Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	MECHANICS OF MATERIAL
COURSE CODE	:	BFC20903
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE/JULY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

Q1 (a) Explain briefly with diagrams the following terms

(i) Average normal stress
(1 mark)

(ii) Average normal strain
(1 mark)

(b) From Hooke's Law, define the relationship between

(i) Stress (σ) and strain (ε)
(1 mark)

(ii) Shear stress (τ) and shear strain (γ)
(1 mark)

(c) Describe with diagrams the following terms

(i) Young's modulus (E)
(1 mark)

(ii) Shear modulus (G)
(1 mark)

(iii) Poisson's Ratio (υ)
(1 mark)

(d) A stress-strain diagram of a specimen made from ductile material is shown in **Figure Q1(d)**. The specimen has an original diameter of d_o = 13.0 mm and a gauge length of L_o = 52.0 mm. When the specimen is subjected to an axial load of 80 kN and Poisson's ratio v = 0.3, determine

(i) The average normal stress (σ)
(1 mark)

(ii) The average normal strain (ε)
(1 mark)

(iii) The new diameter (d)
(1 mark)

(iv) The new length (L)
(1 mark)

(e) Illustrate (with diagrams) the positive strain transformation equation for

(i) Normal strain ($\varepsilon_{x'}$)

(2 marks)

(ii) Shear strain ($\gamma_{x'y'}$)

(2 marks)

(f) A state of plane strain of an element is shown in **Figure Q1(f)**, where ε_x = - 400 x 10^{-6}, $\varepsilon_y = 0$, γ_{xy} = 200 x 10^{-6}. Determine the following

(i) Principal strains (ε_{max}, ε_{min})

(2 marks)

(ii) Orientation of the principal strain (θ_p)

(2 marks)

(iii) Maximum in-plane shear strain

(2 marks)

(iv) Orientation of the maximum in-plane shear strain

(2 marks)

(v) Sketch the deformed element under the state of principal strain and state of maximum in-plane shear strain

(2 marks)

Q2 A loaded, simply supported beam W 5 x 5 x 19 is shown in **Figure Q2.** The detailings of cross section beam are shown in **Table Q2**. Determine

(i) Free body diagram, shear force and bending moment diagram by using Area Method.

(5 marks)

(ii) The maximum bending moment (and where it occurs in the beam)

(5 marks)

(iii) The maximum bending stress at that location, and also the bending stress at that location along the beam and 8 m from the bottom of the beam cross section.

(5 marks)

(iv) Determine and draw the shear stress distribution for the beam section

(10 marks)

Q3 (a) A steel rectangular hollow section of weighting beam is given in **Figure Q3(a).**

(i) Sketch the free body diagram of the beam.

(4 marks)

(ii) Determine the maximum force that can be applied to the beam, if the allowable deflection at point B is $\delta = 10$ mm. Use double integration method to solve this problem.

Given;

Modulus of elasticity of steel beam	: 205 GPa
Moment of inertia	: 730 cm^4

(11 marks)

(b) An illustration of torsional laboratory testing on 2.5 m solid square timber beam is given in **Figure Q3(b).** Calculate the maximum torque, T, that can be applied if the allowable shear stress is 4 N/mm^2 and allowable angle of twist is 0.05 rad.

Given;

Timber beam size	: 75 mm x 75 mm,
MOE of timber beam	: 15 GPa
Poisson ratio, υ	: 0.25.

(10 marks)

Q4 (a) Describe **ONE (1)** similarity and **TWO (2)** differences between strut and column.

(5 marks)

(b) Two structural steel angles back to back are used as a compression member that is 4.5 m long. The angles are separated at intervals by spacer blocks and connected by bolts as shown in **Figure Q4(b)**, a configuration which ensures that the double-angle shape acts as a unified structural member. Assume the pinned connections at each end of the column, and use E=200 GPa for the steel. A single angle has the following properties, A = 1600 mm, $I_x = 1.64 \times 10^6$ mm^4, $I_y = 0.787 \times 10^6$ mm^4, x = 19.7mm. Determine the Euler buckling load for the double-angle column if the spacer block thickness is

(i) 5 mm

(10 marks)

(ii) 20 mm

(10 marks)

– END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER/SESSION	: SEM II / 2018/2019	PROGRAMME CODE	: 2 BFF
COURSE NAME	: MECHANICS OF MATERIAL	COURSE CODE	: BFC20903

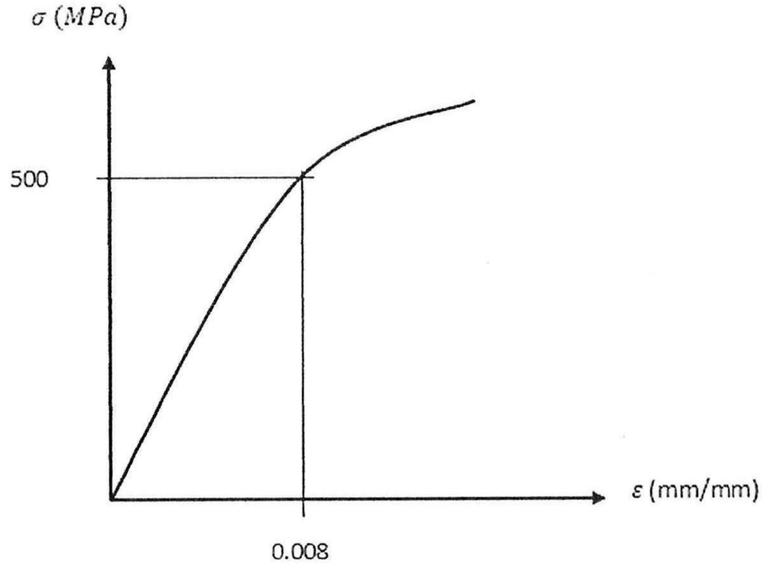


FIGURE Q1(d)

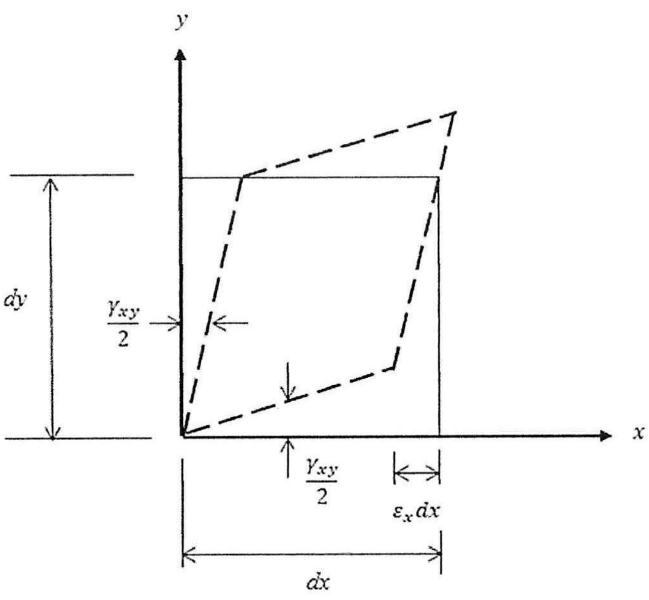


FIGURE Q1(f)

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2018/2019
COURSE NAME : MECHANICS OF MATERIAL
PROGRAMME CODE : 2 BFF
COURSE CODE : BFC20903

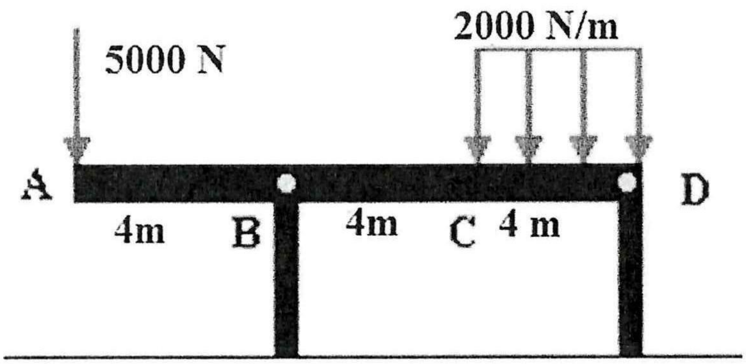


FIGURE Q2

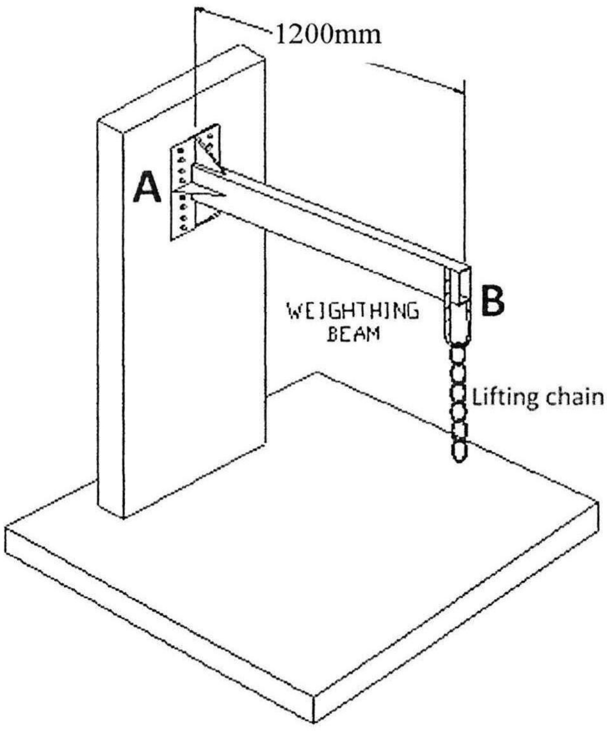


FIGURE Q3 (a)

FINAL EXAMINATION

SEMESTER/SESSION	: SEM II / 2018/2019	PROGRAMME CODE	: 2 BFF
COURSE NAME	: MECHANICS OF MATERIAL	COURSE CODE	: BFC20903

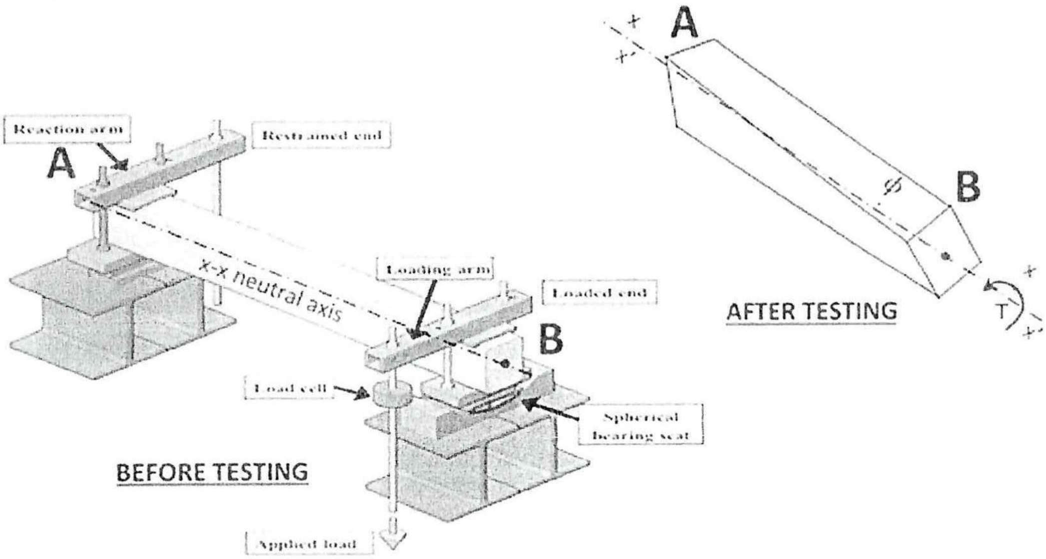


FIGURE Q3 (b)

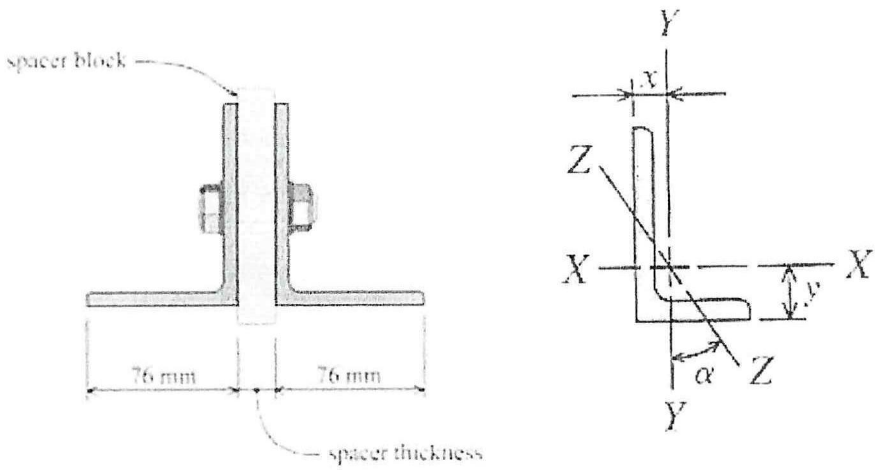
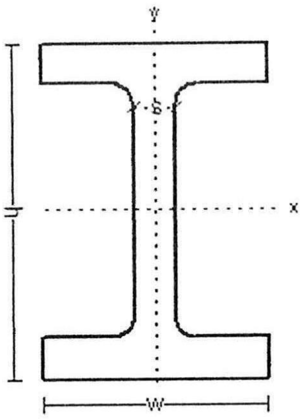


FIGURE Q4(b)

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2018/2019
COURSE NAME : MECHANICS OF MATERIAL
PROGRAMME CODE : 2 BFF
COURSE CODE : BFC20903

TABLE Q2



Designation		Dimensions					Static Parameters			
							Moment of Inertia		Elastic Section Modulus	
Imperal (*in x in x lb/ft*)	Metric (*mm x mm x kg/m*)	Depth - *h* - (*mm*)	Width - *w* - (*mm*)	Web Thickness - *s* - (*mm*)	Sectional Area (cm^2)	Weight (*kg/m*)	I_x (cm^4)	I_y (cm^4)	S_x (cm^3)	S_y (cm^3)
W 4 x 4 x 13	W 100 x 100 x 19.3	106	103	7.1	24.7	19.3	475.9	160.6	89.9	31.2
W 5 x 5 x 16	W 130 x 130 x 23.8	127	127	6.1	30.4	23.8	885.5	311	139.5	49
W 5 x 5 x 19	W 130 x 130 x 28.1	131	128	6.9	35.9	28.1	1099	381.4	167.7	59.6
W 6 x 4 x 9	W 150 x 100 x 13.5	150	100	4.3	17.3	13.5	685.5	91.8	91.4	18.4
W 6 x 4 x 12	W 150 x 100 x 18.0	153	102	5.8	22.9	18	915.9	125.9	122.1	25.4
W 6 x 4 x 16	W 150 x 100 x 24.0	160	102	6.6	30.6	24	1342	182.6	167.8	35.8

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2018/2019
COURSE NAME : MECHANICS OF MATERIAL
PROGRAMME CODE : 2 BFF
COURSE CODE : BFC20903

Formula:

$$G = \frac{MOE}{2(1+\upsilon)} \qquad \tau_{all.} = \frac{4.81T}{a^3} \qquad \phi_{all.} = \frac{7.10TL}{a^4 G}$$