
UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2004/2005

Mac 2005

EMM 212/4 – DINAMIK & MEKANISMA

Masa : 3 jam

ARAHAN KEPADA CALON :

Sila pastikan bahawa kertas soalan ini mengandungi **LAPAN (8)** mukasurat dan **ENAM (6)** soalan serta **SATU (1)** lampiran yang bercetak sebelum anda memulakan peperiksaan.

Sila jawab **LIMA (5)** soalan sahaja.

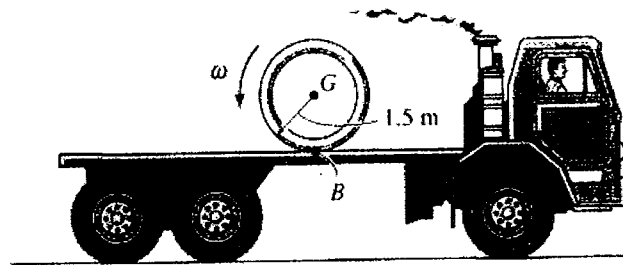
Lampiran A : Formula Asas Dinamik

Pelajar dibenarkan menjawab semua soalan dalam **Bahasa Inggeris** ATAU **Bahasa Malaysia** ATAU kombinasi kedua-duanya.

Setiap soalan mestilah dimulakan pada mukasurat yang baru.

- S1. [a] Pada ketika yang ditunjukkan pada Rajah S1[a] trak yang membawa paip sedang bergerak ke kanan pada halaju $8t$ m/s. Paip yang dibawa oleh trak tersebut berguling tanpa gelincir pada titik B lawan arah jam dengan halaju putaran $\omega = 2t$ rad/s. Tentukan halaju pusat paip, G dalam bentuk fungsi masa, t.

The truck as shown in Figure Q1[a] is traveling to the right at a velocity of $8t$ m/s, while the pipe is rolling counterclockwise at an angular velocity of $\omega = 2t$ rad/s without slipping at B. Determine the velocity of the pipe's center G as a function of time.



Rajah S1[a]
Figure Q1[a]

(40 markah)

- [b] Rajah S1[b] menunjukkan mekanisma penyambung 4-bar. Pada ketika yang ditunjukkan lengan AB diputar dengan halaju sudut ω_{AB} rad/s arah lawan jam seperti yang ditunjukkan.

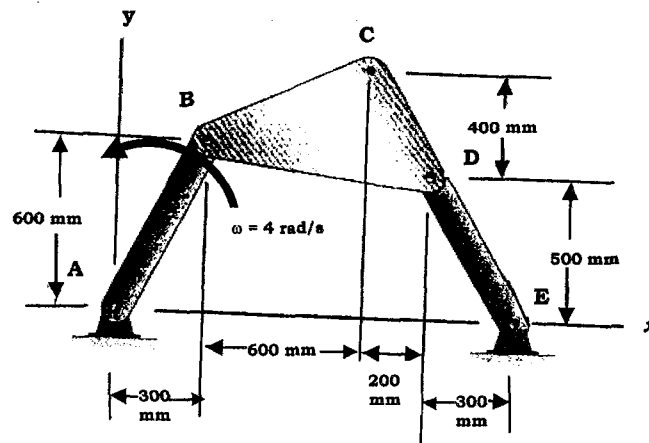
Tentukan halaju, v_C pada :

- i] titik B
- ii] titik D
- iii] titik C

Bar AB in Figure Q1[b] rotates at $\omega = 4$ rad/s in the counterclockwise direction.

Determine the velocity of :

- i] point B
- ii] point D
- iii] point C



Rajah S1[b]
Figure Q1[b]

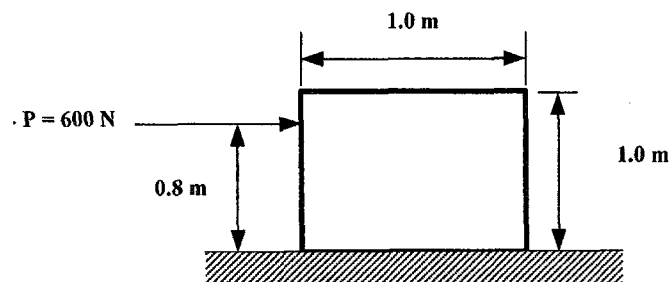
(60 markah)

S2. [a] Rajah S2[a] menunjukkan kotak 50 kg berjisim seragam yang terletak pada permukaan lantai yang mempunyai pekali geseran kinetik, $\mu_k = 0.2$.

- Lukiskan rajah badan bebas dan rajah kinetik bagi kotak tersebut.
- Tentukan pecutan bagi kotak jika daya $P = 600 \text{ N}$ dikenakan pada kotak.

A uniform 50 kg crate as shown in Figure Q2[a] rests on the horizontal surface for which the coefficient of kinetic friction is $\mu_k = 0.2$.

- Draw a free body diagram and kinetic diagrams for the 50 kg crate.
- Determine the crate's acceleration if a force of $P = 600 \text{ N}$ is applied to the crate.

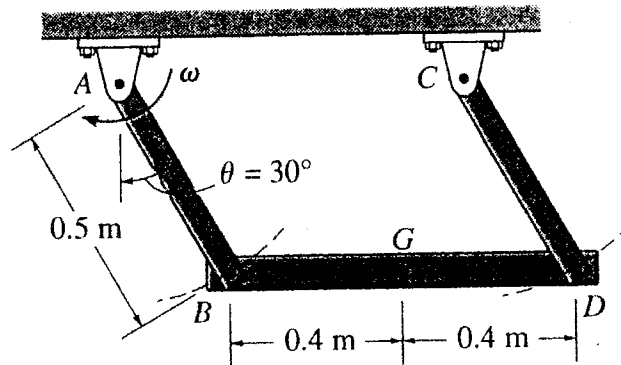


Rajah S2[a]
Figure Q2[a]

(50 markah)

- [b] Palang berjisim 100kg pada Rajah S2[b] disokong oleh dua rod yang jisimnya boleh diabaikan. Tentukan daya yang dihasilkan bagi setiap rod pada ketika rod berada pada sudut $\theta = 30^\circ$ dan kedua-duanya berputar pada halaju sudut, $\omega = 6 \text{ rad/s}$.

The 100 kg beam BD shown in Figure Q2[b] is supported by two rods having negligible mass. Determine the force created in each rod if at the instant $\theta = 30^\circ$ in which the rods are both rotating with an angular velocity of $\omega = 6 \text{ rad/s}$.

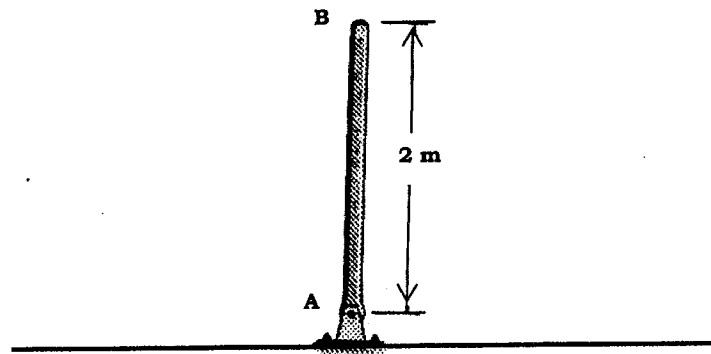


Rajah S2[b]
Figure Q2[b]

(50 markah)

- S3. [a] Palang berjisim 50 kg pada Rajah S3[a] dilepaskan dari keadaan rehat. Dengan menggunakan Prinsip Kerja dan Tenaga, tentukan laju hujung B sebaik sahaja palang menghempas tanah.

The 50 kg bar as shown in Figure Q3[a] falls from rest. By using the Principle of Work and Energy, determine the speed of its end B just before it strikes the ground.

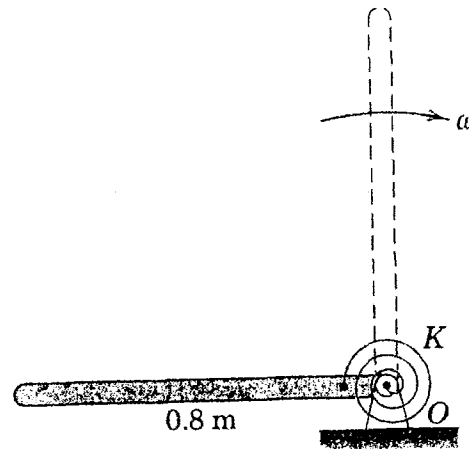


Rajah S3[a]
Figure Q3[a]

(40 markah)

- [b] Palang langsing yang berjisim 6 kg diikat pada titik O secara menegak seperti pada Rajah S3[b]. Kekakuan pegas kilasan, K, ialah 30 N.m/rad. Jika palang itu dilepaskan pada keadaan rehat dari kedudukan mengufuk, tentukan halaju putaran, ω apabila palang melepasi kedudukan menegak. (Abaikan geseran).

The torsional spring has a stiffness of 30 N.m/rad and is undeflected when the 6 kg uniform slender bar is in the upright position. If the bar is released from rest in the horizontal position shown in Figure Q3[b], determine its angular velocity ω as it passes the vertical position. Friction is negligible.



Rajah S3[b]
Figure Q3[b]

(60 markah)

- S4. [a] Terangkan dengan ringkas klasifikasi untuk gear.
Classify the gears with brief explanation.

(25 markah)

- [b] Lakarkan jenis-jenis rangkaian gear berikut dan terbitkan persamaan untuk nisbah halaju gear masukan dan gear keluaran.

- i] susunan gear ringkas
- ii] susunan gear majmuk
- iii] susunan gear balikan

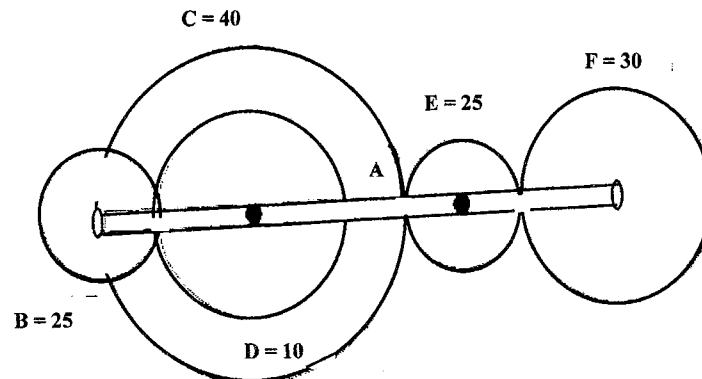
Sketch the following types of gear trains and derive an expression of velocity ratios between input gear and output gear.

- i] simple gear train.
- ii] compound gear train.
- iii] reverted gear train.

(25 markah)

- [c] Rajah S4[c] menunjukkan susunan rangkaian gear kisar. Roda E dimatikan manakala roda C dan D adalah gear majmuk dan dipasang pada pin. Jika lengan A berputar dalam arah ikut jam sebanyak 120 p.s.m., tentukan kelajuan dan arah pusingan roda B dan F.

Figure Q4[c] shows an epicyclic gear train arrangement. Wheel E is fixed and wheels C and D are compound gears which is mounted on the pin. If the arm A is rotating in the clockwise direction with a speed of 120 rpm determine the speed and directions of rotation of wheels B and F.



Rajah S4[c]
Figure Q4[c]

(50 markah)

- S5. [a] Terangkan dengan ringkas kesan ketidakimbangan jisim berputar.
Explain briefly the effect of an unbalance rotating masses.

(15 markah)

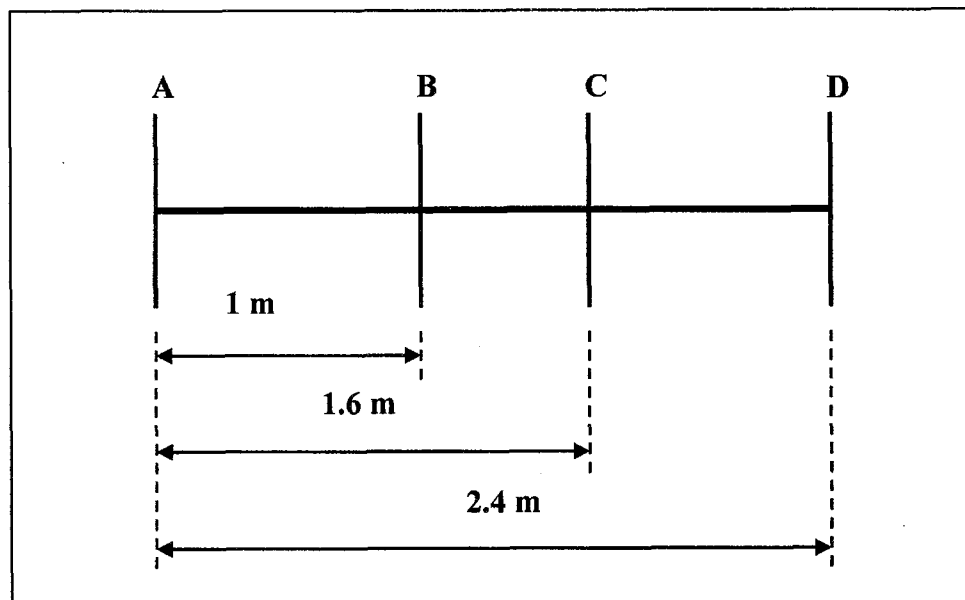
- [b] Apakah perbezaan di antara pengimbangan statik dan pengimbangan dinamik. Buktikan jika jisim berputar dalam keseimbangan dinamik ianya juga berada dalam keseimbangan statik tetapi tidak sebaliknya.

Explain the difference between static and dynamic balancing. Prove that if a body is in dynamic balance, it will be in static balance but the reverse is not true.

(35 markah)

- [c] Empat jisim mempunyai magnitud 6 kg, 7 kg, 8 kg dan m kg masing-masing berputar pada satah A, B, C dan D. Jarak di antara satah ditunjukkan dalam Rajah S5[c]. Kesemua jisim mempunyai jejari putaran yang sama. Jika sistem jisim dalam keseimbangan sempurna, tentukan magnitud jisim m dan kedudukan sudutannya relatif kepada jisim yang lain.

Four masses of magnitudes 6 kg, 7 kg, 8 kg and m kg revolve in planes A, B, C and D, respectively. The planes are spaced as shown in Figure Q5[c]. The masses are all located at the same radius. Determine the magnitude of m and the relative angular positions of the masses for complete balance.



Rajah S5[c]
Figure Q5[c]

(50 markah)

- S6. [a] Profil pergerakan sesondol dan pengikut diberikan seperti berikut:

- Pengikut naik semasa pusingan sesondol 60°
- Pengikut dalam keadaan rehat semasa pusingan sesondol 30° seterusnya
- Pengikut turun semasa pusingan sesondol 90° seterusnya, dan
- Pengikut dalam keadaan rehat semasa pusingan sesondol 180° seterusnya.

Lejang pengikut adalah 30 mm. Lakarkan rajah anjakan (mengikut skala) apabila pengikut bergerak dengan:

- i] gerakan harmonik mudah,
- ii] gerakan pecutan dan rencatan malar.

A profile of motion of a cam and a follower is given as follows :

- *Outbreak during 60° of cam rotation*
- *Dwell for the next 30° of cam rotation*
- *Return stroke during next 90° of cam rotation, and*
- *Dwell of the remaining 180° of cam rotation.*

The stroke of the follower is 30 mm. Sketch the displacement diagram (appropriate scale) when the follower moves with:

- i] simple harmonic motion,*
- ii] uniform acceleration and retardation.*

(30 markah)

- [b] Jika sesondol beputar dengan kelajuan 300 p.s.m., tentukan nilai halaju dan nilai pecutan maksimum pengikut bagi gerakan dalam soalan S6[a], masing-masingnya semasa pengikut naik dan turun.**

If the cam rotates at 300 r.p.m., determine the maximum velocity and acceleration of the follower for the motions mention in question Q6[a] during outbreak and return stroke respectively.

(25 markah)

- [c] Bincangkan jenis-jenis tegasan yang teraruh dalam rim roda tenaga dan langkah-langkah mengatasinya.**

Discuss the various types of stresses induced in a flywheel rim and steps taken to overcome it.

(20 markah)

- [d] Bincangkan prosidur untuk menentukan saiz dan jisim roda tenaga dengan bantuan rajah momen.**

Explain the procedure for determining the size and mass of a flywheel with the help of a turning moment diagram.

(25 markah)

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Fundamental Equations of Dynamics

KINEMATICS		Equations of Motion	
Particle Rectilinear Motion Variable a Constant $a = a_c$ $a = \frac{dv}{dt}$ $v = v_0 + a_c t$ $v = \frac{ds}{dt}$ $s = s_0 + v_0 t + \frac{1}{2} a_c t^2$ $a ds = v dv$ $v^2 = v_0^2 + 2a_c(s - s_0)$		Particle $\Sigma F = ma$ Rigid Body $\Sigma F_x = m(a_G)_x$ (Plane Motion) $\Sigma F_y = m(a_G)_y$ $\Sigma M_G = I_G \alpha$ or $\Sigma M_P = \Sigma (M_k)_P$	
Particle Curvilinear Motion x, y, z Coordinates r, θ, z Coordinates $v_x = \dot{x}$ $a_x = \ddot{x}$ $v_r = \dot{r}$ $a_r = \ddot{r} - r\dot{\theta}^2$ $v_y = \dot{y}$ $a_y = \ddot{y}$ $v_\theta = r\dot{\theta}$ $a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta}$ $v_z = \dot{z}$ $a_z = \ddot{z}$ $v_z = \dot{z}$ $a_z = \ddot{z}$		Principle of Work and Energy $T_1 + U_{1-2} = T_2$ Kinetic Energy Particle $T = \frac{1}{2} m v^2$ Rigid Body $T = \frac{1}{2} m v_G^2 + \frac{1}{2} I_G \omega^2$ (Plane Motion) 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 $U_s = -(\frac{1}{2} k s_2^2 - \frac{1}{2} k s_1^2)$ Couple moment $U_M = M \Delta \theta$	
n, t, b Coordinates $v = \dot{s}$ $a_t = \dot{v} = v \frac{dv}{ds}$ $a_n = \frac{v^2}{\rho}$ $\rho = \frac{[1 + (dy/dx)^2]^{3/2}}{ d^2y/dx^2 }$		Power and Efficiency $P = \frac{dU}{dt} = F \cdot v$ $\epsilon = \frac{P_{out}}{P_{in}} = \frac{U_{out}}{U_{in}}$ Conservation of Energy Theorem $T_1 + V_1 = T_2 + V_2$ Potential Energy $V = V_g + V_e$, where $V_g = \pm W y$, $V_e = +\frac{1}{2} k s^2$	
Relative Motion $v_B = v_A + v_{B/A}$ $a_B = a_A + a_{B/A}$		Principle of Linear Impulse and Momentum Particle $mv_1 + \Sigma \int F dt = mv_2$ Rigid Body $m(v_G)_1 + \Sigma \int F dt = m(v_G)_2$	
Rigid Body Motion About a Fixed Axis Variable α Constant $\alpha = \alpha_c$ $\alpha = \frac{d\omega}{dt}$ $\omega = \omega_0 + \alpha_c t$ $\omega = \frac{d\theta}{dt}$ $\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha_c t^2$ $\omega d\omega = \alpha d\theta$ $\omega^2 = \omega_0^2 + 2\alpha_c(\theta - \theta_0)$		Conservation of Linear Momentum $\Sigma(\text{sys. } mv)_1 = \Sigma(\text{sys. } mv)_2$ Coefficient of Restitution $e = \frac{(v_B)_2 - (v_A)_2}{(v_A)_1 - (v_B)_1}$	
For Point P $s = \theta r$ $v = \omega r$ $a_t = \alpha r$ $a_n = \omega^2 r$		Principle of Angular Impulse and Momentum Particle $(H_O)_1 + \Sigma \int M_O dt = (H_O)_2$ where $H_O = (d)(mv)$ Rigid Body $(H_G)_1 + \Sigma \int M_G dt = (H_G)_2$ (Plane motion) where $H_G = I_G \omega$ $(H_O)_1 + \Sigma \int M_O dt = (H_O)_2$ where $H_O = I_O \omega$	
Relative General Plane Motion—Translating Axes $v_B = v_A + v_{B/A(\text{pin})}$ $a_B = a_A + a_{B/A(\text{pin})}$		Conservation of Angular Momentum $\Sigma(\text{sys. } H)_1 = \Sigma(\text{sys. } H)_2$	
Relative General Plane Motion—Trans. and Rot. Axis $v_B = v_A + \Omega \times r_{B/A} \times (v_{B/A})_{xyz}$ $a_B = a_A + \Omega \times r_{B/A} + \Omega \times (\Omega \times r_{B/A}) + 2\Omega \times (v_{B/A})_{xyz} \times (a_{B/A})_{xyz}$			
KINETICS			
Mass Moment of Inertia $I = \int r^2 dm$			
Parallel-Axis Theorem $I = I_G + md^2$			
Radius of Gyration $k = \sqrt{\frac{I}{m}}$			