(2 markah)

(ii) halaju sudut sambungan BC, ω_{BC} rad/s dan sambungan CD, ω_{CD} rad/s.

(4 markah)

(iii) pecutan sudut sambungan CB, α_{CB} rad/s^2.

(5 markah)

(iv) pecutan sudut sambungan CD, α_{CD} rad/s^2.

(4 markah)

S5 Dua keluli seragam, rod langsing dan plat nipis, dikimpal bersama-sama untuk membentuk sebuah bandul seperti yang ditunjukkan dalam **RAJAH S5**. Ketumpatan bagi rod langsing 1.5 kg/m dan plat nipis 10 kg/m^2. Tentukan:

(a) jisim rod langsing dan plat nipis.

(4 markah)

(b) kedudukan pusat jisim, G bagi bandul tersebut.

(4 markah)

(c) momen inersia bandul tersebut pada satu paksi berserenjang kepada halaman ini dan melalui G.

(6 markah)

(d) momen inersia bandul tersebut pada satu paksi berserenjang kepada halaman ini dan melalui O.

(6 markah)

S6 Sebuah spring yang mempunyai kekakuan k = 600N/m disambungkan ke titik B pada sebatang rod berjisim 6 kg, dengan panjang sebelum regangan adalah 300 mm seperti yang ditunjukkan dalam **Rajah S6**. Jika rod dilepaskan dari keadaan rehat pada $\theta = 30°$ hingga $\theta = 0°$:

(a) lakarkan gambarajah rod, apabila ia berada pada kedudukan awal ($\theta = 30°$) dan akhir ($\theta = 0°$).

(4 markah)

(c) hitungkan jumlah tenaga upaya pada kedudukan awal dan akhir.

(8 markah)

(d) tentukan halaju sudut, ω rod pada ketika $\theta = 0°$.

(8 markah)

- END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2012/2013 PROGRAMME : 2BDD
COURSE : DYNAMICS COURSE CODE : BDA20103/2013

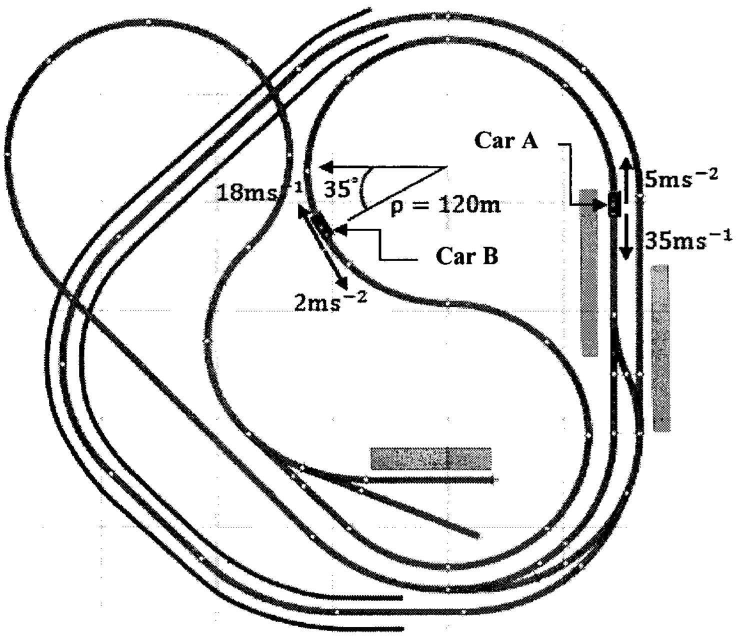


FIGURE Q1 / RAJAH S1

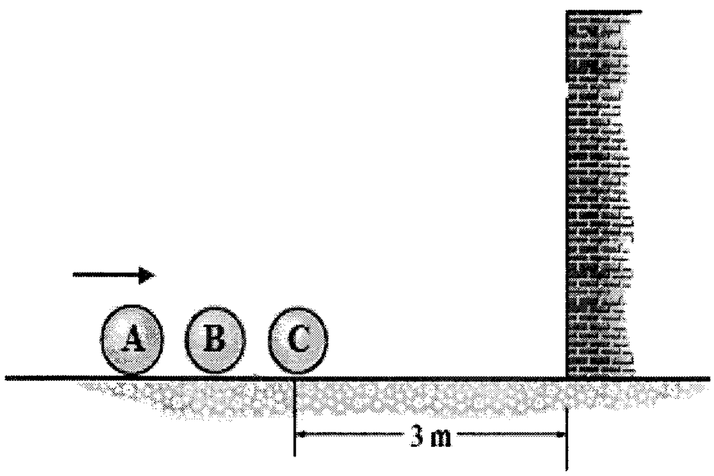


FIGURE Q2 / RAJAH S2

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2012/2013
COURSE : DYNAMICS

PROGRAMME : 2BDD
COURSE CODE : BDA20103/2013

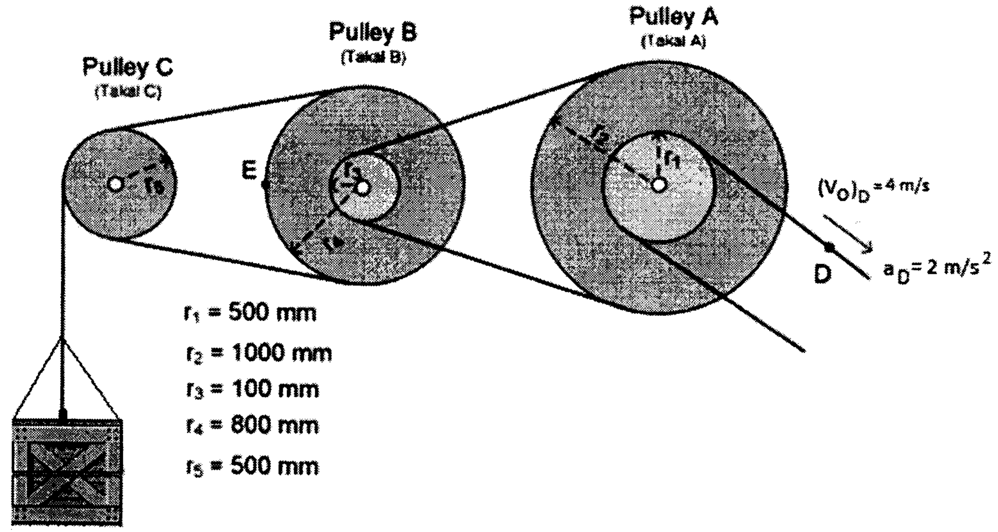


FIGURE Q3/ RAJAH S3

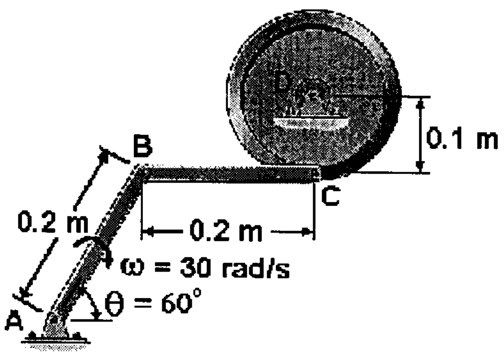


FIGURE Q4(a) / RAJAH S4(a)

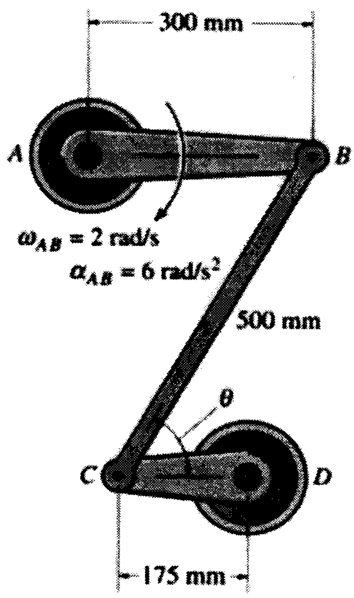


FIGURE Q4(b) / RAJAH S4(b)

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2012/2013
COURSE : DYNAMICS

PROGRAMME : 2BDD
COURSE CODE : BDA20103/2013

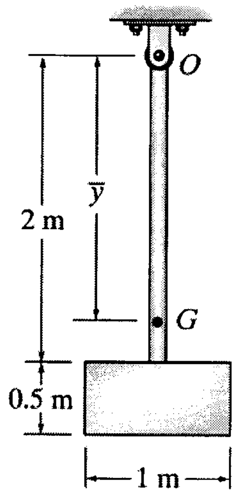


FIGURE Q5 / RAJAH S5

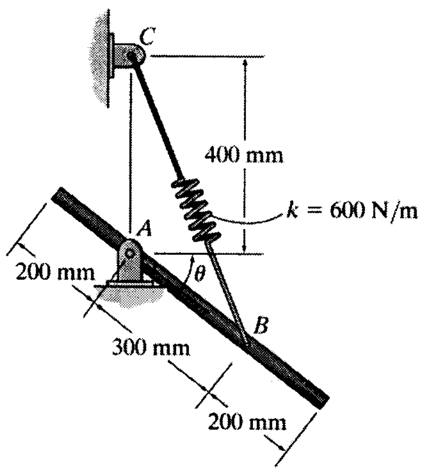


FIGURE Q6/ RAJAH S6

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2012/2013 PROGRAMME : 2BDD
COURSE : DYNAMICS COURSE CODE : BDA20103/2013

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

$$v = v_0 + at$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$(H_0)_1 + \sum\int_{t_1}^{t_2} M_0\,dt = (H_0)_2$$

Given formula:

$I_{ZZ} = \frac{1}{12}m(a^2 + b^2)$ for thin plate

$I_{ZZ} = \frac{1}{12}ml^2$ for slender rod

$$m_A(v_A)_1 + m_B(v_B)_1 = m_A(v_A)_2 + m_B(v_B)_2$$

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

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

$$(v_A)_1^t = (v_A)_2^t$$

$$\sum M_G = I_G\alpha$$

$$\sum F = ma$$

$$T_1 + V_1 = T_2 + V_2$$

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

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

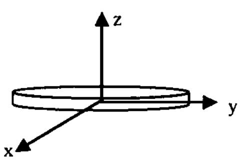
$$\mathbf{a}_P = \mathbf{a}_{P'} + \mathbf{a}_{P/Oxy} + \mathbf{a}_C$$

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

$$I = mk_G^2$$

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

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



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

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