Second Semester Examination
2017/2018 Academic Session

May/June 2018

EEM222 – Fundamentals Of Dynamics & Mechanisms
(Asas Dinamik & Mekanisma)

Duration : 3 hours
(Masa : 3 jam)

Please ensure that this examination paper consists of **FOURTEEN (14)** pages before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **EMPAT BELAS (14)** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

Instructions: This question paper consists of **FOUR (4)** questions. Answer **ALL** questions. All questions carry the same marks.

[***Arahan:*** *Kertas soalan ini mengandungi **EMPAT (4)** soalan. Jawab **SEMUA** soalan. Semua soalan membawa jumlah markah yang sama.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

1. (a) The balloon *A* in Figure 1(a) is ascending at the rate v_A = 12 km/h and is being carried horizontally by the wind at v_w = 20 km/h. If a ballast bag is dropped from the balloon at the instant h = 50 m, determine the time t_s needed for the bag to strike the ground. Assume that the bag was released from the balloon with the same velocity as the balloon. Also, at what speed v_s does the bag hit the ground?

Belon udara dalam Rajah 1 (a) menaik pada kadar v_A = 12 km /j dan sedang ditiup secara mendatar oleh angin dengan v_w = 20 km/j. Jika beg digugurkan daripada belon pada ketinggian h = 50 m, tentukan t_s masa yang diperlukan untuk beg tersebut jatuh ke tanah. Andaian bahawa beg itu dilepaskan daripada belon dengan halaju yang sama dengan belon. Juga, apa kelajuan v_s ketika beg mencecah tanah?

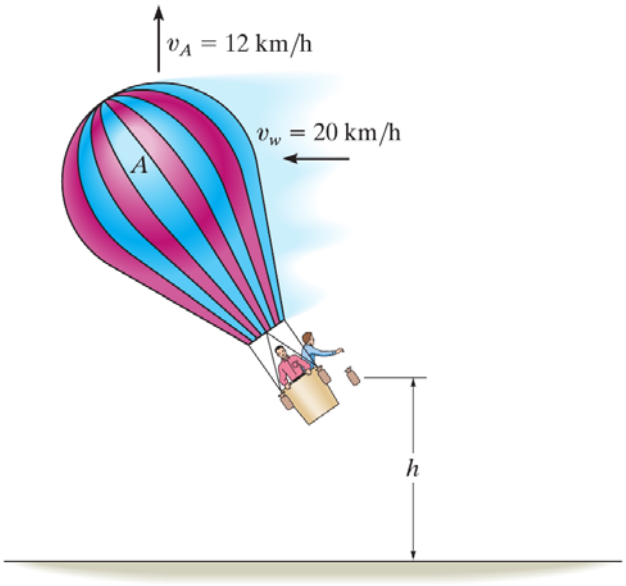

Figure 1(a)

Rajah 1(a)

(25 marks/*markah*)

(b) When the bicycle in Figure 1(b) passes point *A*, it has a speed of 6 m/s, which is increasing at the rate of $\dot{v}$ = 10.52 m/s^2. Determine the magnitude of its acceleration when it is at point *A*.

Apabila basikal dalam Rajah 1(b) melepasi titik A, ia mempunyai kelajuan 6 m/s, yang meningkat pada kadar $\dot{v}$= 10.52 m/s^2. Tentukan magnitud pecutan apabila ia berada pada titik A.

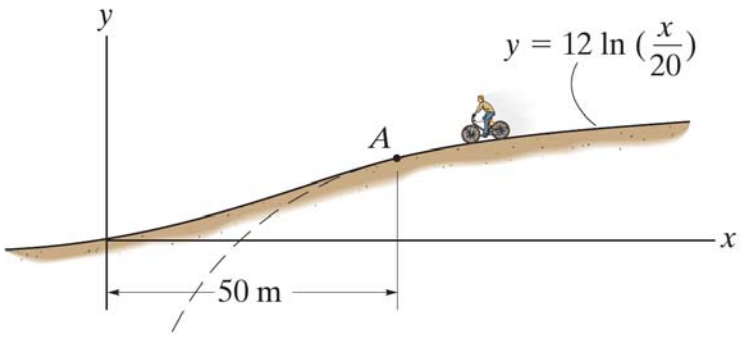

Figure 1(b)

Rajah 1(b)

(25 marks/*markah*)

(c) Each of the two elastic rubber bands of the slingshot (Figure 1(c)) has an unstretched length of 180 mm. If they are pulled back to the position shown and released from rest, determine the maximum height h_{max} the 30-g pellet will reach if it is fired vertically upward. Neglect the mass of the rubber bands and the change in elevation of the pellet while it is constrained by the rubber bands. Each rubber band has a stiffness k = 80N/m.

Setiap satu daripada dua getah elastik katapel (Rajah 1 (c)) mempunyai panjang tak regang 180 mm. Jika getah ditarik kembali ke kedudukan yang ditunjukkan dan dibebaskan dari diam, tentukan ketinggian maksimum h_{max} pelet 30-g akan mencapai jika ia dilepas menegak ke atas. Abaikan jisim band getah dan perubahan dalam ketinggian pelet semasa ia dikekang oleh getah. Setiap getah elastik mempunyai kekakuan k = 80N / m.

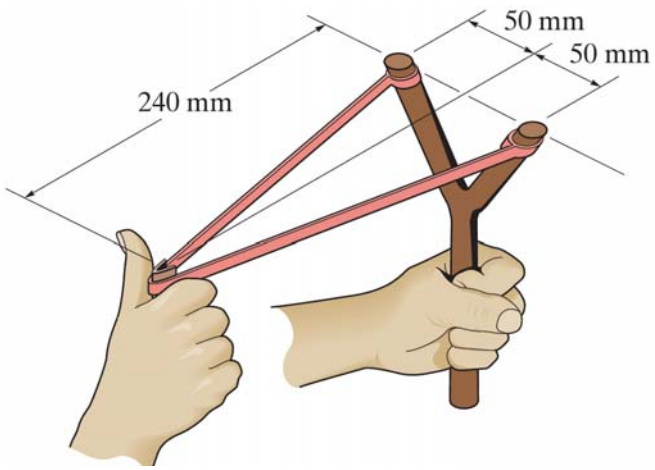

Figure 1(c)

Rajah 1(c)

(25 marks/*markah*)

(d) A small box (Figure 1(d)) of mass *m* is given a speed of $v = \sqrt{\frac{1}{4}gr}$ at the top of the smooth half cylinder. Determine the angle *θ* at which the box leaves the cylinder.

Kotak kecil (Rajah 1(d)) jisim m pada kelajuan $v = \sqrt{\frac{1}{4}gr}$ *di bahagian atas silinder separuh yang licin. Tentukan sudut θ di mana kotak meninggalkan silinder.*

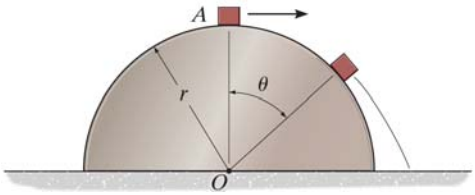

Figure 1(d)

Rajah 1(d)

(25 marks/*markah*)

2. (a) The particle in Figure 2(a) has a mass of 0.5 kg and is confined to move along the smooth horizontal slot due to the rotation of the arm *OA*.

Zarah dalam Rajah 2(a) mempunyai jisim 0.5 kg dan terhad untuk bergerak di sepanjang slot mendatar lancar disebabkan oleh putaran lengan OA.

Determine the force of the rod F_r on the particle and the normal force F_n of the slot on the particle when $\theta = 30°$. The rod is rotating with a constant angular velocity $\dot{\theta} = 2\text{rad/s}$. Assume the particle contacts only one side of the slot at any instant.

Tentukan daya F_r rod pada zarah dan daya normal F_n slot pada zarah semasa $\theta = 30°$. *Rod tersebut berputar dengan halaju sudut* $\dot{\theta} = 2\text{rad/s}$. *Andaikan zarah hanya bersentuhan sebelah slot pada setiap ketika.*

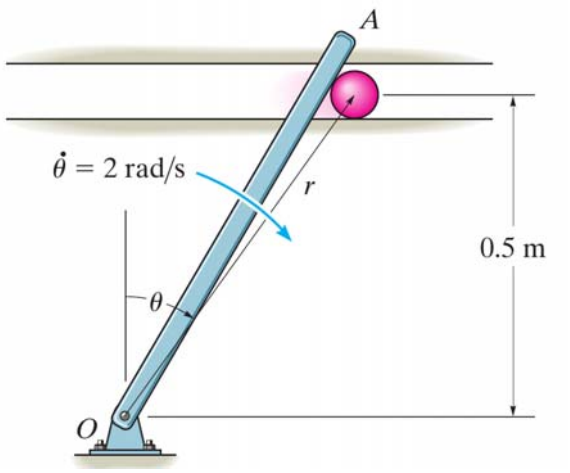

Figure 2(a)

Rajah 2(a)

(25 marks/*markah*)

(b) The 800-kg motorbike in Figure 2(b) travels with a constant speed of 80 km/h up the hill. Determine the normal force the surface exerts on its wheels when it reaches point *A*. Neglect its size.

Motosikal 800 kg dalam Rajah 2(b) bergerak dengan kelajuan tetap 80 km/j ke atas bukit. Tentukan daya normal permukaan yang dikenakan pada roda apabila ia mencapai titik A. Abaikan saiznya.

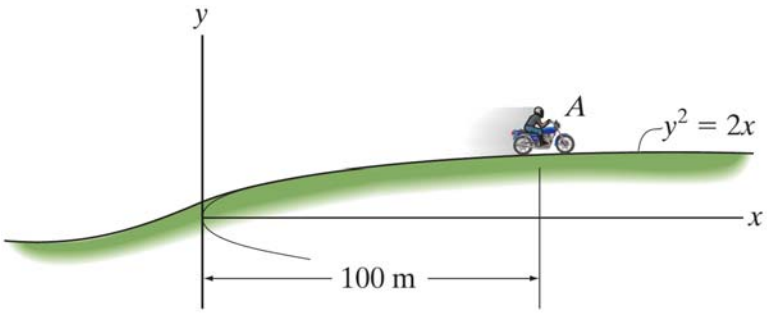

Figure 2(b)

Rajah 2(b)

(25 marks/*markah*)

(c) The balloon in Figure 2(c) has a total mass of 400 kg including the passengersand ballast. The balloon is rising at a constant velocity of 18 km/h when h = 10 m. If the man drops the 40kg sand bag, determine the velocity of the balloon when the bag strikes the ground. Neglect air resistance.

Belon udara dalam Rajah 2(c) mempunyai jisim 400 kg termasuk penumpang dan balast. Belon naik pada halaju yang tetap 18 km/j apabila h = 10 m. Jika lelaki itu menjatuhkan beg pasir 40kg, tentukan halaju belon apabila beg itu menyentuh tanah. Abaikan rintangan udara.

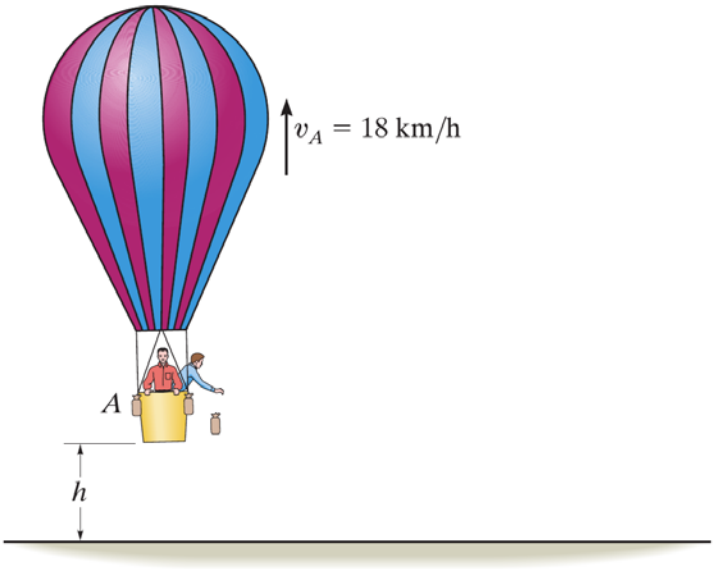

Figure 2(c)

Rajah 2(c)

(25 marks/*markah*)

(d) The crate *B* and cylinder *A* in Figure 2(d), have a mass of 200 kg and 75 kg, respectively. If the system is released from rest; state the assumption you would make and determine the speed of the crate and cylinder when t = 3 s.

Peti B dan silinder A dalam Rajah 2(d), mempunyai jisim masing-masing 200 kg dan 75 kg. Jika sistem ini dibebaskan dari keadaan pegun; nyatakan andaian anda akan buat dan tentukan kelajuan peti dan silinder pada t = 3 s.

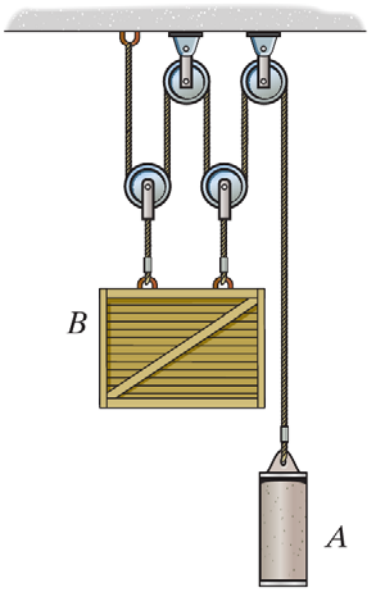

Figure 2(d)

Rajah 2(d)

(25 marks/*markah*)

3. (a) In analyzing the motion of a machine, it is often difficult to visualize the movement of the components in a full assembly drawing. The “stripped-down” sketches of mechanisms are often referred as kinematic diagrams.

Untuk menganalisa pergerakan sesebuah mesin, biasanya agak sukar untuk mendapat gambaran pergerakan untuk keseluruhan lukisan. Lakaran ringkas kepada pergerakan mekanisma biasanya merujuk kepada gambarajah kinematik.

(i) Name THREE elements used in the kinematic diagrams and briefly describe each element.

Namakan TIGA elemen yg digunakan dalam gambarajah kinematik dan terangkan secara ringkas setiap satu.

(10 marks/*markah*)

(ii) Name FOUR type of joints used in mechanism design.

Namakan EMPAT jenis penyambungan yang digunakan dalam rekabentuk mekanisma.

(10 marks/*markah*)

(b) Figure 3(a) and 3(b) show two types of mechanisms. Draw a kinematic diagram and determine the mobility for each mechanism.

Rajah 3(a) dan 3(b) merupakan dua sejenis mekanisma. Lukiskan gambarajah kinematik dan tentukan mobiliti untuk setiap mekanisma tersebut.

(30 marks/*markah*)

Figure 3(a) Bolt cutter.
Rajah 3(a)

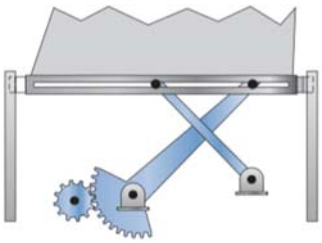

Figure 3(b) Automotive power window.
Rajah 3(b)

(c) Figure 3(c) shows a shearing mechanism. Analytically determine the linear displacement of the blade as the 0.75-in. crank is rotated from its current position 50° counterclockwise. Also determine the maximum stroke, imbalance angle β, time ratio Q and crank angular velocity ω_{crank} , if the cutting stroke takes 1.4s and return stroke takes 1s.

Rajah 3(c) menunjukkan satu mekanisma pemotong. Tentukan secara analitikal sasaran linear pisau pemotong apabila engkol 0.75-in. berpusing 50° melawan jam daripada keadaan asalnya. Tentukan juga jurang sasaran, sudut tidak seimbang, nisbah masa Q dan halaju angular engkol ω_{crank} , jika stroke memotong mengambil masa 1.2 s dan strok kembali mengambil masa 0.8 s.

(50 marks/*markah*)

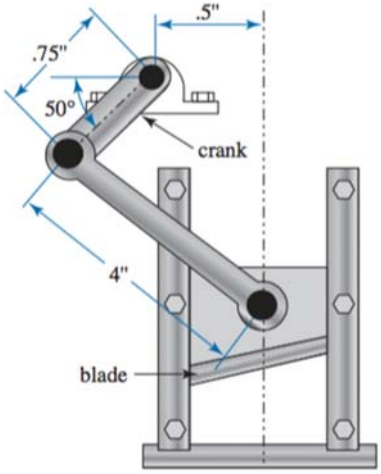

Figure 3(c)

Rajah 3(c)

4. (a) Figure 4(a) shows a cam with a flat-face follower. The cam follower must rise upward 1.0 in. With constant velocity in 3.0 s, dwell for 0.5 s, fall with constant velocity in 2.0 s and repeat the sequence. Determine the required speed of the cam and graphically plot a follower displacement. The cam has a base circle radius, R_b= 1 in. (1 in = 2.5 cm).

Rajah 4(a) menunjukkan gambarajah cam dengan roda pengikut. Roda pengikut perlu diangkat sebanyak 1.0 in. dengan halaju malar selama 3.0 s, berhenti selama 0.5 s, turun dengan halaju malar dalam 2.0 s dan pergerakan ini berulang. Tentukan laju cam tersebut dan lakarkan gambarajah sasaran roda pengikut. Cam tersebut mempunyai jejari bulatan asas, R_b =1 in. (1 in =2.5 cm).

(50 marks*/markah*)

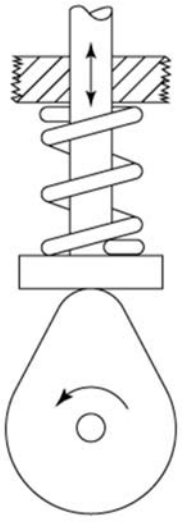

Figure 4(a)
Rajah 4(a)

(b) A gear train is shown in Figure 4(b). The gears have the following properties: N_2 = 20 teeth and P_d = 10; d_3 = 6 in. ; d_4 = 2 in., and P_d = 8; and N_5 = 48 teeth. Determine the velocity of gear 5 as gear 2 drives at 1600 rpm counterclockwise. Also determine the center distance between gears 3 and 5.

Sebuah sambungan gear ditunjukkan dalam Rajah 4(b). Gear tersebut mempunyaispesifikasi seperti berikut. N_2 = 20 gigi dan P_d = 10; d_3 = 6 in. ; d_4 =2 in., dan P_d = 8; dan N_5 = 48 gigi. Tentukan halaju gear 5 apabila gear 2 berputar pada 1600 ppm melawan jam. Tentukan juga jarak antara titik pusat gear 3 dan gear 5.

(25 marks*/markah*)

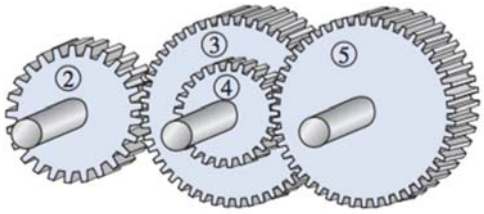

Figure 4(b)
Rajah 4(b)

(c) A gear train is shown in Figure 4(c). The gears have the following properties: N_1 = 12 teeth and P_d = 20; d_2 = 5.5 in.; and d_3 = 2.5in. and P_d = 8. Determine the required speed of gear 1 for the rack 4 to move at a rate of 40 in./min.

Sebuah sambungan gear ditunjukkan dalam Rajah 4(c). Gear tersebut mempunyai spesifikasi seperti berikut: N_1 = 12 teeth dan P_d =20; d_2 =5.5 in.; dan d_3 =2.5 in. dan P_d = 8. Tentukan halaju yang diperlukan oleh gear 1 supaya rak 4 bergerak pada kadar 40 in./min.

(25 marks*/markah)*

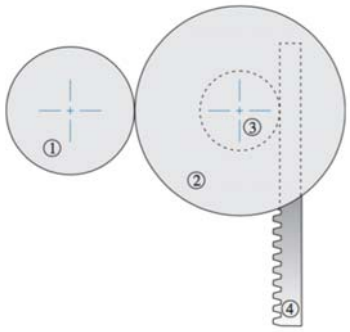

Figure 4(c)
Rajah 4(c)

oooOoooo