UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2009/2010

SUBJECT NAME	:	MECHANICS OF MATERIALS
SUBJECT CODE	:	BFC 2083
COURSE	:	2 BFF
EXAMINATION DATE	:	NOVEMBER 2009
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS PAPER CONSIST OF TWELVE (12) PAGES

Q1 (a) Give the definition of the following:

(i) Poisson ratio, υ
(ii) Thermal stress, σ_T
(iii) Allowable stress, σ_{allow}
(iv) Factor of safety, F.S

(4 marks)

(b) The 15 mm diameter shaft AC is supported by a rigid collar, which is fixed to the shaft at B as shown in Figure **Q1(a)**. If it is subjected to an axial load of 80 kN at its end with elastic modulus of 200 GPa,

(i) determine the uniform pressure distribution, *p* on the collar required for equilibrium

(4 marks)

(ii) calculate the elongation on segment BC and segment BA

(4 marks)

(c) The state of plane stress at point is shown on the element in Figure **Q1(b)**. If element oriented 30^0 counterclockwise from its origional position, by using Mohr's circle, determine,

(i) principal stresses, $\sigma_{max,\ min}$
(ii) maximum shearing stress, τ_{max}
(iii) transformation stresses, $\sigma_{x'}$, $\sigma_{y'}$ and $\tau_{x'y'}$

(13 marks)

Q2 (a) A bending test was performed on an aluminium specimen as shown in Figure **Q2(a)**.

(i) Prove the bending stress of aluminium rectangular cross section is

$$\sigma_{rectangular} = \left(\frac{3PL}{2bd^2}\right)$$

(7 marks)

(ii) Another test is to be performed on a specimen of this same material, but with circular cross section of radius, R = 5.0 mm. Calculate the maximum loading which can be applied on this circular cross section if,

- Rectangular cross section

Width, b	=	15 mm
Height, d	=	15 mm
Length, L	=	2 meter
Maximum loading, P	=	3000 N

- Cicular cross section
  Length, L = 2 meter
  Bending stress,

$$\sigma_{circular} = \left(\frac{PL}{\pi R^3}\right)$$

(7 marks)

(b) A rectangular cross section shown in Figure **Q2(b)** is subjected to maximum shear, V_{max} of 35 kN.

(i) Calculate the maximum shearing stress, τ_{max} and sketch the shearing stress distribution. State the answer in unit N/mm^2.

(8 marks)

(ii) If additional width, b is applied, what can be predicted from shearing stress value?

(3 marks)

Q3 (a) Determine the deflection boundary conditions for the beams shown in Figure **Q3(a)**.

(6 marks)

(b) Figure **Q3(b)** shows a simply supported beam loaded with point loads of 30 kN and 60 kN at point C and F while uniform distributed load, *w* (kN/m) at point D to E. To ensure the beam is safe in serviceability, the maximum deflection at mid span is limited to 12.5 mm. If the beam is made from steel with modulus of elasticity, E = 200 kN/mm^2 and moment of inertia, I = 256 x 10^6 mm^4.

(i) Determine the uniform distributed load, *w* (kN/m) that can be carried by the beam.

(12 marks)

(ii) Determine the slope at point B.

(4 marks)

(c) In structural design, the deflection of a beam is limited to a certain values. In your opinion what is the effect to the beam if the deflection exceed the allowable value?

(3 marks)

Q4 (a) Give the definition with appropriate sketches (if applicable) for the following:

(i) Critical load, P_{cr}
(ii) Critical stress, σ_{cr}
(iii) Short column
(iv) Slender column

(8 marks)

(b) List **four (4)** assumptions of Euler theory for slender column with pin jointed at both ends.

(4 marks)

(c) Calculate the slenderness ratio of a compression member, L/r made from a hollow tube with 20 mm outside diameter and 16 mm inner diameter. Given, the length of compression member is 1.2 meter and

$$I = \left(\frac{\pi D^4}{64}\right)$$

(6 marks)

(d) A compression member is made of 16 mm diameter steel bar. The buckling load is 2400 N and the elastic limit in compression is 320 MPa. Calculate the deflection, y just prior to collapse. Given

$$\sigma_{cr} = \left(\frac{P}{A}\right) + \left(\frac{PyR}{I}\right)$$

where R is the radius of steel bar.

(7 marks)

Q5 Referring to Figure **Q5**, answer the following:

(a) A structure is loaded by a concentrated load P at A and caused small deflection, δ at the same point. If a = L/4, prove the corresponding maximum shearing stress in rod BC is equal to:

$$\tau_{max} = \left(\frac{2Gd}{L^2}\right)\delta$$

where d is the diameter of the rod and G its modulus of rigidity.

(9 marks)

(b) Knowing that the vertical load P = 25 kN, d = 60 mm, a = 250 mm, L = 1000 mm, and modulus of rigidity is 77 GPa, determine the value of:

(i) displacement, δ at A

(6 marks)

(ii) maximum shearing stress, τ_{max} of rod BC

(3 marks)

(iii) How much torque, T can be applied if member BC is square cross section made from the same amount of material and length? Given

$$\tau_{max} = \left(\frac{4.81T}{b^3}\right)$$

with b = 70 mm. Give your comment based on torque, T of both cross sections.

(7 marks)

Q6 (a) In your opinion, what is meant by a truss and give an example for a simple perfect truss?

(3 marks)

(b) Give **two (2)** assumption made in statically determinate plane truss analysis.

(3 marks)

(c) A plane truss is loaded with external loads as shown in Figure **Q6**.

(i) Prove that the plane truss is statically determinate plane truss.

(2 marks)

(ii) Calculate the internal forces for truss member BC, BH, GH and EJ using the cut-section method.

(14 marks)

(d) Material used to built this truss structure is change to other type of material but still having the same applied load and length. Do you think the existing internal forces will also change? Give your reason.

(3 marks)

S1 (a) Berikan maksud bagi perkara berikut:

(i) Nisbah Poisson, υ
(ii) Tegasan suhu, σ_T
(iii) Tegasan izin, σ_{izin}
(iv) Faktor keselamatan, F.S

(4 markah)

(b) Aci AC berdiameter 15 milimeter di sokong oleh satu alang tegar, yang diikat tegar di aci Bseperti dalam Rajah **Q1(a)**. Jika beban paksi sebanyak 80 kN dikenakan pada hujungnya dengan modulus keanjalan 200 GPa,

(i) Tentukan agihan tekanan seragam, *p* ke atas alang bagi memenuhi keperluan keseimbangan.

(4 markah)

(ii) Kirakan perubahan panjang segmen BC dan segmen BA

(4 markah)

(c) Rajah **Q1(b)** menunjukkan satu satah tegasan pada satu titik. Sekiranya elemen ini berputar 30^0 lawan arah jam dari kedudukan asal yang ditunjukkan dengan menggunakan bulatan Mohr's, tentukan

(i) tegasan prinsipal, $\sigma_{maks,\ min}$
(ii) tegasan ricih maksimum, τ_{maks}
(iii) tegasan tranformasi $\sigma_{x'}$, $\sigma_{y'}$ dan $\tau_{x'y'}$

(13 markah)

S2 (a) Ujian lenturan dijalankan ke atas spesimen aluminium seperti yang ditunjukkan di Rajah **Q2(a)**.

(i) Buktikan tegasan lentur adalah bagi keratan rentas segiempat tepat ialah;

$$\sigma_{segiempatepat} = \left(\frac{3PL}{2bd^2}\right)$$

(7 markah)

(iii) Satu ujian lain dijalankan ke atas jenis spesimen yang sama tetapi mempunyai keratan rentas berbentuk bulat dengan jejari, R = 5.0 mm. Kirakan beban maksimum yang boleh dikenakan ke atas keratan rentas bulat ini sekiranya,

- Keratan rentas segiempat sama

Lebar, b	=	15 mm
Tinggi, d	=	15 mm
Panjang, L	=	2 meter
Beban maksimum, P	=	3000 N

- Keratan rentas bulat
  Panjang, L = 2 meter
  Tegasan lentur,

$$\sigma_{bulat} = \left(\frac{PL}{\pi R^3}\right)$$

(7markah)

(c) Rajah **Q2(b)** menunjukkan satu keratan rentas berbentuk segiempat sama yang dikenakan daya ricih maksimum, V_{maks} = 35 kN.

(i) Kira tegasan ricih maksimum keratan dan lakarkan taburan tegasan ricih keratan. Nyatakan jawapan anda dalam N/mm^2.

(8 markah)

(ii) Jika lebar b ditambah, apakah yang dapat dijangkakan dari nilai tegasan ricih ini?

(3 markah)

S3 (a) Tentukan keadaan sempadan pesongan bagi rasuk-rasuk yang ditunjukkan pada Rajah **Q3**(a).

(6 markah)

(b) Rajah **Q3(b)** menunjukkan rasuk sokong mudah yang dibebani dengan beban tumpu, 30 kN dan 60 kN pada titik C dan F manakala beban teragih seragam, *w* (kN/m) pada titik D hingga E. Bagi memastikan rasuk selamat di dalam kebolehkhidmatan, pesongan maksimum di pertengahan rentang telah dihadkan kepada 12.5 mm. Sekiranya rasuk diperbuat daripada keluli dengan nilai modulus keanjalan, E = 200 kN/mm^2 dan momen sifat tekun, I = 256 x 10^6 mm^4.

(i) Tentukan nilai beban teragih seragam, *w* (kN/m) yang boleh ditanggung oleh rasuk.

(12 markah)

(ii) Tentukan cerun pada titik B.

(4 markah)

(c) Di dalam rekabentuk struktur, pesongan rasuk telah dihadkan kepada nilai-nilai tertentu. Pada pendapat anda apakah kesan terhadap rasuk sekiranya nilai pesongan melebihi had yang dibenarkan?

(3 markah)

S4 (a) Berikan definisi beserta gambarajah (sekiranya berkaitan) penyataan berikut:

(i) Beban kritikal, $P_{kritikal}$
(ii) Tegasan kritikal, $\sigma_{kritikal}$
(iii) Tiang pendek
(iv) Tiang langsing

(8 markah)

(b) Senaraikan **empat** (4) anggapan teori Euler bagi tiang langsing di mana kedua-dua hujungnya diikat pin.

(4 markah)

(c) Kira nisbah kelangsingan, L/r untuk anggota mampatan yang diperbuat daripada tiub berongga dengan diameter luar 20 mm dan berdiameter dalam 16 mm. Diberi panjang anggota mampatan ialah 1.2 meter dan

$$I = \left(\frac{\pi D^4}{64}\right)$$

(6 markah)

(d) Satu anggota mampatan diperbuat daripada bar keluli berdiameter 16 mm. Beban lengkokan ialah 2400 N dan had elastik mampatan ialah 320 MPa. Kirakan pesongan,y anggota mampatan sejurus ia gagal. Diberi

$$\sigma_{cr} = \left(\frac{P}{A}\right) + \left(\frac{PyR}{I}\right)$$

di mana R ialah jejari bar keluli.

(7 markah)

S5 Soalan di bawah merujuk kepada Rajah **Q5**.

(a) Satu struktur ditindaki dengan beban tumpu P di A dan mengakibatkan pesongan kecil, δ pada titik yang sama. Jika a = L/4, buktikan tegasan ricih maksimum rod BC bersamaan dengan,

$$\tau_{max} = \left(\frac{2Gd}{L^2}\right)\delta$$

di mana d adalah diameter rod dan G ialah modulus ketegaran

(9 markah)

(b) Diketahui bahawa beban pugak P = 25 kN, d = 60 mm, a = 250 mm, L = 1000 mm, dan modulus ketegaran = 77 GPa, tentukan nilai:

(i) pesongan δ di A,

(6 markah)

(ii) tegasan ricih maximum τ_{max} untuk rod BC

(3 markah)

(iii) Berapakah nilai beban puntiran, T yang boleh dikenakan jika anggota BC berbentuk segiempat sama dan diperbuat dari bahan serta panjang yang sama?

Diberi

$$\tau_{\max} = \left(\frac{4.81T}{b^3}\right)$$

dengan b = 70 mm. Berikan komen anda berdasarkan nilai beban puntiran, T bagi kedua-dua bentuk keratan.

(7 markah)

S6 (a) Pada pandangan anda, apa yang dimaksudkan dengan kekuda dan berikan contoh kekuda sempurna yang mudah.

(3 markah)

(i) Berikan **dua (2)** anggapan dalam menganalisa kekuda satah boleh tentu statik

(3 markah)

(ii) Sebuah kekuda satah yang ditindaki daya-daya luaran seperti yang ditunjukkan dalam Rajah **Q6**.

(iii) Buktikan kekuda berkenaan adalah kekuda boleh tentu statik.

(2 markah)

(iv) Kira daya dalaman bagi anggota BC, BH, GH dan EJ menggunakan kaedah keratan.

(14 markah)

(v) Sekiranya bahan untuk membina struktur kekuda ini ditukar ke satu jenis bahan yang lain tetapi masih mempunyai panjang serta beban yang sama, adakah nilai daya-daya dalam anggota akan turut berubah? Berikan alasan anda.

(3 markah)

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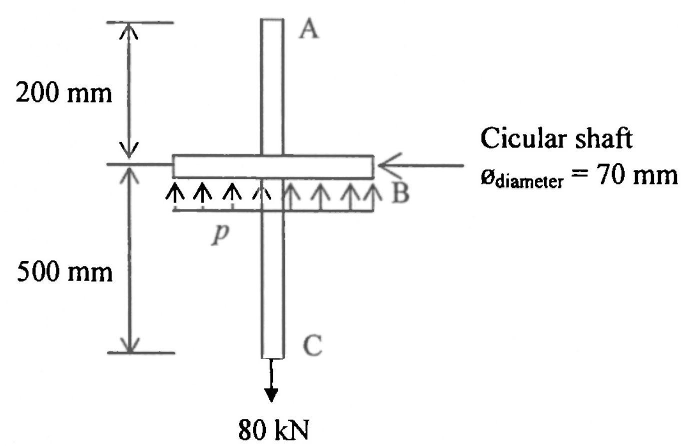

FIGURE Q1(a)

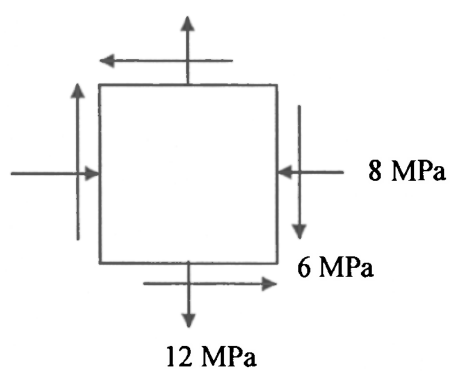

FIGURE Q1(b)

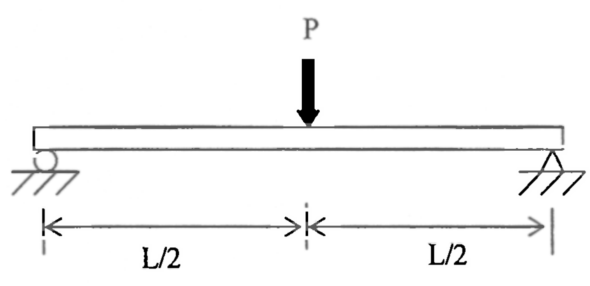

FIGURE Q2(a)

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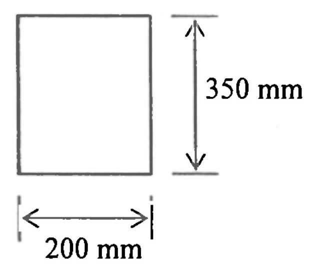

FIGURE Q2(b)

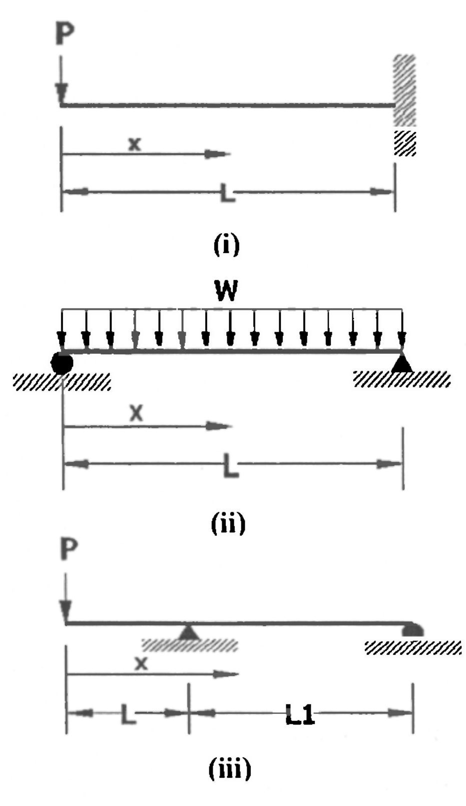

FIGURE Q3(a)

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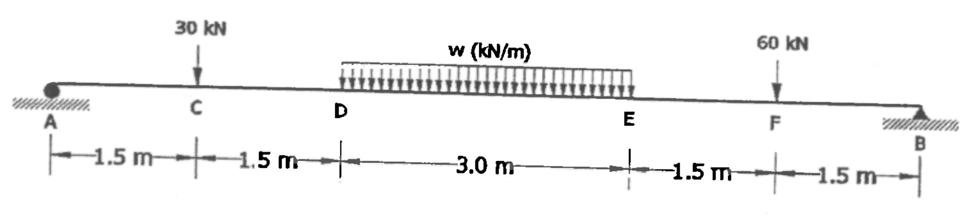

FIGURE Q3(b)

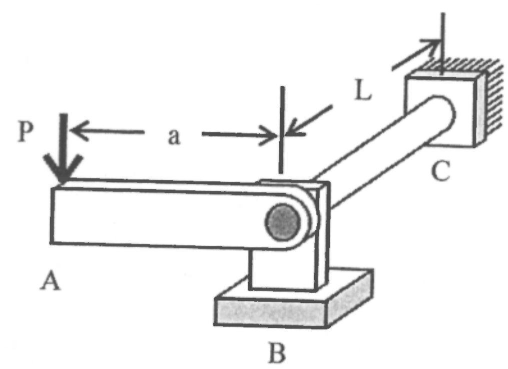

FIGURE Q5

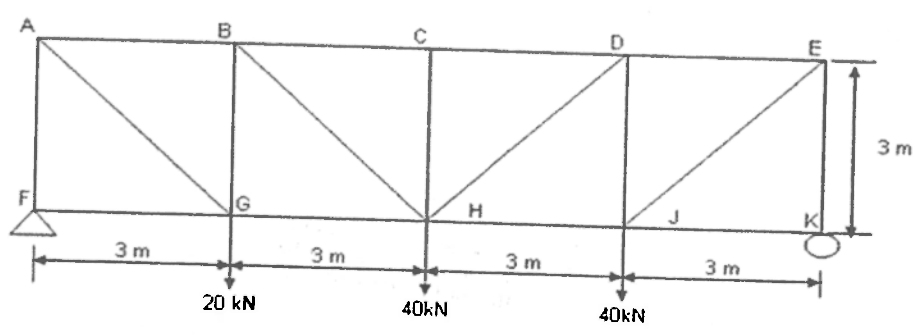

FIGURE Q6