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UNIVERSITI SAINS MALAYSIA

First Semester Examination  
Academic Session 2007/2008  
*Peperiksaan Semester Pertama  
Sidang Akademik 2007/2008*

October / November 2007  
*Oktober / November 2007*

**EMM 101/3 – Mechanical Engineering**  
***Mekanik Kejuruteraan***

Duration : 3 hours  
*Masa : 3 jam*

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**INSTRUCTIONS TO CANDIDATE:**

**ARAHAN KEPADA CALON:**

Please check that this paper contains **TWELVE (12)** printed pages, **TWO (2)** pages appendices and **EIGHT (8)** questions before you begin the examination.

*Sila pastikan bahawa kertas soalan ini mengandungi **DUA BELAS (12)** muka surat bercetak, **DUA (2)** halaman lampiran dan **LAPAN (8)** soalan sebelum anda memulakan peperiksaan.*

Answer **FIVE (5)** questions.

*Jawab **LIMA (5)** soalan.*

This paper has **TWO (2)** parts that is **SECTION A** and **SECTION B**. Candidate must answer at least **TWO (2)** questions from each part.

*Kertas soalan ini dibahagikan kepada **DUA (2)** bahagian, iaitu **BAHAGIAN A** dan **BAHAGIAN B**. Calon mesti menjawab sekurang-kurangnya **DUA (2)** soalan dari setiap bahagian.*

Answer all questions in **ENGLISH OR BAHASA MALAYSIA** OR a combination of both.

*Calon boleh menjawab semua soalan dalam **BAHASA MALAYSIA** ATAU **BAHASA INGGERIS** ATAU kombinasi kedua-duanya.*

Each question must begin from a new page.

*Setiap soalan mestilah dimulakan pada mukasurat yang baru.*

**Appendix/Lampiran:**

1. Supports for Rigid Bodies Subjected to Two-Dimensional Force Systems

[1 page/mukasurat]

2. Supports for Rigid Bodies Subjected to Three-Dimensional Force Systems

[1 page/mukasurat]

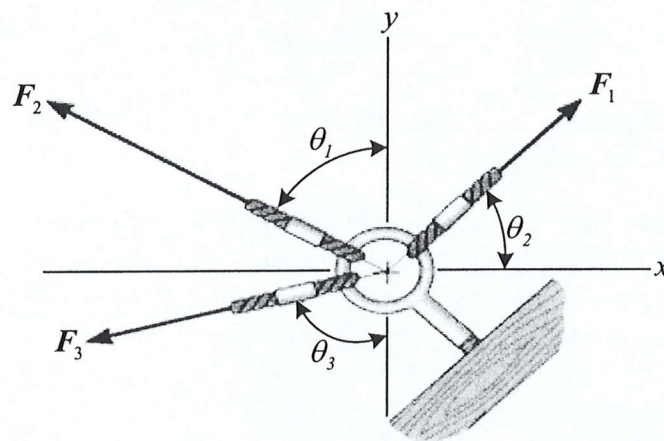
## BAHAGIAN A

- S1. [a] Tentukan magnitud daya paduan  $F_R = F_1 + F_2 + F_3$  beserta dengan arahnya, diukur lawan arah jam daripada paksi x positif dengan menjumlahkan komponen-komponen daya x dan y untuk mendapatkan daya paduan.

(Diberi:  $F_1 = 600 \text{ N}$ ,  $F_2 = 800 \text{ N}$ ,  $F_3 = 450 \text{ N}$ ,  $\theta_1 = 60^\circ$ ,  $\theta_2 = 45^\circ$  and  $\theta_3 = 75^\circ$ )

*Determine the magnitude of the resultant force  $F_R = F_1 + F_2 + F_3$  and its direction, measured counterclockwise from the positive x axis by summing the rectangular components of the forces to obtain the resultant force.*

*(Given:  $F_1 = 600 \text{ N}$ ,  $F_2 = 800 \text{ N}$ ,  $F_3 = 450 \text{ N}$ ,  $\theta_1 = 60^\circ$ ,  $\theta_2 = 45^\circ$  and  $\theta_3 = 75^\circ$ )*



Rajah S1[a]  
Figure Q1[a]

(50 markah)

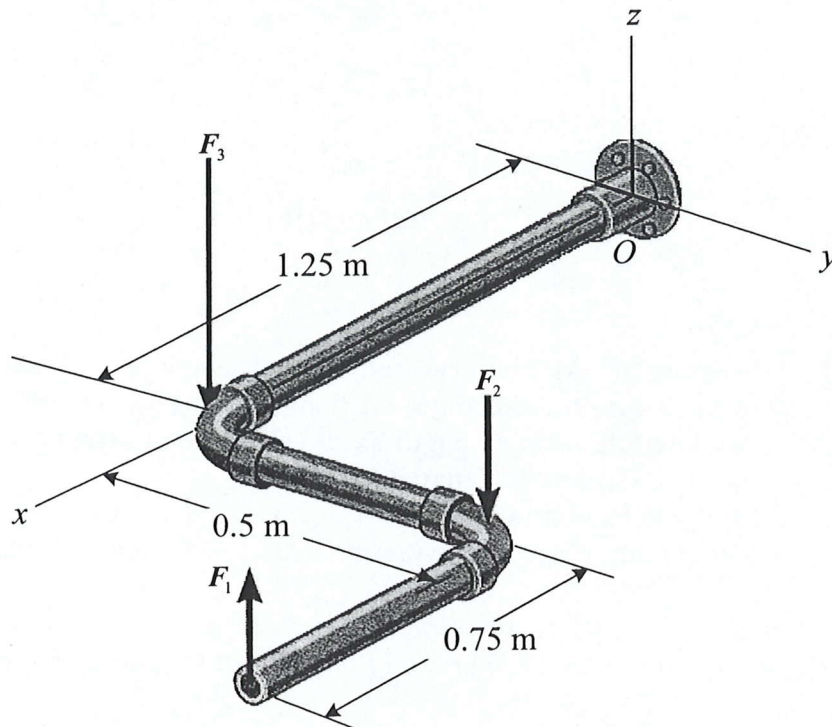
- [b] Kabel sepanjang 4 m diikat sekeliling takal tanpa geseran di A, B, C dan D. Sekiranya setiap pegas diregangkan 300 mm, tentukan jisim  $m$  untuk setiap bongkah. Abaikan berat takal dan kord. Pegas tidak teregang apabila  $d = 2 \text{ m}$  (Pemalar pegas,  $k = 500 \text{ N/m}$ )

*A continuous cable of total length 4 m is wrapped around the small frictionless pulleys at A, B, C, and D. If each spring is stretched 300 mm, determine the mass  $m$  of each block. Neglect the weight of the pulleys and cords. The springs are unstretched when  $d = 2 \text{ m}$  (The spring constant  $k = 500 \text{ N/m}$ ).*



- [b] Tiga daya dikenakan pada paip berkenaan. Sekiranya,  $F_1 = 50 \text{ N}$ ,  $F_2 = 80 \text{ N}$  dan  $F_3 = 180 \text{ N}$  gantikan sistem ini dengan paduan daya yang setara dan momen ganding bertindak pada O. Nyatakan keputusan dalam format vektor Cartesian.

*Three forces acts on the pipe assembly. If  $F_1 = 50 \text{ N}$ ,  $F_2 = 80 \text{ N}$ , and  $F_3 = 180 \text{ N}$ , replace this system by an equivalent resultant force and couple moment acting at O. Express the results in Cartesian vector form.*

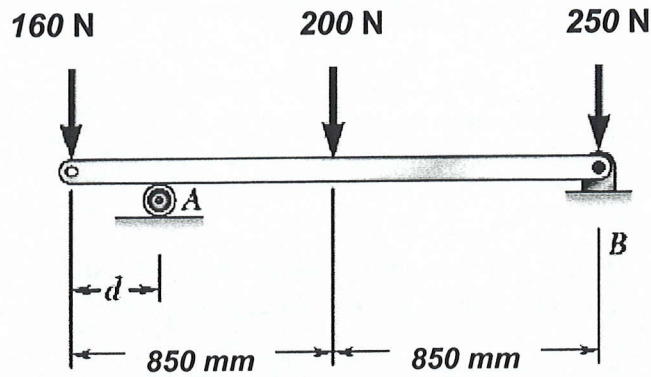


Rajah S2[b]  
Figure Q2[b]

(50 markah)

- S3. [a] Sebatang rasuk yang diletakkan di atas penggelek di A dan disokong oleh engsel di B seperti yang ditunjukkan oleh Rajah S3[a], dikenakan tiga daya luar menegak 160 N, 200 N dan 250 N pada jarak-jarak yang ditentukan. Didapati bahawa nilai maksimum tidakbalas daya yang dibenarkan pada setiap sokongan adalah 350 N. Dengan mengabaikan berat rasuk, tentukan julat nilai bagi jarak  $d$  supaya rasuk tersebut selamat untuk menampung beban kenaaan tersebut.

*A beam rested on a roller at A and supported by a hinge at B as shown in Figure Q3[a] below, is subjected to three vertical external forces of 160 N, 200 N and 250 N at given points. It was found that the maximum allowable value of each of the reactions at the supports is 350 N. Neglecting the weight of the beam, determine the range of values of the distance  $d$  for which the beam is safe to sustain such applied loads.*



Rajah S3[a]  
Figure Q3[a]

(40 markah)

- [b] Ketika berlepas, sayap kapal terbang Air-Asia Boeing 737-300 telah dikenakan daya tujahan  $T$  daripada injinnya yang menyebabkan terhasilnya daya angkatan  $L$  seperti yang ditunjukkan dalam Rajah S3[b] di bawah. Ia telah ditunjukkan bahawa sayap tersebut adalah bersambung secara kekal pada badan kapal terbang di  $A$ . Dengan mengandaikan jisim sayap tersebut adalah  $M$  dan pusat jisimnya di  $G$ :

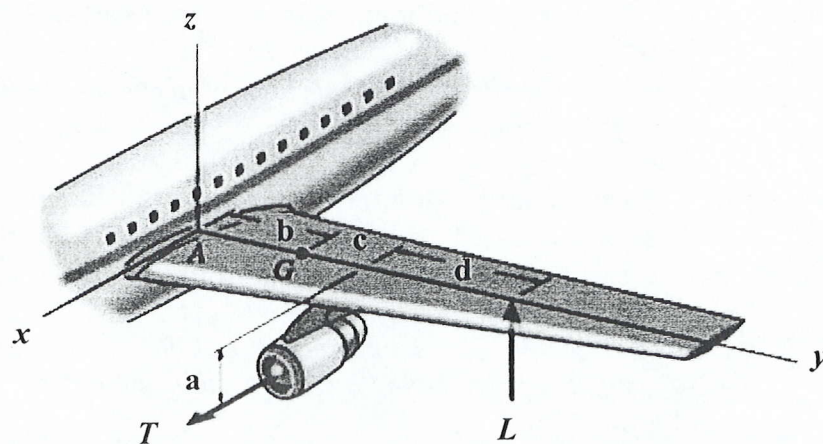
*During a take off, the wing of Boeing 737-300 Air-Asia is subjected to a thrust  $T$  from its engine which results in a lift force  $L$  as shown in Figure Q3[b] below. It was shown that the wing is fixed to the fuselage at  $A$ . Assuming the mass of the wing is  $M$  and the mass center is at  $G$ :*

Diberikan:

Given:

$$\begin{aligned} T &= 9.5 \text{ kN} \\ M &= 2 \times 10^3 \text{ kg} \\ b &= 5.5 \text{ m} \\ d &= 7 \text{ m} \end{aligned}$$

$$\begin{aligned} L &= 50 \text{ kN} \\ a &= 3 \text{ m} \\ c &= 2.5 \text{ m} \end{aligned}$$

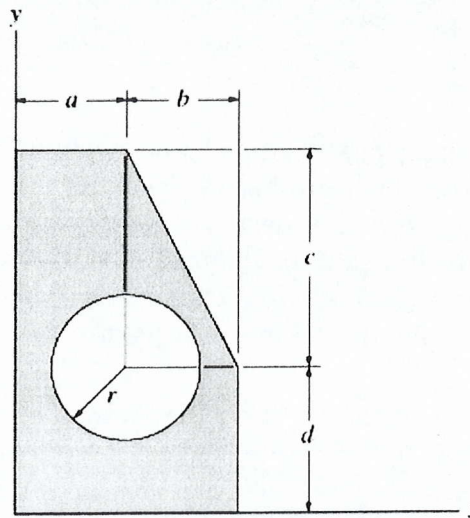


Rajah S3[b]  
Figure Q3[b]

- (i) **Lukis rajah badan bebas komponen sayap tersebut.**  
*Draw the free-body diagram of the wing components.* (20 markah)
- (ii) **Tentukan komponen x, y dan z bagi tindakbalas di A.**  
*Determine the x, y, z components of reaction at A.* (40 markah)

S4. [a] **Rajah S4[a] menunjukkan luas keratan rentas satu komponen. Dengan mengandaikan  $a = b = 3 \text{ cm}$ ,  $c = 6 \text{ cm}$ ,  $d = 4 \text{ cm}$  and  $r = 2 \text{ cm}$ ;**

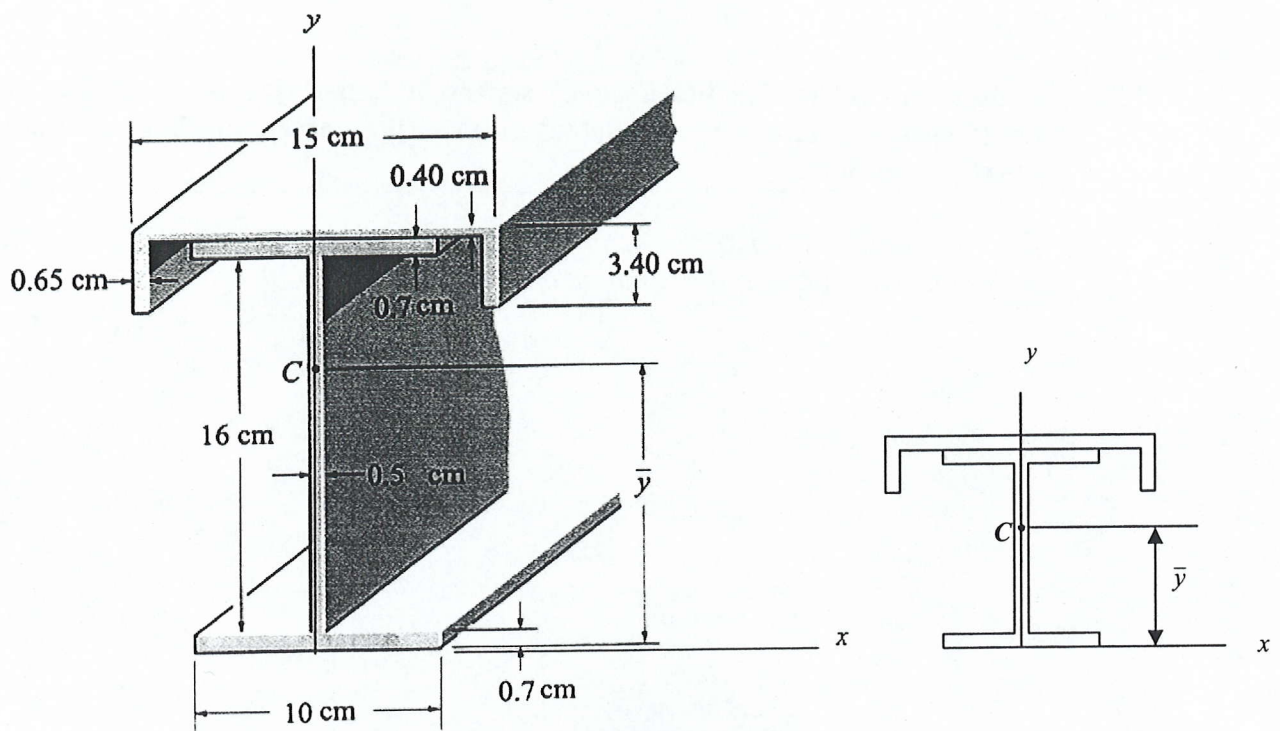
*Figure Q4[a] shows a cross-sectional area of a component. Assuming that  $a = b = 3 \text{ cm}$ ,  $c = 6 \text{ cm}$ ,  $d = 4 \text{ cm}$  and  $r = 2 \text{ cm}$ ;*



**Rajah S4[a]**  
*Figure Q4[a]*

- (i) **Tentukan sentroid kawasan berlorek bagi keratan rentas.**  
*Determine the centroid of the shaded area of the cross-section.* (20 markah)
- (ii) **Tentukan momen inersia bagi kawasan berlorek di sekitar paksi- x dan y.**  
*Determine the moments of inertia of the shaded area about the x- and y- axes.* (20 markah)
- [b] **Satu struktur aluminium yang dibina daripada satu rasuk terusan dan satu rasuk I yang mempunyai luas-keratan rentas seperti yang ditunjukkan dalam Rajah S4[b] di bawah.**

*An aluminium structural member is built up from a channel and a wide-flange beam (I-beam) having a cross-section shown as in Figure Q4[b] below.*



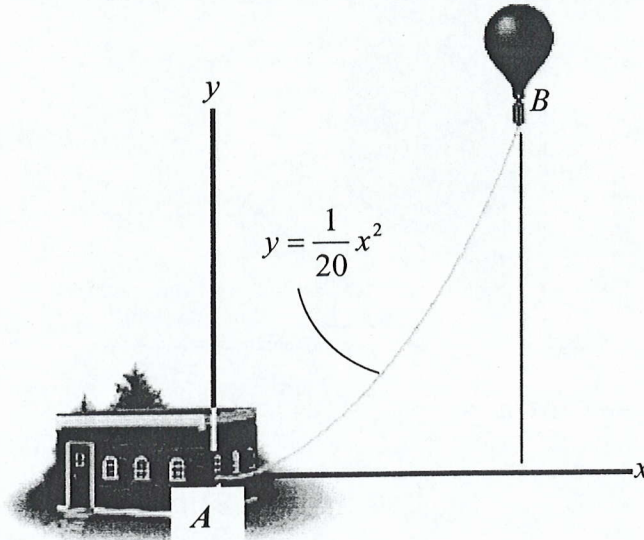
Rajah S4[b]  
Figure Q4[b]

- (i) Dapatkan jarak  $\bar{y}$  kepada sentroid bagi luas keratan rentas struktur tersebut.  
*Locate the distance  $\bar{y}$  to the centroid for the cross-sectional area of the construction.* (20 markah)
- (ii) Tentukan momen inersia di sekitar paksi  $x$ .  
*Determine the moment of inertia about the  $x$  axis.* (40 markah)

## BAHAGIAN B

- S5. Kedudukan mengufuk belon cuaca seperti dalam Rajah S5 diberikan sebagai  $x = (5t)$  m, di mana  $t$  adalah dalam minit. Jika persamaan bagi laluan adalah  $y = x^2/20$ , tentukan,

The horizontal position of the weather balloon in Figure Q5 is defined by  $x = (5t)$  m, where  $t$  is in minutes. If the equation of the path is  $y = x^2/20$ , determine,

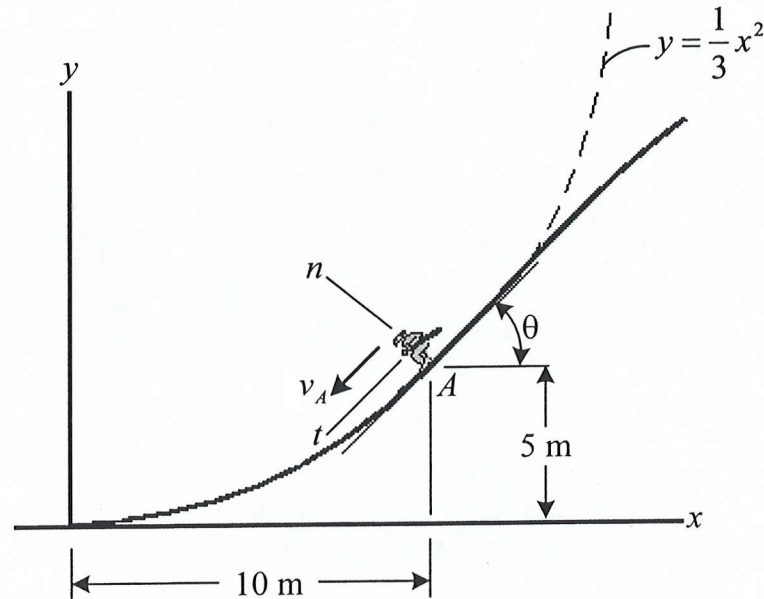


Rajah S5  
Figure Q5

- [a] jarak belon tersebut daripada stesen A selepas  $t$  adalah 10 minit,  
the distance of the balloon from the station A after  $t$  is 10 minutes. (20 markah)
- [b] magnitud dan arah halaju apabila  $t$  adalah 10 minit dan,  
the magnitude and direction of the velocity when  $t$  is 10 minutes and, (40 markah)
- [c] magnitud dan arah pecutan apabila  $t$  adalah 10 minit.  
the magnitude and direction of the acceleration when  $t$  is 10 minutes. (40 markah)

- S6. Seorang peluncur ski bermula daripada keadaan rehat dan mencapai kedudukan A sepanjang laluan parabola seperti dalam Rajah S6, di mana kelajuannya bertambah pada kadar  $2 \text{ m/s}^2$ . Tentukan

*A skier starts from rest and he reaches the point A along the parabolic path as in Figure Q6, where his speed is increasing at  $2 \text{ m/s}^2$ . Determine*



Rajah S6  
Figure Q6

- [a] kedua-dua magnitud dan arah bagi halajunya pada masa tersebut iaitu 5 s,

*both magnitude and direction of his velocity at this instant where time is 5 s,*  
(20 markah)

- [b] kedua-dua magnitud dan arah pecutannya pada masa tersebut iaitu 5 s dan,

Diberi bahawa jejari kelengkungan,  $\rho = \frac{\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2}}{\frac{d^2y}{dx^2}}$

both magnitude and direction of acceleration at this instant where time is 5 s and,

Given that the radius of curvature,  $\rho = \frac{\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2}}{\frac{d^2y}{dx^2}}$

(40 markah)

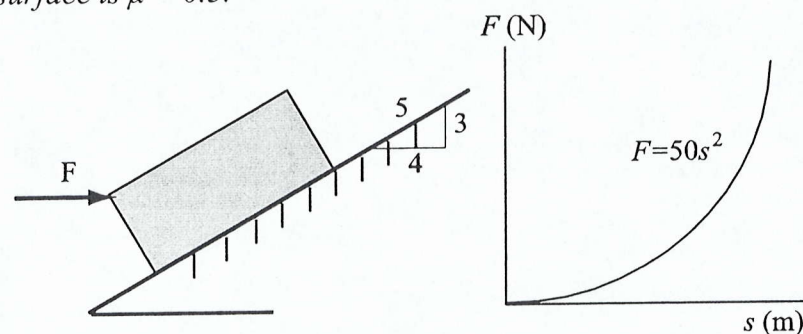
- [c] daya-daya normal dan geseran pada masa tersebut sekiranya peluncur berkenaan mempunyai berat 700 N.

normal and frictional forces acting at this instant if the skier has weight of 700 N.

(40 markah)

- S7. [a] Daya  $F$  pada arah yang tetap yang dikenakan pada blok 20 kg mempunyai magnitud berbeza mengikut kedudukan,  $s$ . Tentukan jarak blok menggelongsor semasa halaju menjadi 5 m/s. Bila  $s = 0$ , blok bergerak ke atas pada 2 m/s. Pekali geseran kinetik antara blok dan permukaan,  $\mu = 0.3$ .

A force  $F$ , acting in a constant direction on the 20 kg block, has a magnitude which varies with the position  $s$  of the block. Determine how far the block slides when its velocity becomes 5 m/s. When  $s = 0$  the block is moving upward at 2 m/s. The coefficient of kinetic friction between the block and surface is  $\mu = 0.3$ .

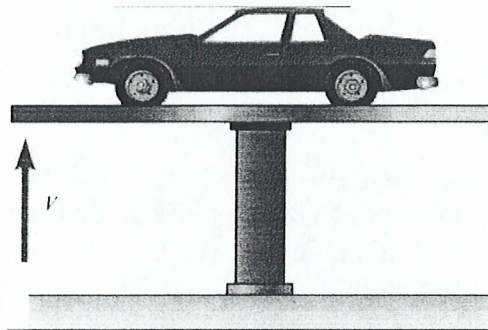


Rajah S7[a]  
Figure Q7[a]

(60 markah)

- [b] Satu sistem pengangkat-kereta hidraulik ditunjukkan dalam Rajah S7[b]. Masa 16 saat diperlukan untuk menaikkan kereta 1200 kg dan pelantar lif-kereta hidraulik 300 kg kepada ketinggian 2 m. Diketahui bahawa keberkesanan penukaran kuasa daripada elektrik kepada mekanikal untuk sistem adalah 82%, tentukan

*A system of a hydraulic car-lift is shown in Figure Q7[b]. It takes 16 s to raise a 1200 kg car and the supporting 300 kg hydraulic car-lift platform to a height of 2 m. Knowing that the overall conversion efficiency from electrical to mechanical power for the system is 82 %, determine*



Rajah S7[b]  
Figure Q7[b]

- (i) purata kuasa keluaran yang disampaikan oleh pam hidraulik untuk mengangkat sistem tersebut.

*the average power output delivered by the hydraulic pump to lift the system*

(20 markah)

- (ii) purata kuasa elektrik yang diperlukan

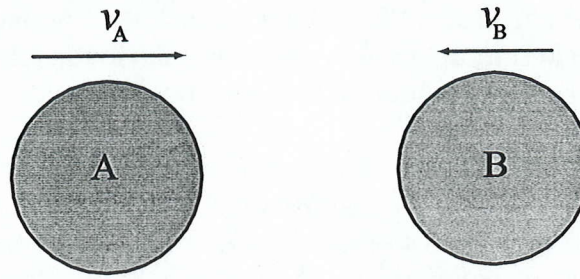
*the average electric power required*

(20 markah)

- S8. [a] Cakera A berjisim 2 kg bergerak ke depan di atas permukaan licin dengan halaju 5 m/s apabila ia menghentam cakera B berjisim 4 kg, yang bergerak ke arah A pada halaju 2 m/s seperti dalam Rajah S8[a] secara hentaman pusat langsung. Jika pekali restitusi antara cakera adalah  $e = 0.4$ , tentukan halaju A dan B selepas pelanggaran.

*Disk A has a mass of 2 kg and is sliding forward on the smooth surface with a velocity 5 m/s when it strikes the 4 kg disk B, which is sliding towards A at 2 m/s, with direct central impact. If the coefficient of restitution between the disks is  $e = 0.4$ , determine the velocities of A and B after collision.*

[Pandangan atas]

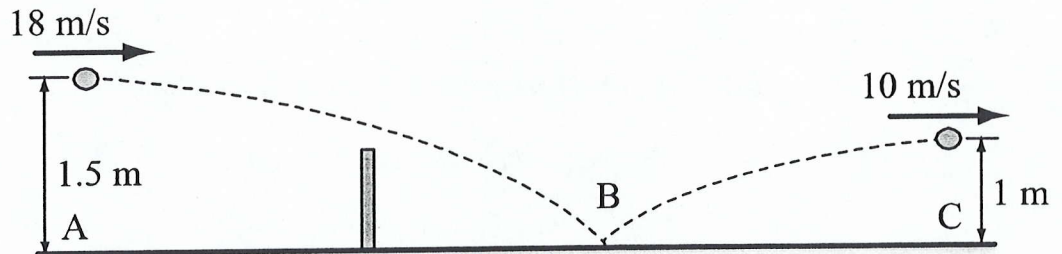


Rajah S8[a]  
Figure Q8[a]

(30 markah)

- [b] Seorang pemain memukul bola tenis berjisim 57 g dengan halaju mengufuk awal 18 m/s pada A dengan ketinggian 1.5 m. Bola melantun pada B dan mencapai tinggi maksimum 1 m pada C dengan halaju 10 m/s. Sekiranya masa hentaman adalah 0.004 s, tentukan daya impuls yang dihasilkan pada bola di B.

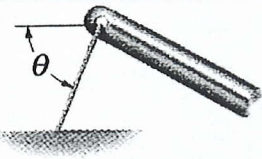
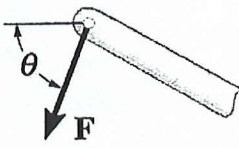
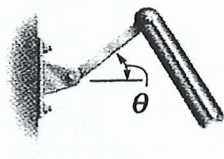
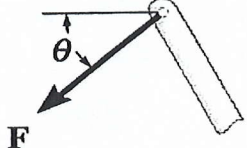
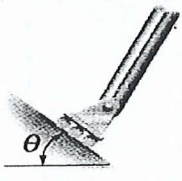
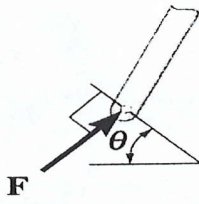
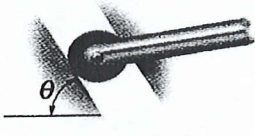
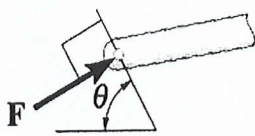
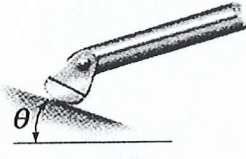
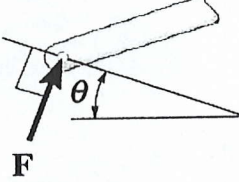
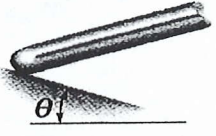
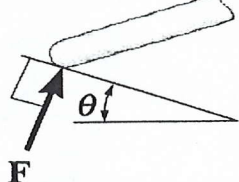
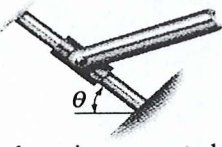
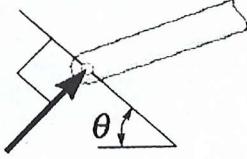
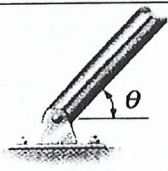
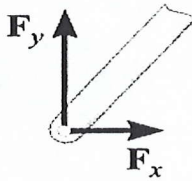

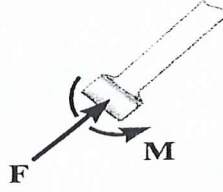

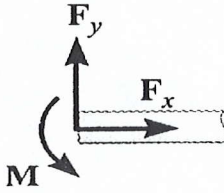
*A player hits a 57 g tennis ball with a horizontal initial velocity of 18 m/s at A with a height of 1.5 m. The ball bounces at B and rises to a maximum height at C with a height of 1 m where the velocity is 10 m/s. Knowing that the duration of impact is 0.004 s, determine the impulsive force exerted on the ball at B.*



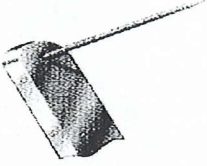
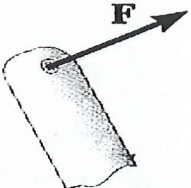

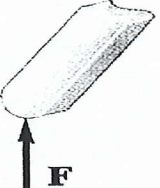

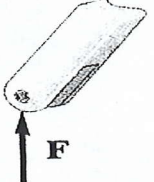
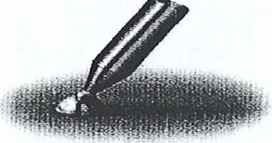
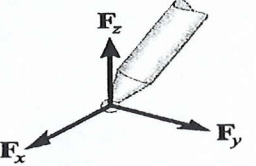
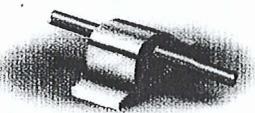
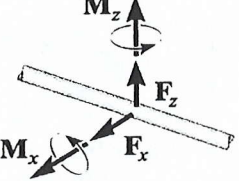
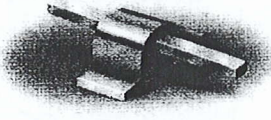
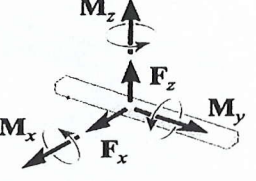

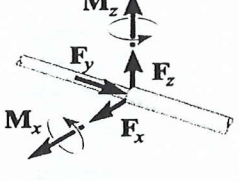
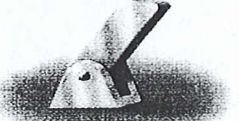
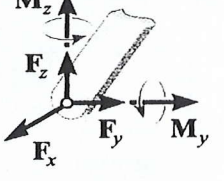
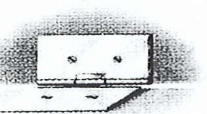
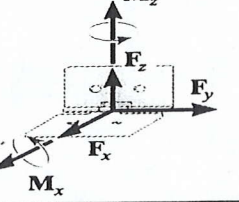
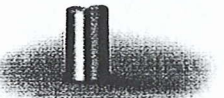
Rajah S8[b]  
Figure Q8[b]

(70 markah)

**TABLE 1: Supports for Rigid Bodies Subjected to Two-Dimensional Force Systems**

Types of Connection	Reaction	Types of Connection	Reaction
 <p>cable</p>		 <p>weightless link</p>	
 <p>roller</p>		 <p>roller or pin in confined smooth slot</p>	
 <p>rocker</p>		 <p>smooth contacting surface</p>	
 <p>member pin connected to collar on smooth rod</p>		 <p>smooth pin or hinge</p>	
 <p>member fixed connected to collar on smooth rod</p>		 <p>fixed support</p>	

**TABLE 2: Supports for Rigid Bodies Subjected to Three-Dimensional Force Systems**

Types of Connection	Reaction	Types of Connection	Reaction
 <p>cable</p>		 <p>smooth surface support</p>	
 <p>roller</p>		 <p>ball and socket</p>	
 <p>single journal bearing</p>		 <p>single journal bearing with square shaft</p>	
 <p>single thrust bearing</p>		 <p>single smooth pin</p>	
 <p>single hinge</p>		 <p>fixed support</p>	