UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	MECHANICS OF MATERIAL
COURSE CODE	:	BFC 20903/BFC 2083
PROGRAMME	:	2 BFF
EXAMINATION DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **TWELVE (12)** PAGES

Q1 (a) Figure **Q1(a)** shows the stress-strain relationship diagram for a steel bar. What are the differences between elastic, plastic and strain hardening region.

(6 marks)

(b) An axial load P = 1000 kN is applied to the rigid steel bearing plate on the top of the short column shown in Figure **Q1(b)**. The outside segment of the column is made of structural steel with an allowable stress of 175 MPa and a modulus of elasticity of 200 GPa. The inside core is made of concrete with an allowable stress of 20 MPa and a modulus of elasticity of 16 GPa. If the area of the concrete is to be 10 times the area of the steel, determine the required dimensions if both segments are square.

(10 marks)

(c) Normal and shearing stresses on horizontal; and vertical planes through a point in a structural member subjected to plane stress are shown in Figure **Q1(c)**. Determine:

(i) the principal stresses and element orientation

(4 marks)

(ii) the maximum in plane shear stress and average normal stress on the element as well as element orientation

(5 marks)

Q2 A steel beam with standard size of 254 x 102 x 28 kg/m UB with the cross-section area shown in Figure **Q2(a)** is subjected to the uniform distributed load of 30 kN/m and concentrate load of 15 kN at C as in Figure **Q2(b)**. From British Standard moment of Inertia are given as $I_x = 4008\ cm^4$.

(a) Draw the shear force diagram (SFD) and bending moment diagram (BMD) for the beam.

(5 marks)

(b) Determine the absolute maximum bending stress

(5 marks)

(c) Sketch the shear distribution along the cross-section of the beam.

(10 marks)

(d) If the steel beam is changed to a rectangular cross-section wood beam, determine the suitable width, b and height, h of the beam that will support the same load. Assume $h = 2b$ and $\sigma_{allow} = 58$ MPa.

(5 marks)

Q3 (a) By using a sketch, give definition of slope and deflection in beams. In your opinion, explain **Two (2) reasons** why deflection is important to calculate in analysis structure.

(7 marks)

(b) Consider a simply supported beam AB of length L, and carrying a point load P at mid span as shown in Figure **Q3**.

(i) Calculate the vertical reactions of the beam

(2 marks)

(ii) Sketch the bending moment diagram of the beam

(4 marks)

(iii) Prove the maximum slope at point A, $\theta_A = PL^2/16EI$ by using Moment Area Method.

(6 marks)

(iv) Continue your calculations using the same method as in Q3(iii), for the maximum deflection of the beam by proving, $\delta_{max} = PL^3/48EI$.

(6 marks)

Q4 (a) Sketch the support condition and buckle shape of the columns including the effective length (L_e) for the given condition.

(i) Pinned-pinned
(ii) Fixed-free
(iii) Fixed-fixed
(iv) Fixed-pinned

(8 marks)

(b) A structural steel column in the form of a tube thickness 30mm and external diameter 250mm. The length of the column is 3.2m. It's one end is fixed and other end is free. Take E=200 Gpa.

(i) Find the maximum axial load to be applied to the column.

(7 marks)

(ii) If the similar cross section is used and the columns is pinned both ends subjected to axial load , calculate the minimum length of the column using Euler's formula. The limit of proportionality is 300 N/mm^2.

(10 marks)

Q5 Two circular steel shafts (G=83Gpa) of diameter 50mm are securely connected to an aluminum shaft (G=28Gpa) of diameter 35mm as shown in Figure **Q5**. If the torsional shear strain varies linearly across a homogeneous cross section of AB and CD, and the shear strain variation is independent of material behaviour across the cross section of BC:

(a) Describe **Two (2)** characteristics of torsional loading on the homogenous shaft AB.

(5 marks)

(b) Determine the rotation of section D with respect to the wall

(10 marks)

(c) Determine the maximum shear stress in the shaft.

(10 marks)

Q6 (a) List **Two (2)** assumptions of analysis to determine the member's force of the truss.

(2 marks)

(b) The determinate structure mechanics imposed with unknown forces on the structures. Identify the equations for determination of its equilibrium.

(3 marks)

(c) In Figure **Q6**, a statically determinate plane truss is pinned at A and supported by roller at B.

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

(2 marks)

(ii) Determine the support reaction at A and B.

(5 marks)

(iii) Determine all member forces by using Method of Joints. State whether the member are in tension or compression.

(13 marks)

S1 (a) Rajah **Q1(a)** menunjukkan hubungan tegasan-terikan untuk bar keluli. Apakah perbezaan di antara keanjalan, plastik dan pengerasan terikan.

(6 markah)

(b) Beban paksi P = 1000 kN telah dikenakan terhadap bearing plat keluli pada bahagian permukaan atas tiang pendek seperti yang ditunjukkan dalam Rajah **Q1(b).** Segmen luar tiang tersebut telah diperbuat daripada struktur keluli dengan tegasan yang dibenarkan ialah 175 MPa dan elastik keanjalan 200 GPa. Bahagian dalam pula diperbuat daripada konkrit dengan tegasan 20 MPa dan modulus keanjalan 16 Gpa. Jika keluasan konkrit adalah 10 kali ganda daripada keluasan keluli, tentukan dimensi yang diperlukan jika kedua-dua segmen adalah segiempat sama sisi.

(10 markah)

(c) Tegasan normal dan tegasan ricih pada satu satah melintang dan menegak yang melalui satu titik pada anggota struktur adalah berdasarkan kepada tegasan satah seperti yang ditunjukkan dalam Rajah **Q1(c)**. Tentukan:

(i) Tegasan principal dan sudut putaran

(5 markah)

(ii) Tegasan ricih maksimum dan tegasan normal purata pada elemen serta sudut putaran

(4 markah

S2 Satu rasuk keluli saiz piawai 254 x 146 x 37 kg/m UB dengan keratan rentas seperti yang di tunjukkan pada Rajah **Q2(a).** Rasuk tersebut dikenakan beban teragih seragam 30 kN/m dan beban tumpu 15 kN pada tengah rentang seperti dalam Rajah **Q2(b)**. Diberi momen sifat tekun $I_x = 5540\ cm^4$ dan $I_y = 571\ cm^4$.

(a) Lukiskan gambarajah daya ricih (GDR) dan momen lentur (GML) bagi rasuk tersebut.

(5 markah)

(b) Dapatkan tegasan lentur maksimum

(5 markah)

(c) Lakarkan agihan tegasan ricih pada keratan rentas rasuk tersebut.

(10 markah)

(d) Jika rasuk keluli ditukar kepada rasuk kayu segiempat tepat, dapatkan dimensi lebar, *b* dan tinggi, *h* rasuk yang akan menyokong beban yang sama. Anggap $h = 2b$ and $\sigma_{allow} = 58$ MPa.

(5 markah)

S3 (a) Dengan menggunakan lakaran, nyatakan definisi cerun dan pesongan dalam rasuk. Pada pendapat anda, terangkan **Dua (2)** sebab mengapa pesongan adalah penting untuk dikira dalam analisis struktur.

(7 markah)

(b) Rajah **Q3** menunjukkan rasuk disokong mudah AB dengan panjang L menampung daya P pada pertengahan rentang.

(i) **Kirakan daya tindakbalas pada penyokong A dan B**

(2 markah)

(ii) Lukiskan gambarajah momen lentur rasuk

(4 markah)

(iii) Dengan menggunakan Kaedah Momen Luas, buktikan kecerunan maksimum pada titik A, $\theta_A = PL^2/16EI$

(6 markah)

(iv) Dengan menggunakan kaedah yang sama seperti S3(iii), buktikan pesongan maksimum rasuk, $\delta_{max} = PL^3/48EI$

(6 markah)

S4 (a) Lakarkan keadaan penyokong dan bentuk lenturan serta panjang berkesan *(L_e)* bagi keadaan-keadaan berikut:

(i) Pin-pin
(ii) Ikat tegar-hujung bebas
(iii) Ikat tegar-ikat tegar
(iv) Ikat tegar-pin

(8 markah)

(b) Struktur tiang yang diperbuat daripada besi mempunyai ketebalan tiub 30mm and diameter luar 250mm. Panjang tiang adalah 3.2m. Keadaan hujung tiang adalah ikat tegar dan hujung bebas. **Dengan menggunakan nilai** E=200 Gpa,

(i) Tentukan beban maksimum dikenakan pada tiang

(7markah)

(ii) Jika bentuk tiang yang sama digunakan dan kedua-dua hujung tiang adalah pin dikenakan beban menegak, **tentukan panjang minimum** tiang tersebut menggunakan Euler's formula. **Had tegasan** yang boleh ditanggung oleh tiang adalah $300N/mm^2$.

(10 markah)

S5 Dua batang aci silinder besi (G=83GPa) berdiameter 50mm telah disambungkan secara rapi dengan sebatang aci silinder aluminium (G=28GPa) yang berukuran diameter 35mm seperti di dalam Rajah **Q5**. Sekiranya kilasan terikan ricih berubah secara linear merentasi keratan rentas seragam AB dan CD, dan perubahan terikan ricih adalah bebas daripada kelakunan bahan merentasi keratan rentas BC:

(a) **Huraikan dua ciri daya kilasan pada aci silinder homogen.**

(5 markah)

(b) Tentukan sudut putaran seksyen D dengan dinding

(10 markah)

(c) Tentukan tegasan ricih maksimum yang berlaku di dalam aci selinder tersebut.

(10 markah)

S6 (a) Senaraikan **Dua (2)** anggapan dalam analisis untuk menentukan daya pada anggota kekuda.

(2 markah)

(b) Struktur mekanik boleh tentu statik melibatkan daya-daya yang tidak diketahui terhadap sesuatu struktur. Nyatakan persamaan-persamaan dalam penentuan keseimbangannya.

(3 markah)

(c) Dalam Rajah **Q6**, kekuda satah boleh tentu statik di sokong pin pada A dan di sokong rola pada B.

(i) Buktikan bahawa kekuda satah tersebut adalah boleh tentu statik.

(2 markah)

(ii) Tentukan tindakbalas penyokong pada A dan B.

(5 markah)

(iii) Tentukan semua daya anggota dengan menggunakan Kaedah Titik Sambungan. Nyatakan samada anggota dalam keadaan tegangan atau mampatan.

(13 markah)

FINAL EXAMINATION

SEMESTER/SESSION: SEM I/2011/2012 PROGRAMME: 2 BFF
COURSE: MECHANICS OF MATERIAL COURSE CODE: BFC 20903

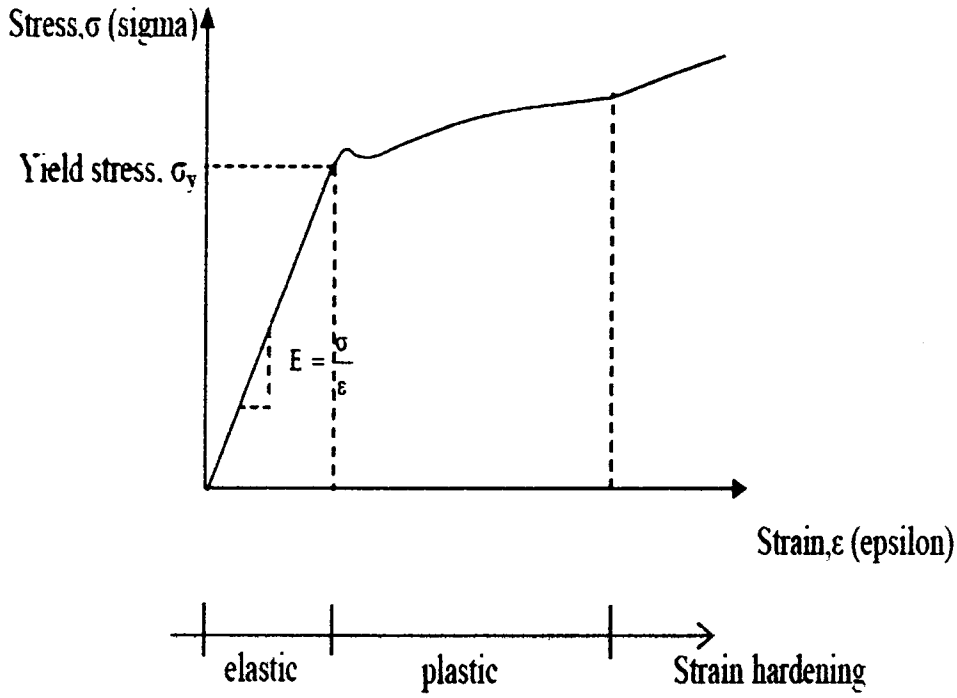

FIGURE Q1(a)

FINAL EXAMINATION

SEMESTER/SESSION: SEM I/2011/2012 PROGRAMME: 2 BFF
COURSE: MECHANICS OF MATERIAL COURSE CODE: BFC 20903

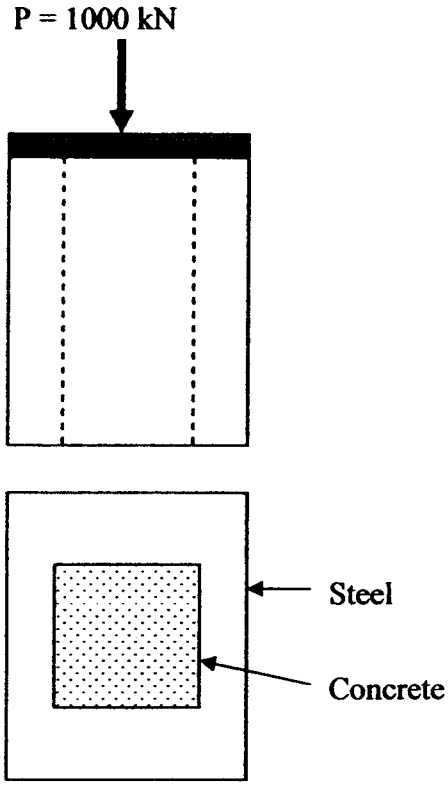

FIGURE Q1(b)

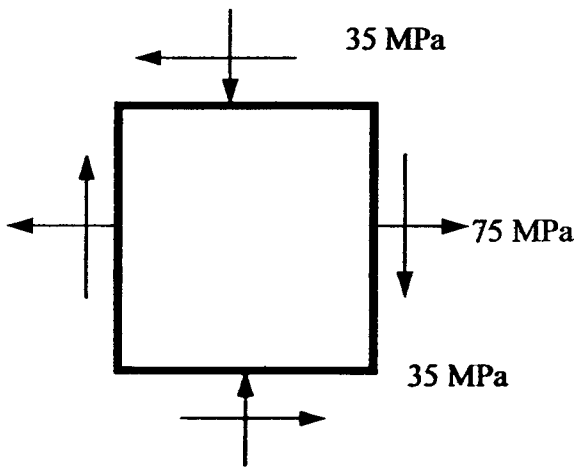

FIGURE Q1(c)

FINAL EXAMINATION

SEMESTER/SESSION: SEM I/2011/2012 PROGRAMME: 2 BFF
COURSE: MECHANICS OF MATERIAL COURSE CODE: BFC 20903

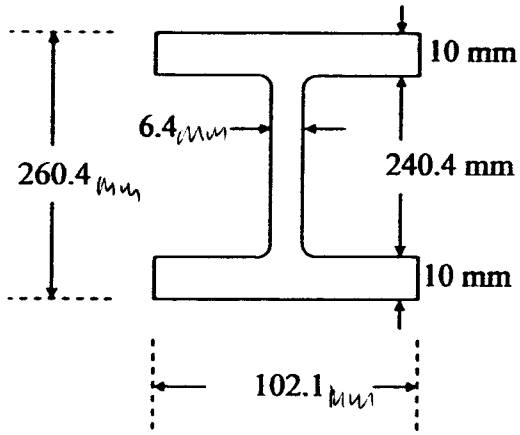

FIGURE Q2(a)

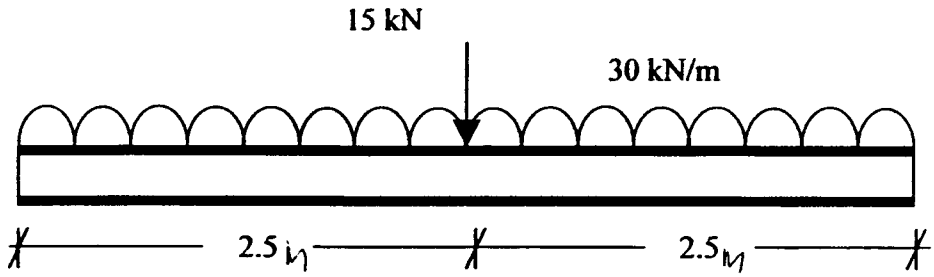

FIGURE Q2(b)

FINAL EXAMINATION

SEMESTER/SESSION: SEM I/2011/2012 PROGRAMME: 2 BFF
COURSE: MECHANICS OF MATERIAL COURSE CODE: BFC 20903

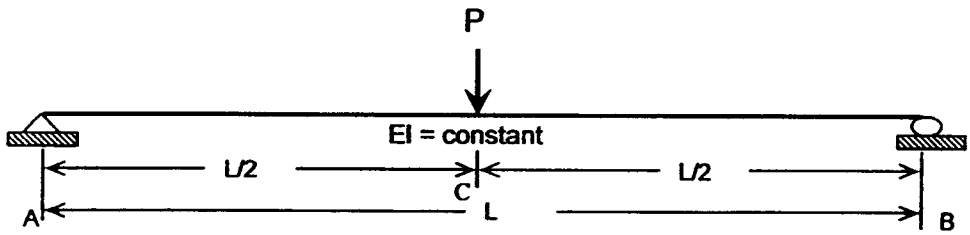

FIGURE Q3

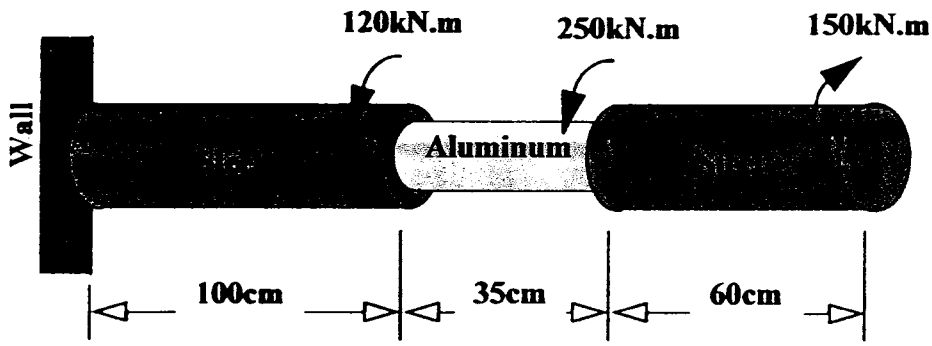

FIGURE Q5

FINAL EXAMINATION

SEMESTER/SESSION: SEM I/2011/2012 PROGRAMME: 2 BFF
COURSE: MECHANICS OF MATERIAL COURSE CODE: BFC 20903

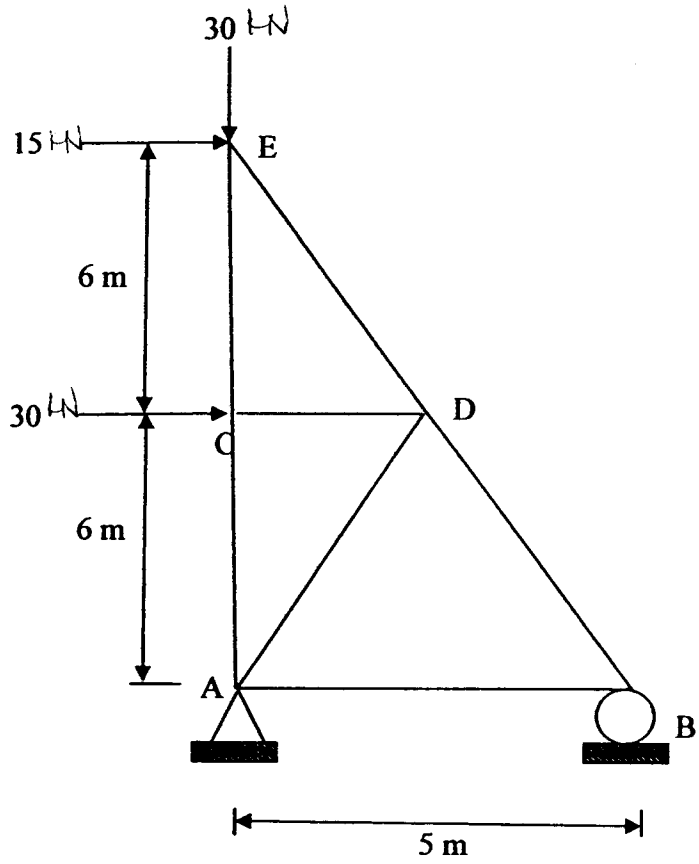

FIGURE Q6