UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2016/2017

December 2016 / January 2017

EMM 213 – Strength of Materials
[Kekuatan Bahan]

Duration : 3 hours
Masa : 3 jam

Please check that this paper contains **EIGHT(8)** printed pages and **FIVE(5)** questions before you begin the examination.

*[Sila pastikan bahawa kertas soalan ini mengandungi **LAPAN(8)** mukasurat dan **LIMA(5)** soalan yang bercetak sebelum anda memulakan peperiksaan.]*

INSTRUCTIONS : Answer **ALL** questions.

*[**ARAHAN** : Jawab **SEMUA** soalan.]*

Answer Questions In English OR Bahasa Malaysia.
[Jawab soalan dalam Bahasa Inggeris ATAU Bahasa Malaysia.]

Answer to each question must begin from a new page.
[Jawapan bagi 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] **A 22 mm-diameter bolt, having a diameter at the root of the threads of 18 mm, is used to fasten two timbers together as shown in Figure Q1[a]. The nut is tightened to cause a tensile stress of 125 MPa in the bolt.**

Bolt berdiameter 22 mm mempunyai benang dengan diameter punca 18 mm digunakan untuk mengikat dua lapis kayu seperti Rajah S1[a]. Nat bolt diketatkan dan menghasilkan tegasan tegangan sebanyak 125 MPa.

(i) **Find the tensile force on the bolt**
Dapatkan daya tegangan dalam bolt.

(ii) **Calculate the shearing stress in the head of the bolt and in the threads.**
Kirakan tegasan ricih di kepala bolt dan juga di benang.

(iii) **Determine the outside diameter of the washers if their inside diameter is 28 mm and the bearing stress is limited to 5.5 MPa.**
Tentukan diameter luar sesendal jika diameter dalamnya 28 mm dan tegasan galas dihadkan pada 5.5 MPa.

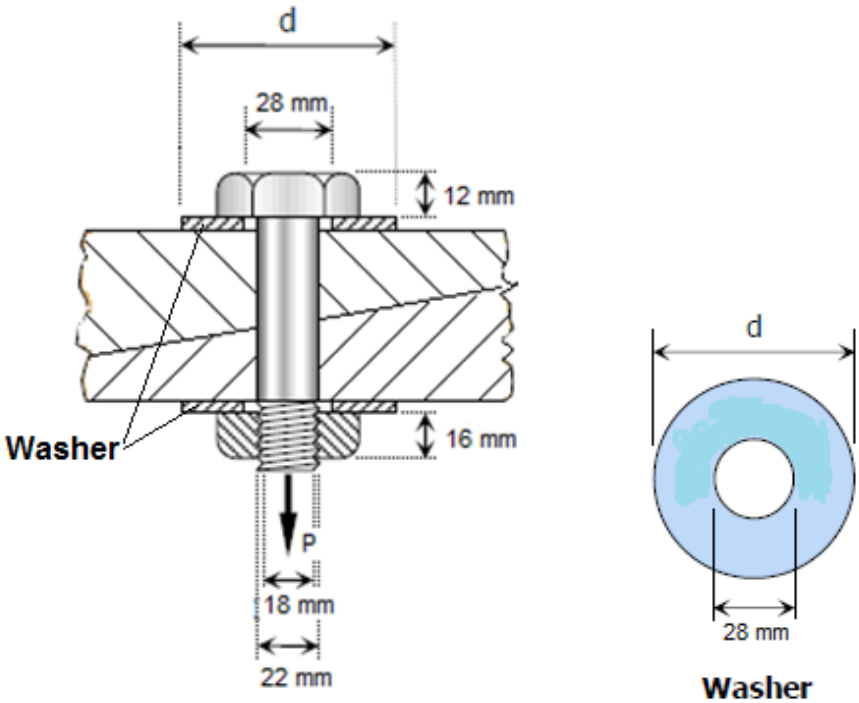

Figure Q1[a]
Rajah S1[a]

(40 marks/*markah*)

[b] **Figure Q1[b] shows a rigid slab that is supported by two copper bars and an aluminium bar. There is a gap of Δ =0.18 mm between the aluminium bar and the rigid slab at T = 10°C. For each copper bar, A = 500 mm^2, E = 120 GPa and α = 16.8 μm/(m.°C) whereas for the aluminum bar, A = 400 mm^2, E = 70 GPa and α = 23.1 μm/(m.°C). Neglecting the mass of the slab, calculate the stress in each rod when the temperature in the assembly is increased to 95°C.**

Rajah S1[b] menunjuk papak tegar yang disokong oleh dua palang kuprum dan satu palang aluminium. Terdapat sela Δ =0.18 mm antara palang aluminium dan papak tegar pada suhu T = 10°C. Untuk palang kuprum, A = 500 mm^2, E = 120 GPa dan α = 16.8 μm/(m.°C) manakala untuk aluminium, A = 400 mm^2, E = 70 GPa dan α = 23.1 μm/(m.°C). Dengan mengabaikan jisim papak, kirakan tegasan dalam setiap palang apabila suhu dalam pemasangan bertambah kepada 95°C.

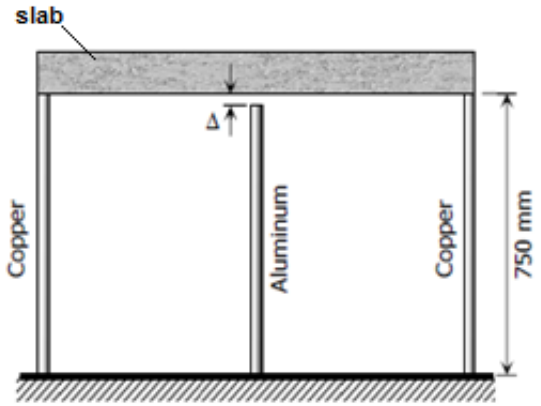

Figure Q1[b]
Rajah S1[b]

(60 marks/*markah*)

Q2. **[a]** **The A-36 steel shaft is supported on smooth bearings that allow it to rotate freely. The shaft carries four gears and are subjected to the torques shown in Figure Q2[a].**

Syaf keluli A-36 disokong oleh galas licin yang mengizinkan syaf berputar bebas. Syaf membawa empat giar dan dikenakan momen seperti Rajah S2[a].

(i) **Draw a free body diagram showing the internal torque developed in segments AB, BC and CD and also the torque diagram of the shaft.**
Lakarkan rajah jasad bebas menunjukkan momen dalaman terjana dalam segmen AB, BC dan CD dan juga rajah momen bagi syaf.

(ii) **Determine the required diameter of the shaft if τ_{all} = 60 MPa.**
Tentukan diameter syaf yang diperlukan jika τ_{all} = 60 MPa.

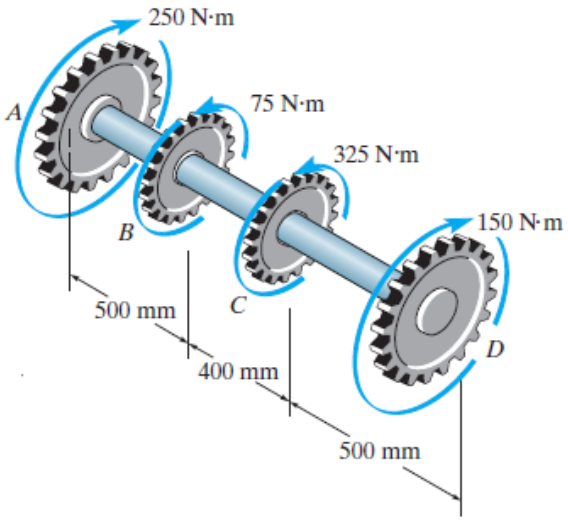

Figure Q2[a]
Rajah S2[a]

(30 marks/*markah*)

[b] **A beam is simply supported at A and D and subjected to uniformly distributed load between B and C as in Figure Q2[b].**

Sebuah rasuk disokong mudah di A dan D dan dikenakan beban teragih seragam antara B dan C seperti Rajah S2[b].

(i) **Find the support reactions for the beam.**
Dapatkan tindakbalas penyokong bagi rasuk.

(ii) **Draw the shear and moment diagrams of the beam and indicate the values at the point of discontinuity and the maximum point.**
Lakarkan rajah ricih dan rajah momen untuk rasuk dan tandakan nilai pada titik tak selanjar dan pada titik maksimum.

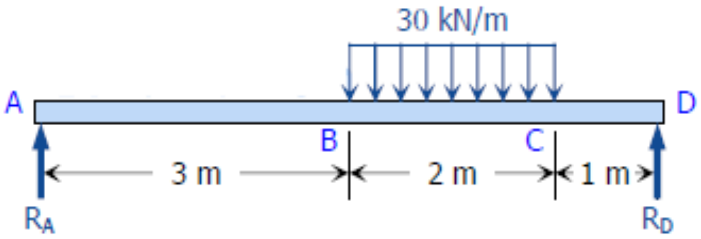

Figure Q2[b]
Rajah S2[b]

(70 marks/*markah*)

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Q3. [a] **If the wide-flange beam as shown in Figure Q3 is subjected to a shear of V = 20 kN, determine**
Jika rasuk bebibir lebar seperti dalam Rajah S3 dikenakan ricihan V = 20 kN, tentukan

(i) **the shear stress on the web at A and indicate the shear-stress components on a volume element located at this point.**
tegasan ricih pada web di A dan tunjukkan komponen tegasan-terikan pada elemen padu di titik tersebut,

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

(ii) **the maximum shear stress,**
tegasan ricih maksimum,

(**10 marks**/*markah*)

(iii) **the shear force resisted by the web of the beam.**
daya ricih yang dikekang oleh web rasuk tersebut.

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

[b] **Several composite parts can be used in order to achieve a greater resistance to loads. Suggest how to assemble the built-up beam for the wide-flange beam in the Figure Q3 and show the difference of the shear strength between both beams.**

Beberapa bahagian komposit boleh digunakan untuk menghasilkan rintangan yang lebih besar terhadap beban. Cadangkan bagaimana pemasangan rasuk terbina bagi rasuk bebibir lebar dalam Rajah S3 dan tunjukkan perbezaan kekuatan ricihan antara rasuk-rasuk tersebut.

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

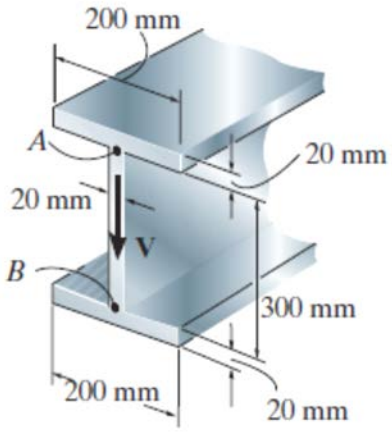

Figure Q3
Rajah S3

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Q4. [a] **The steel water pipe has an inner diameter of 300 mm and wall thickness 6 mm as shown in Figure Q4[a]. If the valve A is opened and the flowing water is under a gauge pressure of 2 MPa, determine the longitudinal and hoop stress developed in the wall of the pipe.**

Dalam Rajah S4[a], paip air keluli berdiameter dalam 300 mm dengan ketebalan dinding 6 mm. Jika injap A dibuka dan air mengalir dibawah tekanan tolok 2 MPa, tentukan tegasan membujur dan tegasan gelang yang terhasil pada dinding paip.

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

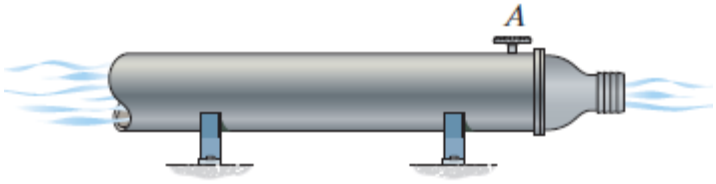

Figure Q4[a]
Rajah S4[a]

[b] **Determine the smallest distance d to the edge of the plate in Figure Q4(b) at which the force P can be applied so that it produces no compressive stresses in the plate at section a-a. The plate has a thickness of 20 mm and P acts along the centerline of this thickness.**

Tentukan nilai terkecil jarak d antara pinggir plat dalam Rajah S4(b)dengan daya P, dimana tiada tegasan mampat pada keratan rentas a-a. Plat berketebalan 20 mm dan P bertindak sepanjang garis tengah ketebalan tersebut.

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

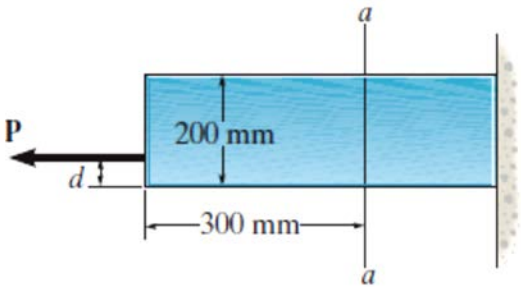

Figure Q4[b]
Rajah S4[b]

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[c] **The tubular shaft of the soil auger is subjected to the axial force and torque as shown in Figure Q4[c]. If the auger is rotating at a constant rate, determine the state of stress at points A and B on the cross section of the shaft at section a-a.**

Aci tiub pada gerimit tanah dikenakan daya paksi dan tork seperti ditunjukkan dalam Rajah S4[c]. Jika gerimit berputar pada kadar tetap, tentukan keadaan tegasan pada titik A dan B pada keratan rentas aci di a-a.

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

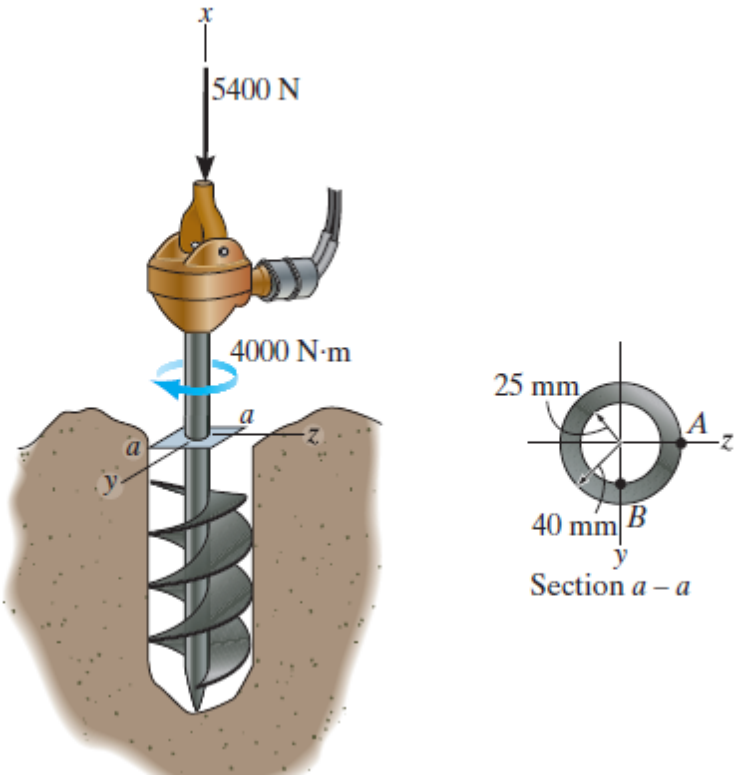

Figure Q4[c]
Rajah S4[c]

Q5. As shown in Figure Q5, determine the equivalent state of stress on an element at the same point which represents (a) the principal stress and (b) the maximum in-plane shear stress and the associated average normal stress. Also, for each case, determine the corresponding orientation of the element with respect to the element shown. Sketch the results on each element.

Seperti ditunjukkan dalam Rajah S5, tentukan tegasan setara bagi elemen pada titik yang sama yang menunjukkan [a] tegasan utama,[b] tegasan ricih maksimum dalam satah dan tegasan normal purata yang berkaitan. Juga, bagi setiap kes, tentukan orientasi elemen berkaitan. Lakarkan keputusan pada setiap elemen.

(**100 marks**/*markah*)

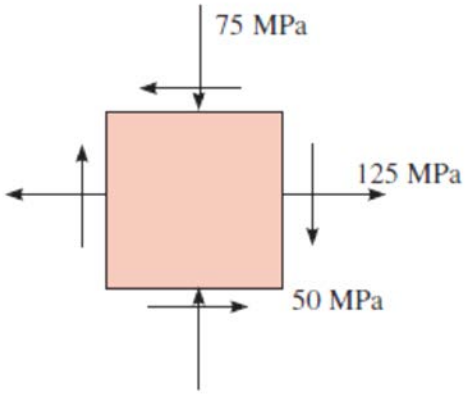

Figure Q5
Rajah S5

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