Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016

COURSE NAME	:	MECHANICS OF MATERIAL
COURSE CODE	:	BFC 20903
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE / JULY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

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

Q1 (a) Briefly explain the differences between each of the following;

(i) Ductile and brittle materials.

(4 marks)

(ii) Elastic and plastic behavior.

(4 marks)

(b) The rod is made of steel and has a cross-sectional area A, length L, modulus of elasticity E and coefficient of thermal expansion α. As shown in **FIGURE Q1**, the bar is placed securely between two walls when the temperature is $T_1 = T_x$°C.

(i) Determine the force exerted on the rigid supports when the temperature reaches $T_2 = T_z$°C.

(5 marks)

(ii) Determine the average normal thermal stress developed in the bar.

(5 marks)

(iii) Calculate the force and stress in the bar if the diameter of the rod is 10mm, the length, L=1m, modulus of elasticity, E=200GPa and the coefficient of thermal expansion, $\alpha=12\text{x}10^{-6}$/°C when the temperature changes from 30°C to 60°C.

(7 marks)

Q2 **FIGURE Q2(a)** shows a building floor plan. From the figure, beams are designed to carry uniformly distributed from reinforced concrete slab and steel beam self-weight. The floor slab overall depth is 250mm from normal concrete with unit mass approximately 2400kg/m^3. The beams are simply supported and its self-weight can be assumed as 70kg/m-run.

(a) Determine the loading from reinforced concrete slab in kN/m subjected on beam B-C/2 if the beam supports half of the slab area (6m x 3m).

(3 marks)

(b) Determine the loading from steel beam in kN/m.

(3 marks)

(c) Determine and draw the shear force and bending moment diagram of beam B-C/2 by considering loads from both reinforced concrete slab and steel beam.

(8 marks)

(d) Determine and draw the shear force and bending moment diagram of beam B/1-3, if the beam has to support additional point load from load transferred by beam B-C/2.

(11 marks)

Q3 (a) A steel pipe is simply supported at the ends and carries the concentrated loads as shown in **FIGURE Q3(a)**. The steel pipe has an outside diameter of 500mm and inside diameter of 400mm. The cross section of A-A is 3m from the right support. Determine the bending stress at point B and C on the cross section.

(5 marks)

(b) A cross section of a timber beam is rectangular as shown in **FIGURE Q3(b)**. The beam has 30kN of transverse shear, V at a certain section.

(i) Find the vertical shearing stress 15mm below the top of the beam.

(4 marks)

(ii) Find the maximum vertical shearing stress on the cross section.

(3 marks)

(c) A beam is loaded and supported as shown in **FIGURE Q3(c)**. The beam has the cross section 3m from the left support.

(i) Find the bending and shear stress at point B and C on the cross section.

(4 marks)

(ii) Analyze the shear stress and plot the shear stress distribution acting over the beam cross-sectional area.

(6 marks)

(iii) If the beam can resist maximum shear strength of 50kN, analyze the maximum shear stress.

(3 marks)

Q4 **FIGURE Q4** shows a simply supported beam with a pinned support at A and a roller support at E. The beam is subjected by moment loads at support A (M_A) and support E (M_E). Assuming that both of the moment loads have the same intensity (M_A=M_E), by using the Double Integration Method;

(i) Determine the reaction at support A and support E.
(3 marks)

(ii) Translate the pattern of the deformation of the beam into an appropriate figure.
(2 marks)

(iii) Sketch the Shear Force Diagram (SFD) and Bending Moment Diagram (BMD).
(4 marks)

(iv) Formulate the moment-displacement equation, slope-displacement equation and displacement-displacement equation.
(6 marks)

(v) Calculate the slope deflection at support A and support E.
(4 marks)

(vi) Calculate the displacement at point B, C and D.
(6 marks)

Q5 (a) List all assumptions for Euler theory in a simply supported column.
(5 marks)

(b) Synthesis the Euler load, $P_{cr} = \frac{n^2\pi^2 EI}{L^2}$ from a simply supported column and is axially loaded with force, P.
(10 marks)

(c) A long, slender structural aluminium (E=70GPa) flanged shape (**FIGURE 5(a)**) is used as a 7m long column. The column is supported in the *x*-direction at base A and pinned at ends A and C against translation in the *y* and *z*-directions. Lateral support is provided to the column so that deflection in the *x*-*z* plane is restrained at mid-height B; however, the column is free to deflect in the *x*-*y* plane at B (**FIGURE 5(b)**). Determine the maximum compressive load, P the column can support if a factor of safety of 2.5 is required. In your analysis, consider the possibility that buckling could occur about either *z*-axis or *y*-axis of the aluminium column.
(10 marks)

Q6 (a) Give **THREE (3)** examples of application of torsion in civil engineering. (3 marks)

(b) List the assumptions that can be taken into account in torsion analysis. (2 marks)

(c) **FIGURE 6** shows lever ABC with horizontal point load parallel to Z axis. Knowing that portion AB of the lever has a diameter d and length of portion BC, a=10d. Synthesis that the shearing stress due to torsion at point A is;

$$\tau_A = \frac{160P}{\pi d^2}$$

(10 marks)

(d) By referring to **FIGURE 6**, knowing that the vertical load P=40kN, d=25mm, a=120mm, and h=280mm, calculate;

(i) Support reaction at point A. (5 marks)

(ii) Shearing stress, τ_A at point A. (5 marks)

- END OF QUESTIONS -

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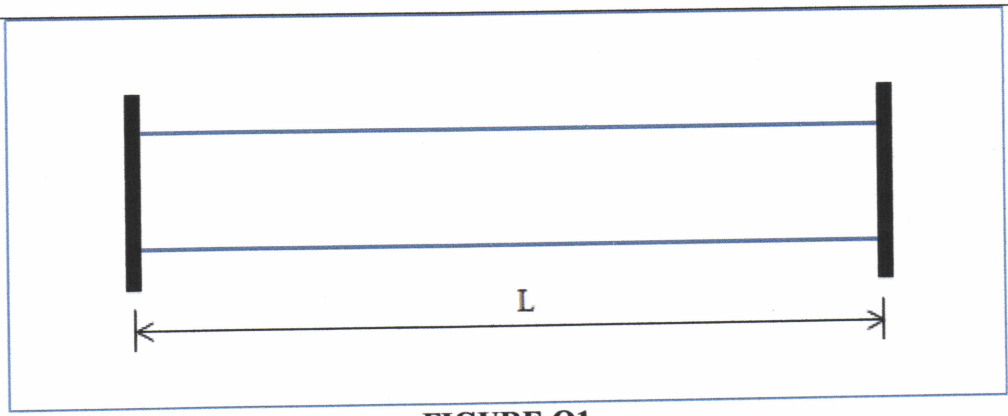

FIGURE Q1

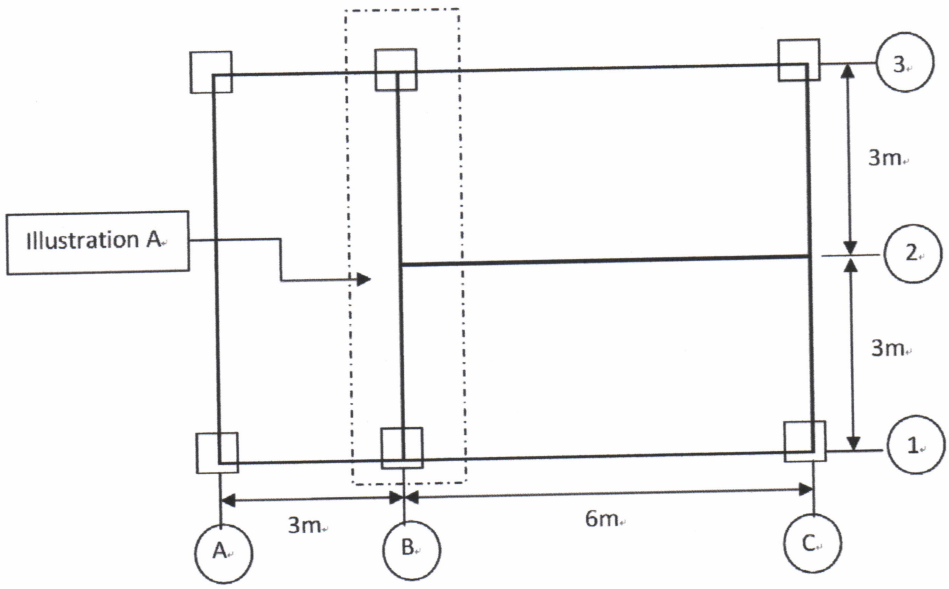

FIGURE Q2(a)

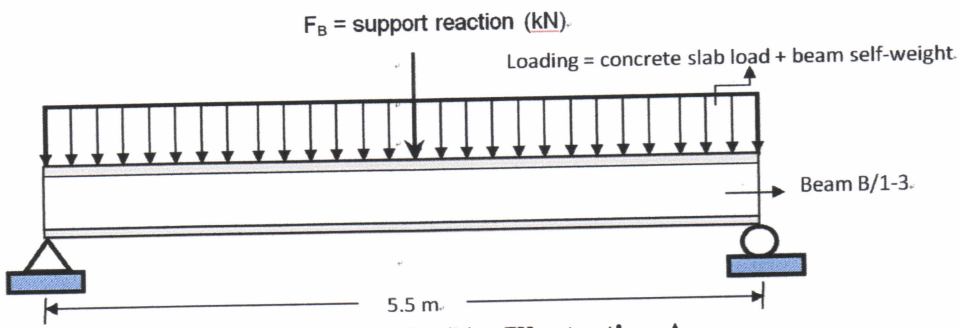

FIGURE Q2(b) : Illustration A

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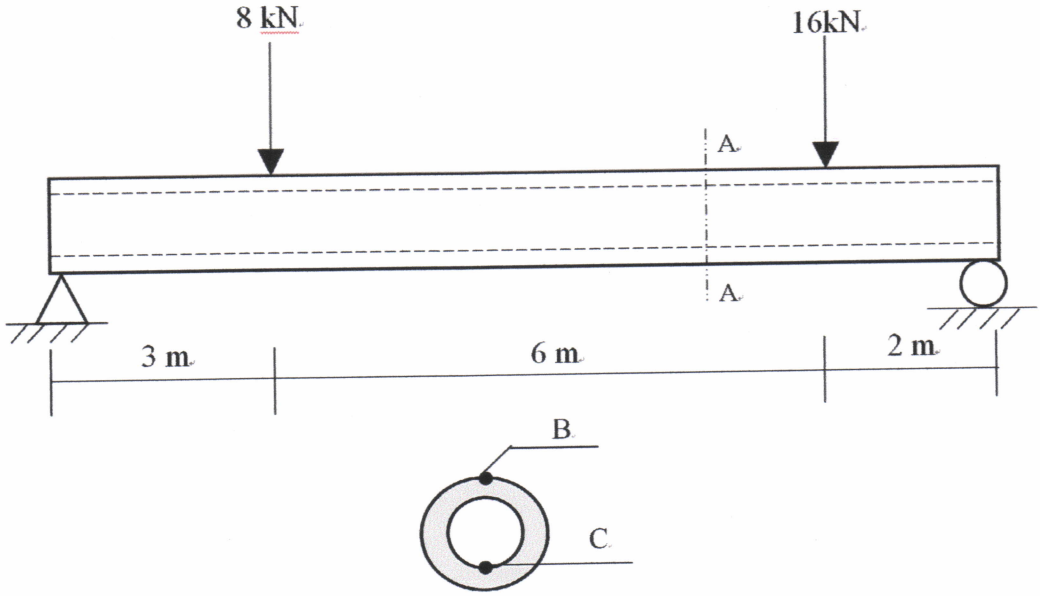
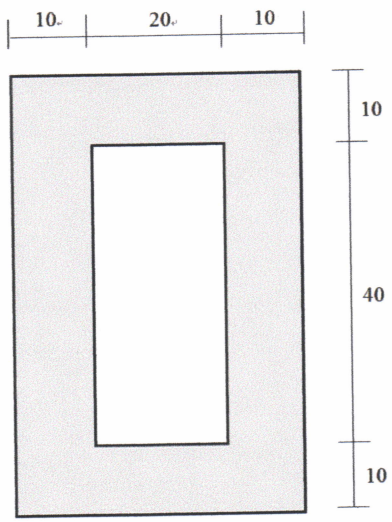


Cross section A-A

FIGURE Q3(a)



Unit in mm

FIGURE Q3(b)

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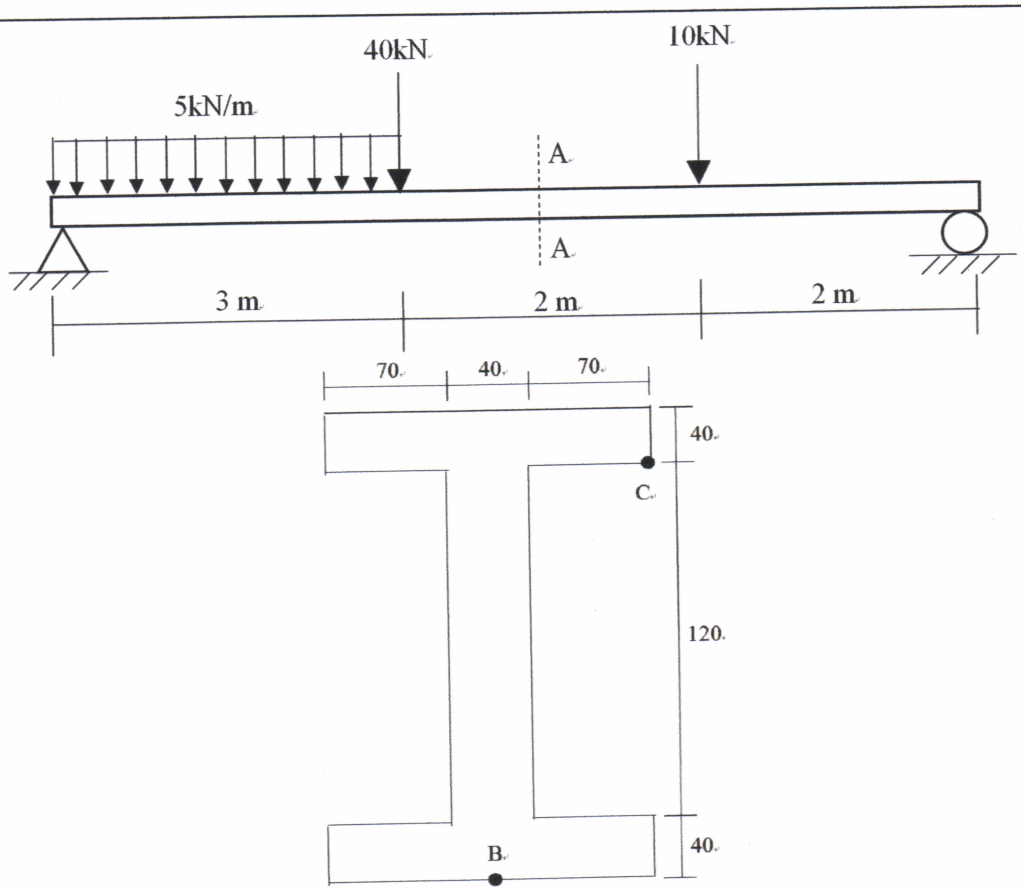

Cross section A-A (Unit in mm)

FIGURE Q3(c)

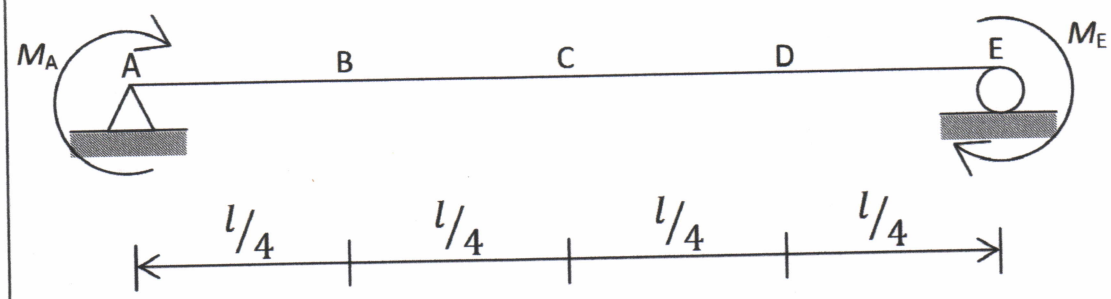

FIGURE Q4

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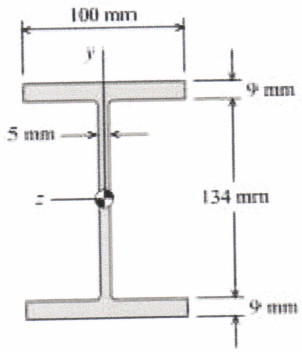

FIGURE Q5(a)

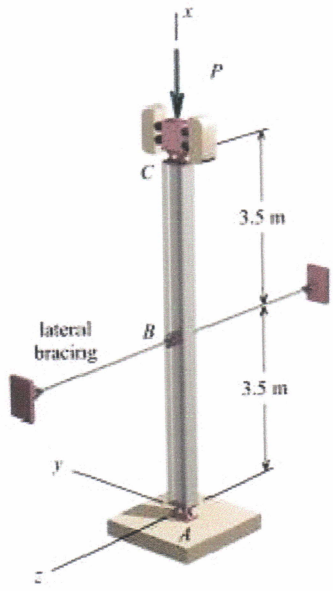

FIGURE Q5(b)

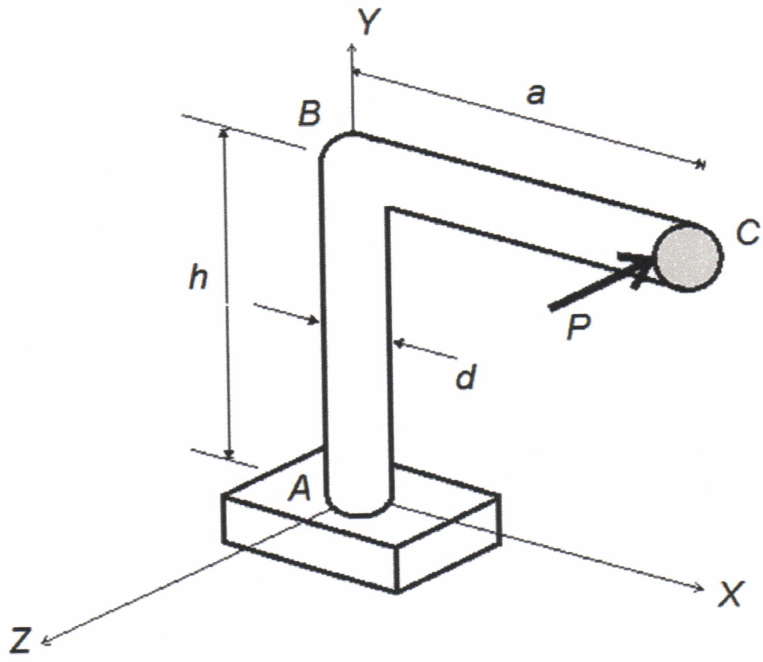

FIGURE Q6