UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2011/2012 Academic Session

June 2012

EMM 102/3 – Statics
[Statik]

Duration : 3 hours
[Masa : 3 jam]

Please check that this paper contains **ELEVEN (11)** printed pages, **ONE (1)** page appendix and **SIX (6)** questions before you begin the examination.

*[Sila pastikan bahawa kertas soalan ini mengandungi **SEBELAS (11)** mukasurat bercetak, **SATU (1)** mukasurat lampiran dan **ENAM (6)** soalan sebelum anda memulakan peperiksaan.]*

Appendix/*Lampiran :*

1. Centroid and Second Moment of Area of Common Shapes [1 page/*mukasurat*]

INSTRUCTIONS : Answer **FIVE (5)** questions only. You may answer all questions in **English** OR **Bahasa Malaysia** OR a combination of both.

***[ARAHAN :** Jawab **LIMA (5)** soalan sahaja. Calon boleh menjawab semua soalan dalam **Bahasa Malaysia** ATAU **Bahasa Inggeris** ATAU kombinasi kedua-duanya.]*

Answer to each question must begin from a new page.
[Jawapan untuk setiap soalan mestilah dimulakan pada mukasurat yang baru.]

In the event of any discrepancies, the English version shall be used.
[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

Q1 [a] The cable AO exerts a force on the top of the pole of F = {-120i -90j -80k} N, as shown in Figure Q1[a]. If the cable has a length of 34 m, determine the height z of the pole and the location (x,y) of its base.

Kabel AO mengenakan daya F = {-120i -90j -80k} N di puncak tiang, seperti di dalam Rajah S1[a]. Sekiranya panjang kabel ialah 34 m, tentukan ketinggian z tiang tersebut dan lokasi (x,y) bagi tapaknya.

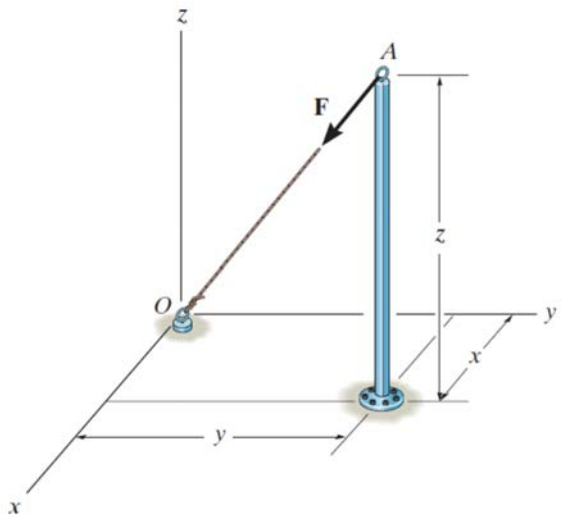

Figure Q1[a]
Rajah S1[a]

(30 marks/*markah***)**

[b] The magnetic tape under a tension of 13 N at D passes around the guide frictionless pulleys and through the erasing head at C at constant speed, as shown in Figure Q1[b]. Determine the tension T in the supporting spring at B. The plate lies in a horizontal plane and is mounted on a bearing at A.

Ketegangan pita magnet di D ialah 13 N dan seterusnya melalui beberapa takal tanpa geseran dan pemadam di C pada kelajuan malar, seperti di dalam Rajah S1[b]. Tentukan ketegangan T bagi pegas penyangga di B. Plat ini berada pada kedudukan mendatar dan diikat pada galas di A.

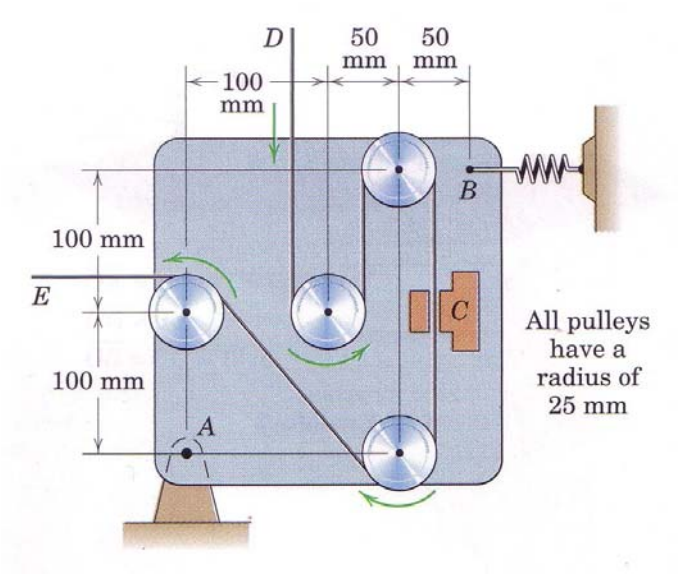

Figure Q1[b]
Rajah S1[b]

(30 marks/*markah***)**

[c] In order to turn over the frame, a couple moment is applied as shown in Figure Q1[c]. If the component of this couple moment along the x-axis is M_x = {-20i} Nm, determine the magnitude F of the couple forces.

Untuk membalikkan kerangka ini momen ganding dikenakan seperti di dalam Rajah S1[c]. Sekiranya komponen momen ganding sepanjang paksi-x ialah M_x = {-20i} Nm, tentukan magnitud daya ganding F.

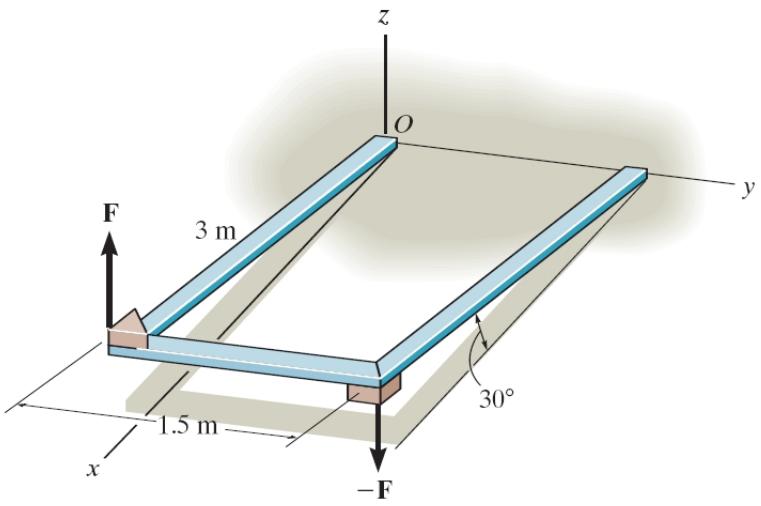

Figure Q1[c]
Rajah S1[c]

(40 marks/*markah***)**

Q2. [a] If the load at G has a weight of 200 kN, as shown in Figure Q2[a], determine the x, y and z components of the reaction at the ball-and-socket joint A and the tension in each of the cables.

Sekiranya berat beban di G ialah 200 kN, seperti di dalam Rajah S2[a], tentukan komponen tindakbalas x, y dan z di bebola-dan-soket A dan juga ketegangan setiap kabel.

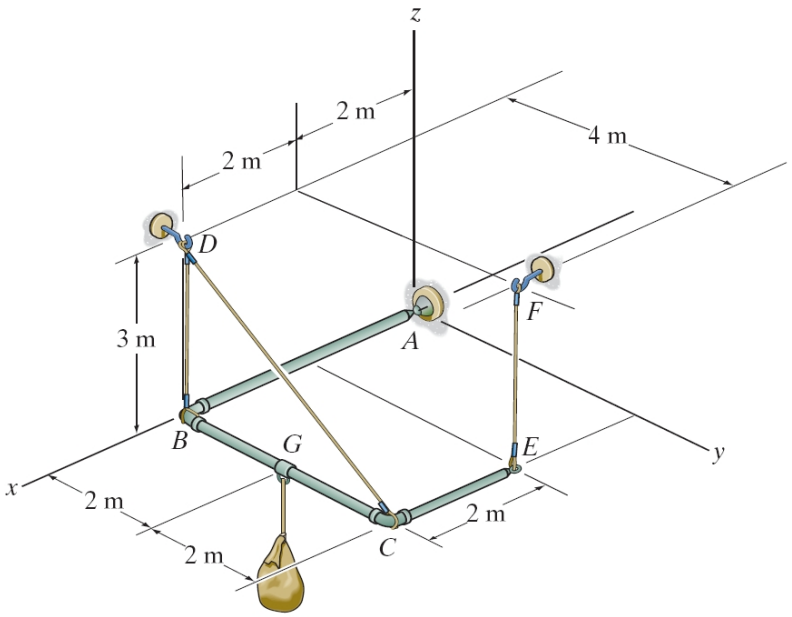

Figure Q2[a]
Rajah S2[a]

(50 marks/*markah*)

[b] Referring to Figure Q2[b], the coefficient of static friction between the drum and brake is μ_s = 0.4. If the moment M = 35 Nm, determine the smallest force P that needs to be applied to prevent the drum from rotating. Also determine the reaction at pin O. Neglect the weight and thickness of the brake bar. The drum has a mass of 25 kg.

Merujuk kepada Rajah S2[b], pekali geseran statik di antara dram dan brek ialah μ_s = 0.4. Sekiranya momen M = 35 Nm, tentukan nilai terkecil daya P yang perlu dikenakan bagi menghalang dram daripada berputar. Juga tentukan tindakbalas di O. Abaikan berat dan ketebalan bar brek. Jisim dram ialah 25 kg.

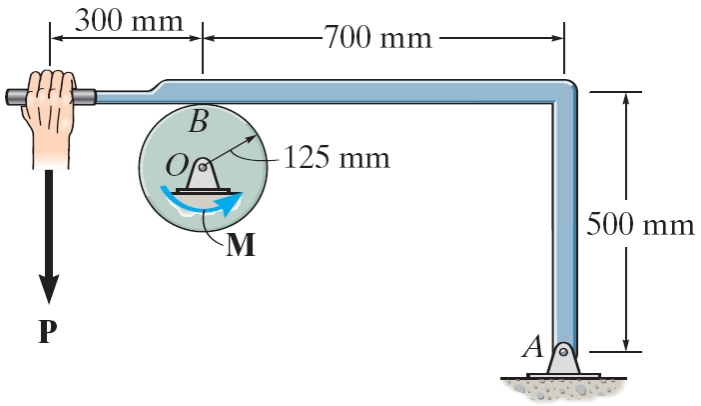

Figure Q2[b]
Rajah S2[b]

(50 marks/*markah*)

Q3. [a] Two cables are used to secure the overhang beam in position and support the 1500 N load at A, as shown in Figure Q3[a]. If the resultant force is directed along the beam from point A towards O, determine the magnitudes of the resultant force and the forces F_B and F_C. Set x = 3 m and z = 2 m.

Dua utas kabel digunakan untuk memastikan rasuk terjuntai berada pada posisi yang ditunjukkan dan menanggung beban sebanyak 1500 N di A, seperti di dalam Rajah S3[a]. Sekiranya arah daya paduan adalah pada sepanjang rasuk dari A ke O, tentukan magnitud daya paduan dan daya F_B dan F_C. Jadikan x = 3 m dan z = 2 m.

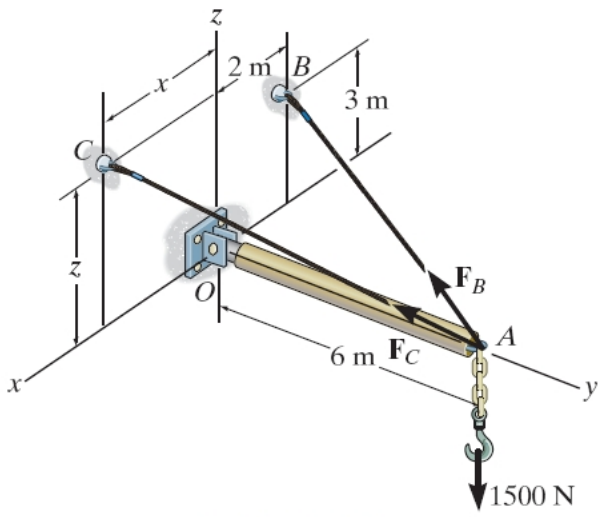

Figure Q3[a]
Rajah S3[a]

(50 marks/*markah*)

[b] Determine the force in members CD, DE and DF of the roof truss shown in Figure Q3[b]. Triangle CDF is an equilateral triangle, and joints E and G are at the midpoints of their respective sides.

Tentukan daya pada setiap anggota CD, DE dan DF bagi kekuda bumbung yang ditunjukkan di dalam Rajah S3[b]. Segitiga CDF ialah segitiga sisi sama, dan sambungan E dan G berada di titik tengah pada setiap bahagian sisi kekuda tersebut.

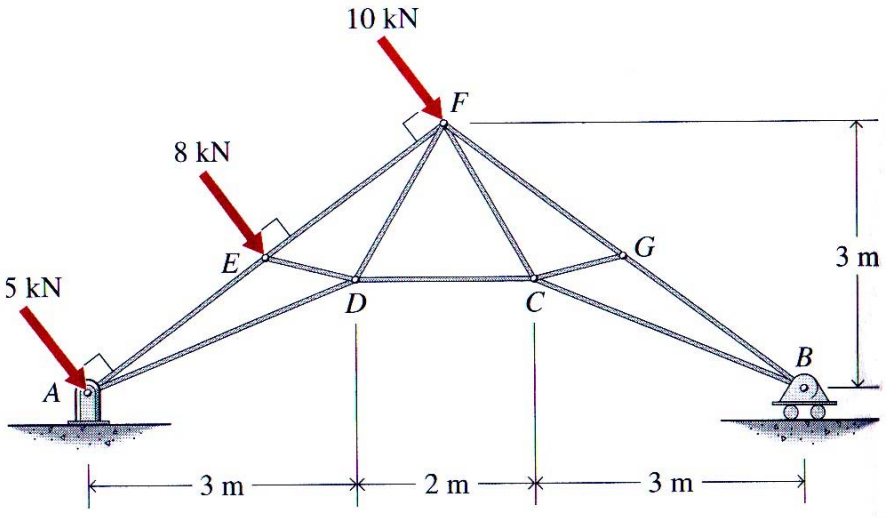

Figure Q3[b]
Rajah S3[b]

(50 marks/*markah***)**

Q4. [a] Figure Q4[a] shows a shaded area under a curve $y^2 = x^3$. By applying method of integration, determine

(i) the centroid $(\bar{x}, \bar{y})$ of the shaded area, and

(ii) the moment of inertia of the shaded area about the x axis.

Rajah S4[a] menunjukkan luas berlorek di bawah lengkung $y^2 = x^3$ dan dengan menggunakan kaedah pengkamiran, tentukan

(i) sentroid $(\bar{x}, \bar{y})$ bagi luas berlorek dan

(ii) momen inersia bagi luas berlorek di sekitar paksi x.

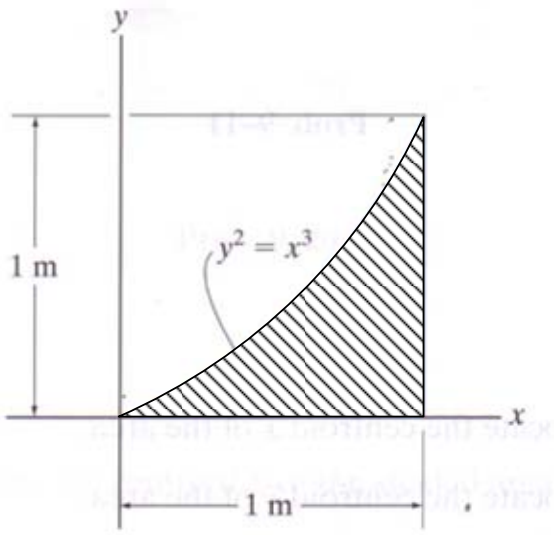

Figure Q4[a]
Rajah S4[a]

(40 marks/*markah*)

[b] By applying a composite area method on an area in Figure Q4[b], determine

(i) the centroid of the shaded area,

(ii) the moment of inertia of the shaded area about the centroidal x axis.

Dengan menggunakan kaedah luas komposit ke atas luas berlorek dalam Rajah S4[b], tentukan

(i) sentroid bagi luas berlorek dan

(ii) momen inersia luas berlorek di sekitar paksi x sentroid.

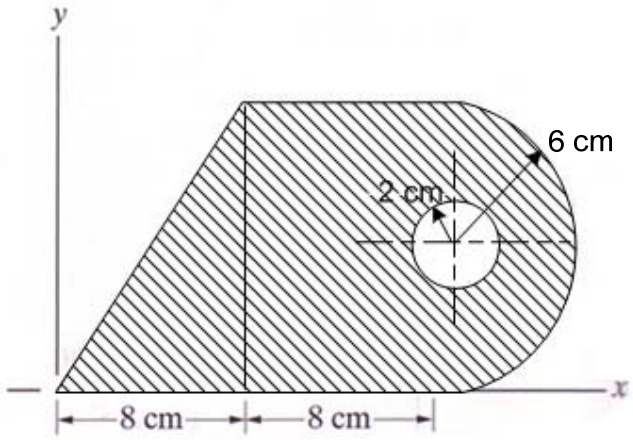

Figure Q4[b]
Rajah S4[b]

(60 marks/*markah*)

Q5. [a] Figure Q5[a] shows a collar bearing that supports a load P = 200 kN. Determine:

(i) the tensile stress in the shaft,

(ii) the shearing stress between the collar and the shaft, and

(iii) the bearing stress between the collar and the support.

Sketch all the respective areas involved in calculating the stresses.

Rajah S5[a] menunjukkan galas relang yang menyokong satu beban P = 200 kN. Tentukan:

(i) tegasan tegangan dalam syaf,

(ii) tegasan ricih antara relang dan syaf, dan

(iii) tegasan galas antara relang dan penyokong.

Lakarkan kesemua luas terbabit dalam pengiraan tegasan.

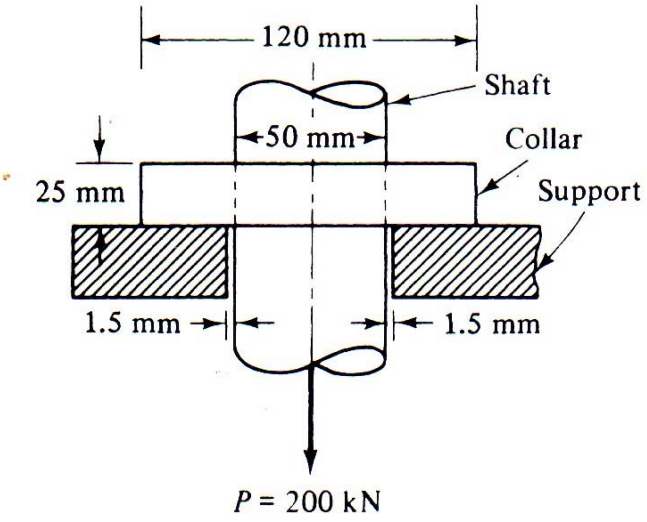

Figure Q5[a]
Rajah S5[a]

(40 marks/*markah*)

[b] A composite bar made of aluminium and steel is held between the supports as shown in Figure Q5[b]. The bars are stress free at a temperature of 37°C.,

(i) What will be the stress in the two bars when the temperature is 20°C if the supports are rigid?

(ii) What is the percentage difference in stress of each bar compared to the above case (i) if the supports move nearer to each other by 0.10 mm?

It can be assumed that the change of temperature is uniform all along the length of the bar. Take E_s = 210 GPa, E_a = 74 GPa, $\alpha_s = 11.7 \times 10^{-6}/^oC$, and $\alpha_a = 23.4 \times 10^{-6}/^oC$

Bar komposit diperbuat dari aluminium dan keluli lembut berada di antara dua penyokong seperti Rajah S5[b]. Bar dalam keadaan bebas tegasan pada suhu 37°C.

(i) Berapakah tegasan dalam kedua-dua bar pada suhu 20°C jika kedua-dua penyokong adalah tegar?

(ii) Berapakah peratus perbezaan dalam tegasan bagi setiap bar berbanding dengan kes (i) di atas jika kedua-dua penyokong bergerak menghampiri sebanyak 0.10 mm.

Diandaikan bahawa perubahan suhu adalah malar sepanjang bar. Ambil E_s = 210 GPa, E_a = 74 GPa, $\alpha_s = 11.7 \times 10^{-6}/^oC$, and $\alpha_a = 23.4 \times 10^{-6}/^oC$..

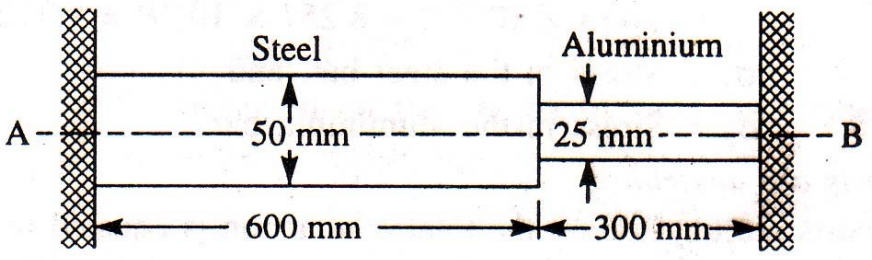

Figure Q5[b]
Rajah S5[b]

(60 marks/*markah*)

Q6. [a] Draw a typical stress-strain curve of a mild steel specimen which is subjected to a tensile load and based on the curve, briefly define:

(i) the modulus of elasticity of the material
(ii) the yield stress, ultimate stress and failure stress of the material.

Also explain the term percentage elongation and percentage reduction of the area of the specimen.

Lukis rajah tegasan-terikan tipikal untuk specimen keluli lembut yang ditindaki beban tegangan dan berdasarkan lengkung tegasan-terikan, jelaskan dengan ringkas

(i) modulus elastik bahan
(ii) tegasan alah, tegasan muktamad dan tegasan patah bahan

Terangkan juga peratus pemanjangan dan peratus pengurangan luas spesimen.

(30 marks/*markah***)**

[b] With the aid of sketches, briefly explain the term strain hardening, modulus of resilience and modulus of toughness.

Dengan berbantukan lakaran, jelaskan dengan ringkas terma pengerasan terikan, modulus kebingkasan dan modulus keliatan.

(20 marks/*markah***)**

[c] **Figure Q6[c] shows a truss member AB and AC subjected to a load W at A. When unloaded, bars AB and AC are each 1 m in length and have a cross-sectional area of 1290 mm^2. Their modulus of elasticity is 11 GPa. If a weight of 50 kN is suspended from the truss at A, what are the changes in length of the two bars?**

Rajah S6[c] menunjukkan anggota kekuda AB dan AC ditindaki beban W di A. Apabila tanpa bebanan, panjang bar AB dan AC ialah 1 m dan luas keratan rentas ialah 1290 mm^2. Modulus kekenyalan bar ialah 11 GPa. Jika berat yang digantung pada kekuda di A ialah 50 kN, berapakah perubahan panjang kedua-dua bar?

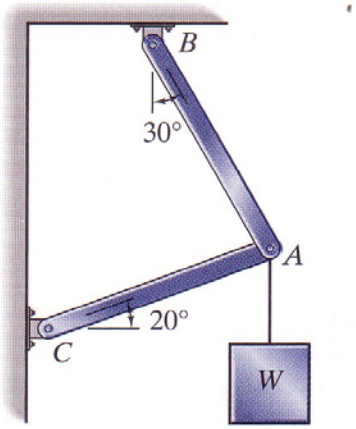

Figure Q6[c]
Rajah S6[c]

(50 marks/*markah*)

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