Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2019/2020

COURSE NAME	:	MECHANICS OF MATERIALS
COURSE CODE	:	BFC20903
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2020
DURATION	:	6 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) An experimental test to determine the material strength of concrete of grade C30 and steel specimen of grade S500 was conducted in tension and compression. The stress-strain curve for each material was plotted and is shown in **Figure 1(a)** and **Figure 1(b)**. From each of the stress-strain curve;

(i) Determine the ultimate stress, yield stress and stress at failure.
(2 marks)

(ii) Determine the strain values at yield load, ultimate load and failure load.
(2 marks)

(iii) Determine the Young's modulus E_c and E_s (assume steel strain at yield is 0.002)
(4 marks)

(iv) Describe the characteristic behaviour for each material and highlight the main features of the curve.
(5 marks)

(b) From the given shearing stress and normal stress as below:

$$\sigma_x = -5\text{MPa}$$
$$\sigma_y = 10\text{MPa}$$
$$\tau_{xy} = -5\text{MPa}$$

(i) Sketch the free body diagram of the stress element.
(2 marks)

(ii) Determine and sketch the free body diagram for the principal stress using transformation equations.
(5 marks)

(iii) Determine and sketch the free body diagram for the maximum shearing stress, correspond with the normal stress using the general transformation equations.
(5 marks)

Q2 An overhanging beam with two types of beam cross sections are given in **Figure Q2**.

(i) Calculate the maximum shear force and maximum bending moment.
(8 marks)

(ii) Determine the maximum bending stress for both beam's cross sections.
(6 marks)

(iii) Determine the maximum shear stress for both beam's cross sections
(8 marks)

(iv) If the allowable bending stress is 50 N/mm^2, and the allowable shear stress is 5 N/mm^2, recommend the best cross section that satisfies both allowable limits.

(3 marks)

Q3 (a) **Figure Q3 (a)** shows a cantilever beam which is carry a load P at point C.

(i) Sketch the deflection curve of the beam.

(2 marks)

(ii) Derive the bending moment deflection, slope deflection and deflection equation at b-b using Double Integration Method.

(10 marks)

(iii) Calculate the maximum deflection. Given:

L = 10 m
a = 3 m
P = 25 kN
EI is constant

(5 marks)

(b) **Figure Q3 (b)** shows a solid steel spindle AB that has a diameter d_s = 38 mm. The allowable shearing stress of the spindle is 84 MPa, while sleeve CD is made of a brass with an allowable shearing stress of 50MPa. Determine the largest torque (T), that can be applied at A.

(8 marks)

Q4. **Figure Q4** shows a steel column that pinned on top and fixed at the base. The column is restrained by steel beams about its x-axis and y-axis on the top of the column. The radius of gyrations of the column about x-axis is 137 mm and y-axis is 77.8 mm. The Modulus Elasticity of the column is 200 x10^6 kPa.

(i) Calculate the moment of inertia of the column on x axis and y axis.

(17 marks)

(ii) Find the effective length of the column about x and y axis.

(2 marks)

(iii) Determine the slenderness ratio of the column and choose the critical slenderness ratio.

(2 marks)

(iv) Calculate the critical buckling stress and axial load of the column.

(4 marks)

END OF QUESTIONS

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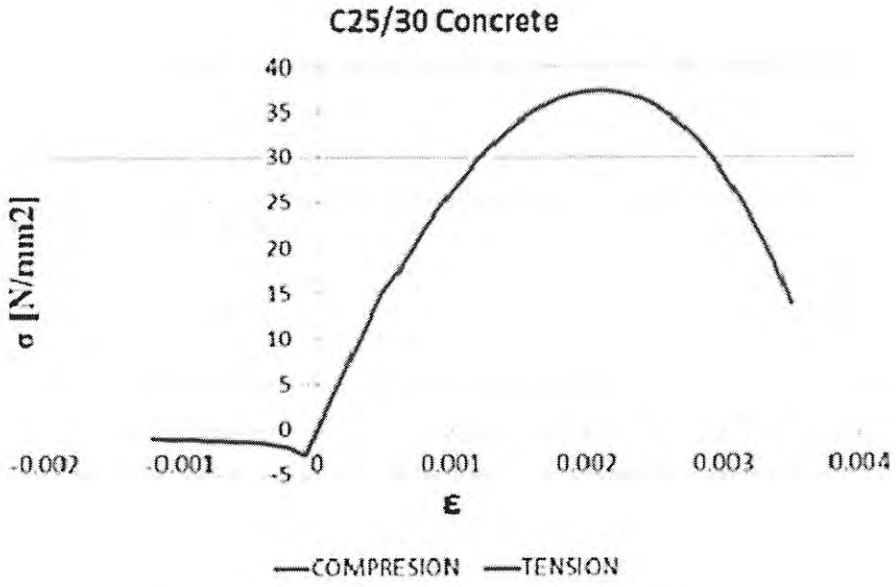
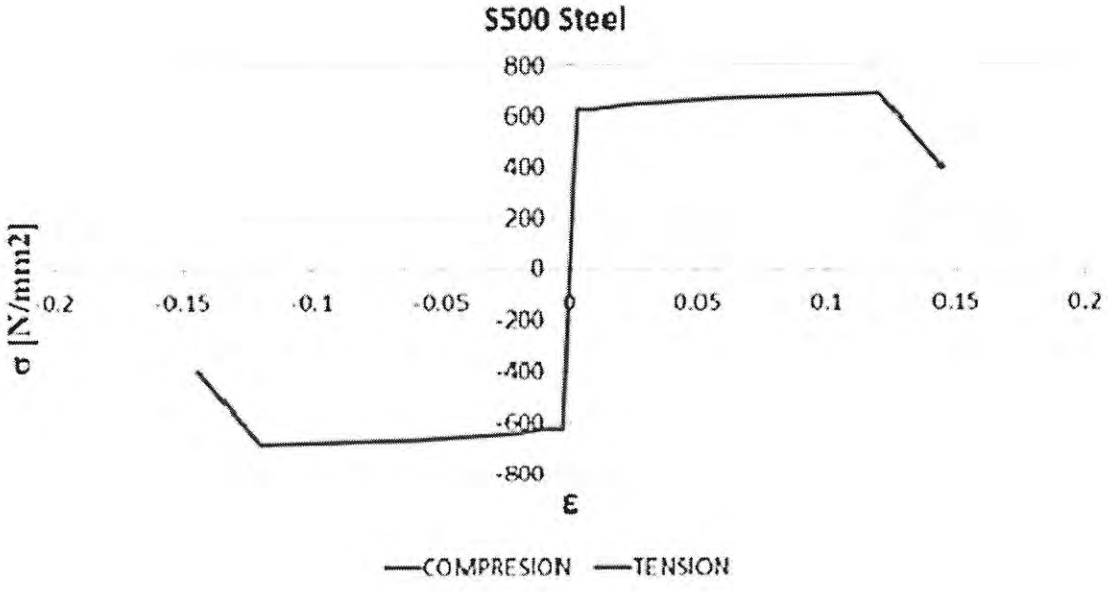


(a) Concrete Grade C30



(b) Steel Grade S500

FIGURE Q1

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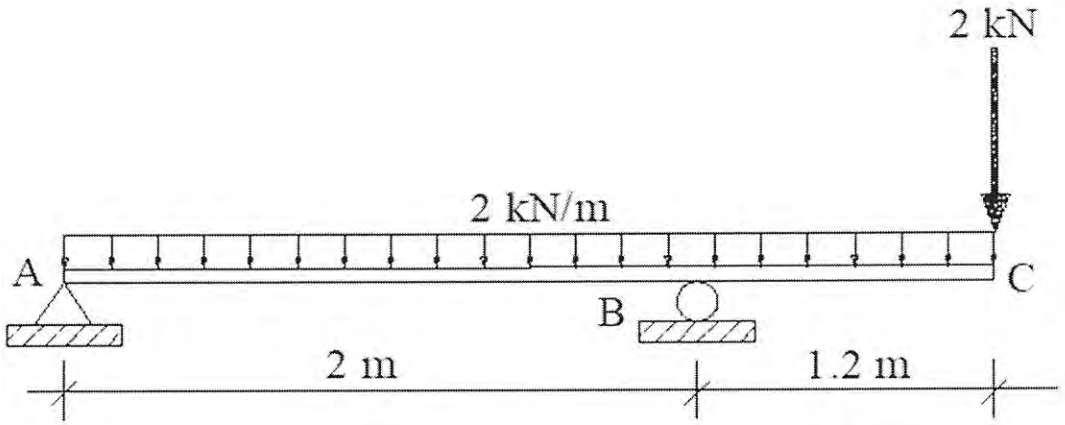

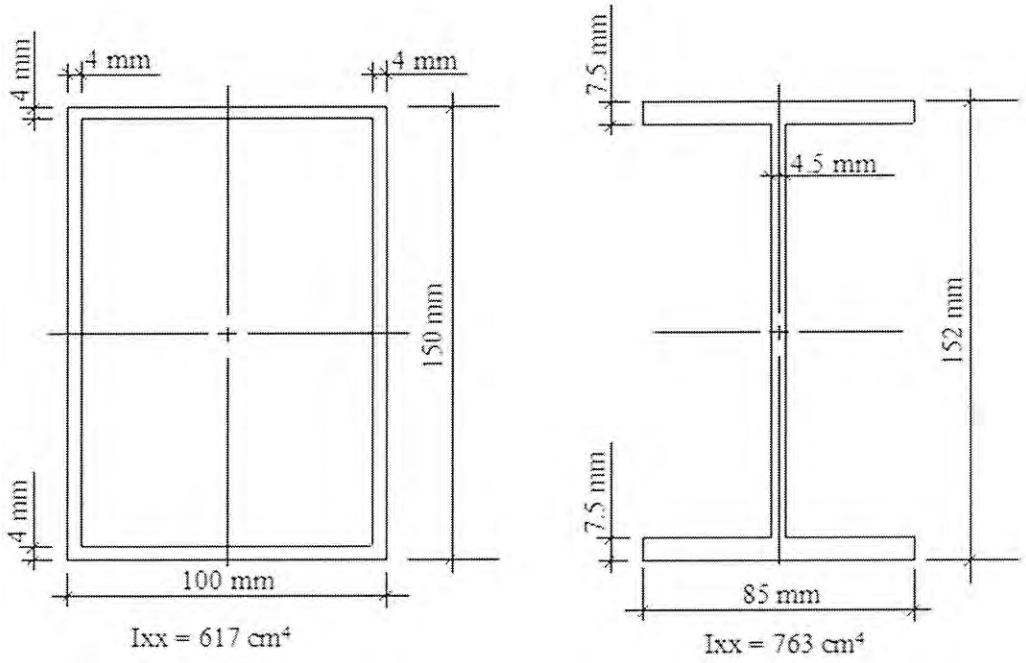

Rectangular Hollow Section (RHS)

Universal Beam (UB)

BEAMS CROSS SECTION

FIGURE Q2

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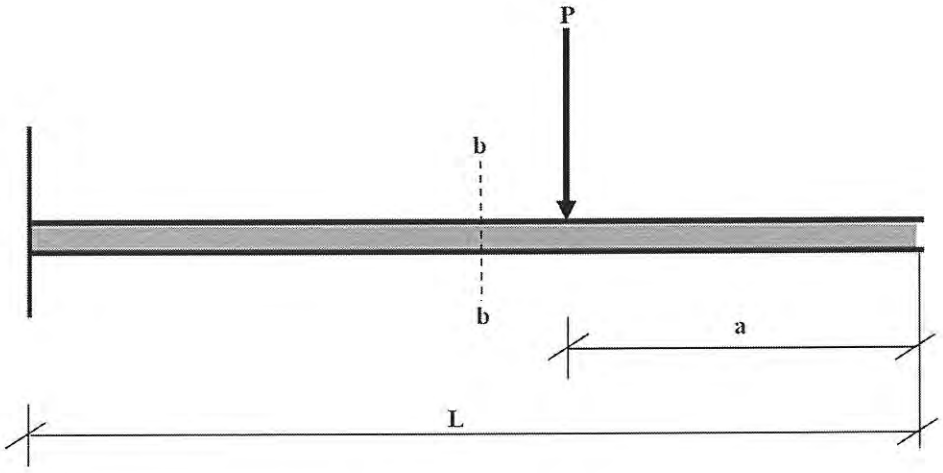

FIGURE Q3 (a)

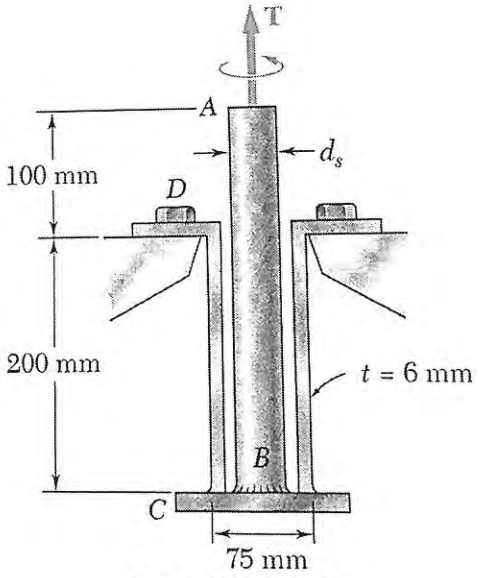

FIGURE Q3 (b)

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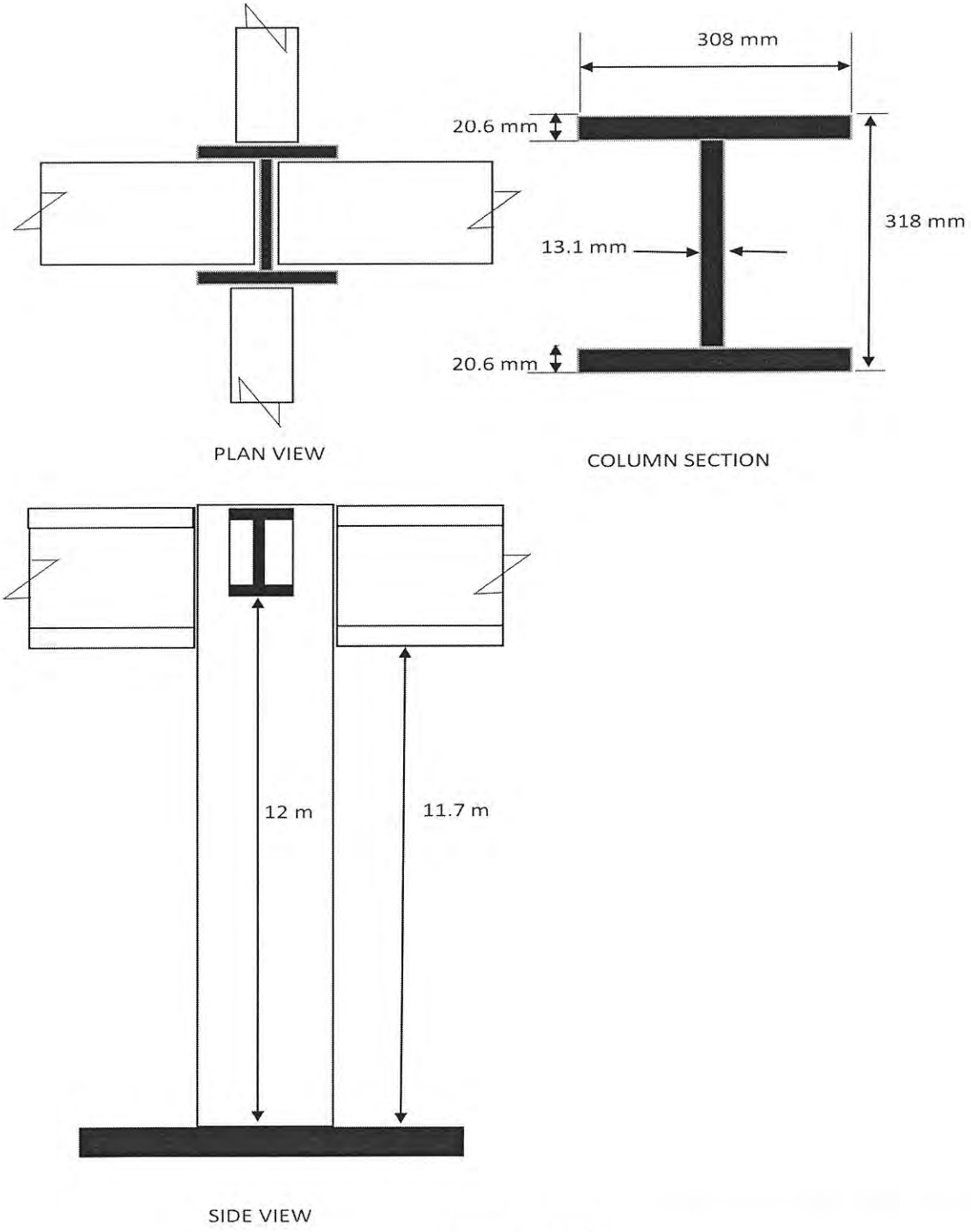

FIGURE Q4

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List of Formula

$$\sigma_{x'} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$\sigma_{y'} = \frac{\sigma_x + \sigma_y}{2} - \frac{\sigma_x - \sigma_y}{2}\cos 2\theta - \tau_{xy}\sin 2\theta$$

$$-\sigma_x + \sigma_y - \sigma_{x'}$$

$$\tau_{x'y'} = -\frac{\sigma_x - \sigma_y}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

$$\sigma_{\max,\min} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\tan 2\theta_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$$

$$\tau_{\max} = R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\tan 2\theta_s = -\frac{\sigma_x - \sigma_y}{2\tau_{xy}}$$