Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	SOLID MECHANICS
COURSE CODE	:	BNJ 10403
PROGRAMME	:	2 BNL/BNM/BNG
EXAMINATION DATE	:	DECEMBER 2014/JANUARY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **EIGHT (10)** PAGES

Q1 (a) Identify **ONE (1)** examples for 'statically determinate beams' and 'statically indeterminate beams'.

(4 marks)

(b) **Figure 1(b)** shows a beam *AE* with loaded and supported and is said to have an overhang *DE*. Show all the significant values:

(i) Determine the support reaction.

(4 marks)

(ii) Sketch the shear diagram.

(5 marks)

(iii) Sketch the moment diagram.

(5 marks)

(iv) Identify the maximum vertical shear and maximum bending occurs.

(2 marks)

Q2 (a) The steel rod shown in **Figure 2(a)** has a diameter of 5 mm. It is attached to the fixed wall at A, and before it is loaded, there is a gap between the wall at B' and the rod of 1 mm. The rod is subjected to an axial force of $P = 20kN$. Neglect the size of the collar at *C*. Take *Est* = 200GPa.

(i) Determine the reactions at *A*.

(5 marks)

(ii) Determine the reactions at *B'*.

(5 marks)

(b) A bar of aluminum, *AB*, a bar of copper, *BC,* and a bar of steel, *CD* are properly connected between each other and fixed to the wall as shown in the **Figure Q2(b).** Cross-sectional area *AB*, *BC* and *CD* respectively 300 mm^2, 200 mm^2 and 100 mm^2. Modulus of elasticity of aluminum, copper, and steel, respectively 70GPa, 110GPa, and 200GPa

(i) Calculate the normal stress in bar *AB, BC* and *CD.*

(6 marks)

(ii) Construct the amount of elongation that occurs on the ABCD as a result of expenses incurred.

(4 marks)

Q3 (a) Hollow shaft shown in **Figure 3(a)** have a maximum shearing stress of 52 MPa and knowing that $d = 30\ mm$.

(i) Express the formula for polar moment of inertia for solid shaft and hollow shaft.

(4 marks)

(ii) Determine the torque, T which causes this maximum shearing stress.

(5 marks)

(b) **Figure 3(b)** show a shaft AD with BC is hollow with inner and outer diameters of 90 mm and 120 mm, respectively. Shafts AB and CD are solid of diameter d. For the loading given where $T_A = 6kN.m$, $T_B = 14kN.m$, $T_C = 26kN.m$, and $T_D = 6kN.m$.

(i) Solves the shearing stress in shaft BC and shows the minimum and maximum value.

(8 marks)

(ii) Determine the required diameter d of shafts AB and CD if the allowable shearing stress in these shafts is 65 MPa.

(3 marks)

Q4 (a) A differential element of material at a point is subjected to a state of plane strain which tends to distort the element as shown in **Figure 4(a).** Determine the equivalent strains acting on an element of the material oriented at the point, *clockwise* 30° from the original position.

(6 marks)

(b) A single horizontal force P of 1000 N magnitude is applied to end D of lever ABD as shown in **Figure Q4(b).**

(i) Determine the normal and shearing stresses on an element at point H having side parallel to the x and y axes.

(5 marks)

(ii) Computes the principal planes and principal stresses at the point H.

(9 marks)

Q5 Member AB shown in **Figure Q5(a)** consists of a steel channel of length 2.5 m. The cross-sectional area of member AB is shown in **Figure Q5(b)**. Knowing that the pins A and B pass through the centroid of the cross section of the channel. Given that $\theta = 30^{o}$, $\sigma_y = 250$ MPa and $E = 200$ GPa.

(a) Draw the free body diagram.

(2 marks)

(b) Carry out the internal forces in member AB and CB

(5 marks)

(c) Calculate the least moment of inertia for member AB

(5 marks)

(d) Examine the Euler force for the member AB

(6 marks)

(e) Find the factor of safety for the member AB

(2 marks)

Q6 (a) (i) With the aid of diagram, define the terms of Strain-Energy Density and Modulus of Toughness.

(4 marks)

(ii) Determine the strain energy due to bending for the timber beam and loading as shown in **Figure Q6(a)**. Given E = 12 GPa.

(6 marks)

(b) State **TWO (2)** types of failure modes in stress analysis.

(2 marks)

(c) The state of plane stress shown in **Figure 6(c)** occurs at a critical point of a steel machine component. As a result of several tensile tests, it has been found that the tensile yield strength is $\sigma_Y = 250$ MPa for the grade of steel used. Determine the factor of safety with respect to yield, using:

(i) the maximum shearing stress theory

(5 marks)

(ii) the maximum distortion energy theory

(3 marks)

-END OF QUESTION-

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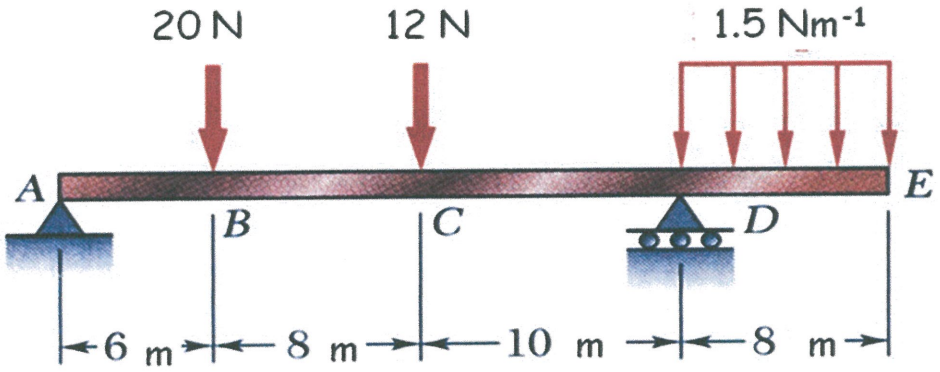

FIGURE 1(b)

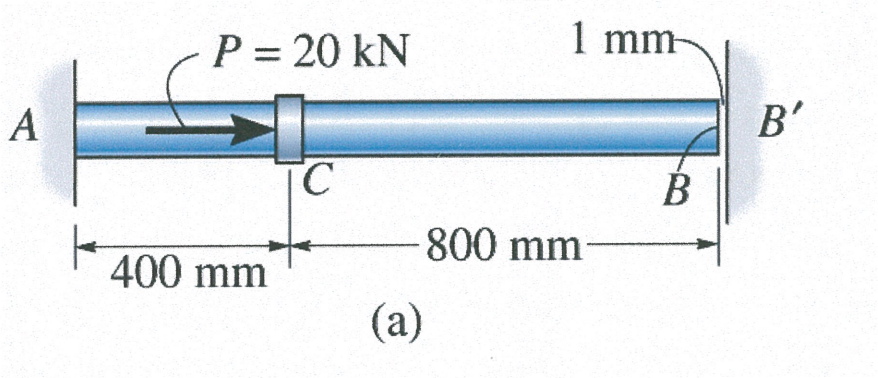

FIGURE 2(a)

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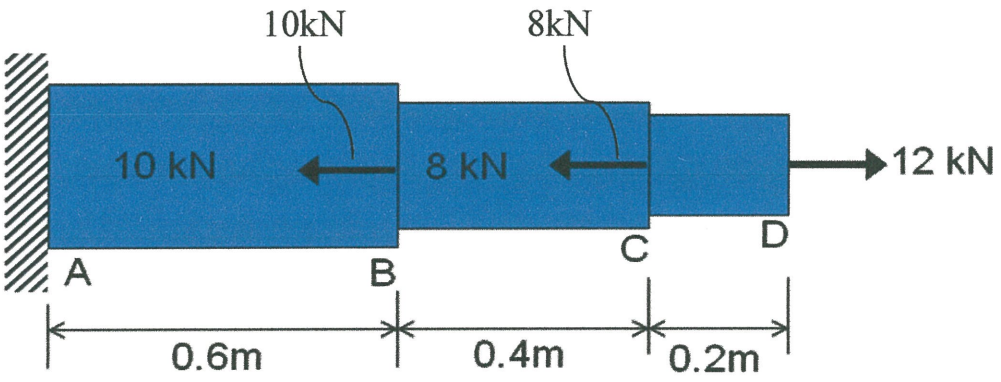

FIGURE 2(b)

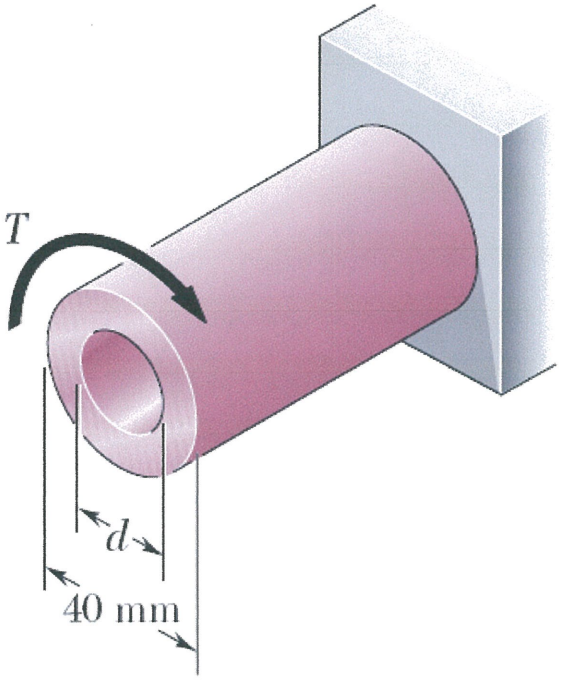

FIGURE 3(a)

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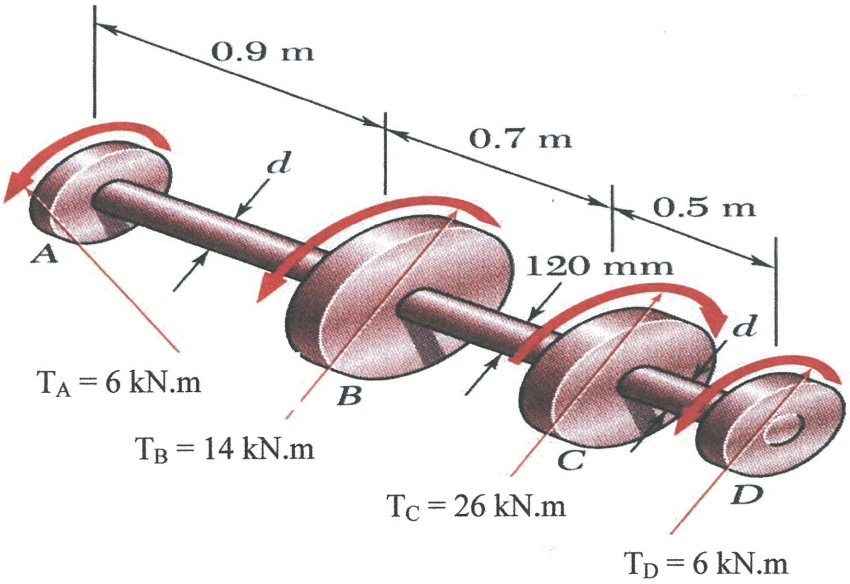

FIGURE 3(b)

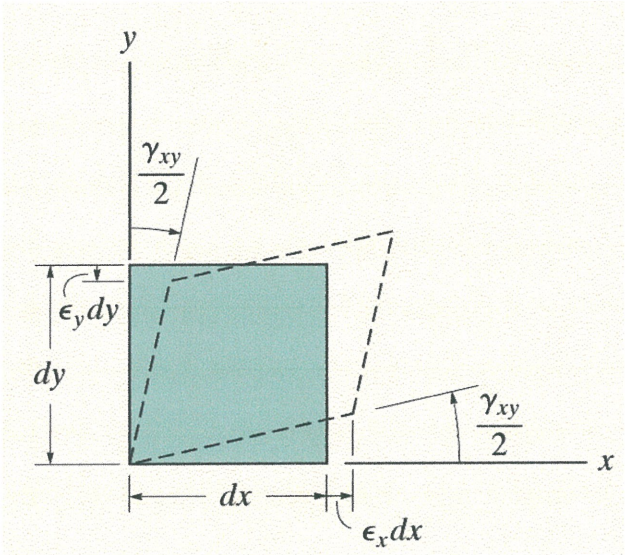

FIGURE 4(a)

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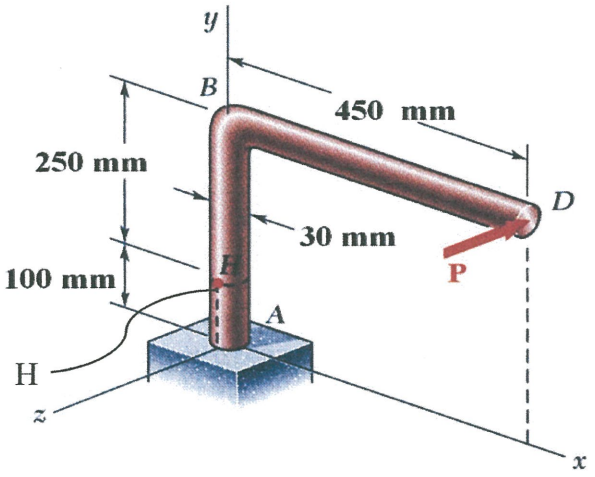

FIGURE 4(b)

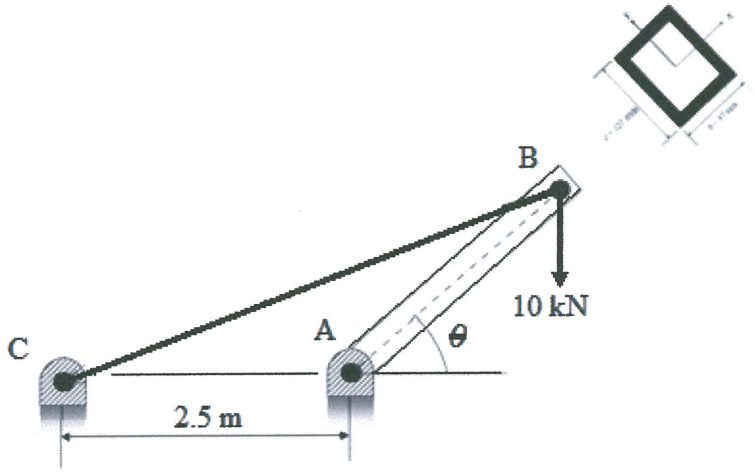

FIGURE 5(a)

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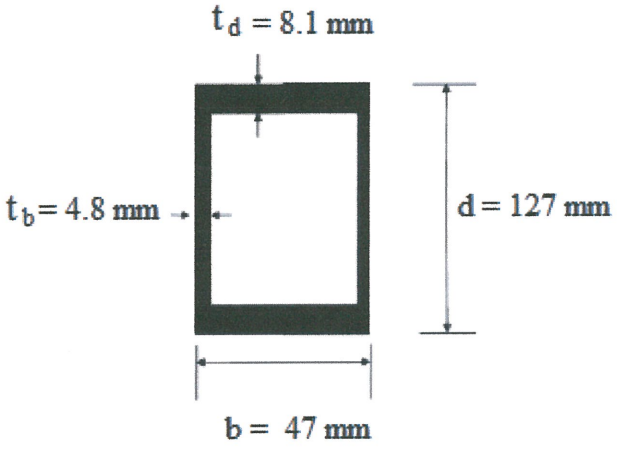

FIGURE 5(b)

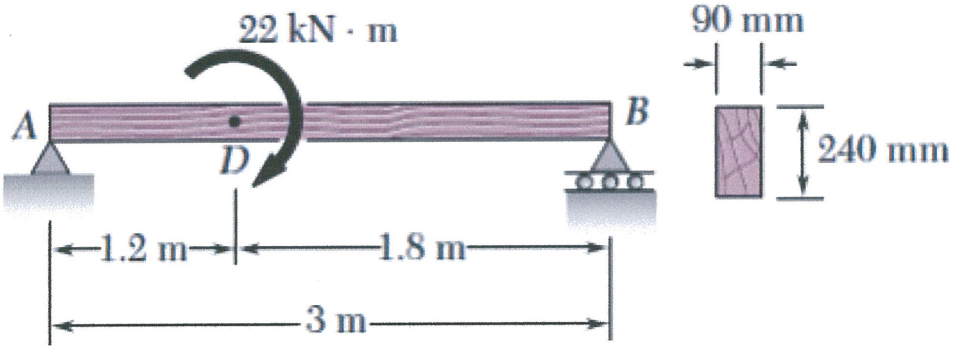

FIGURE 6(a)

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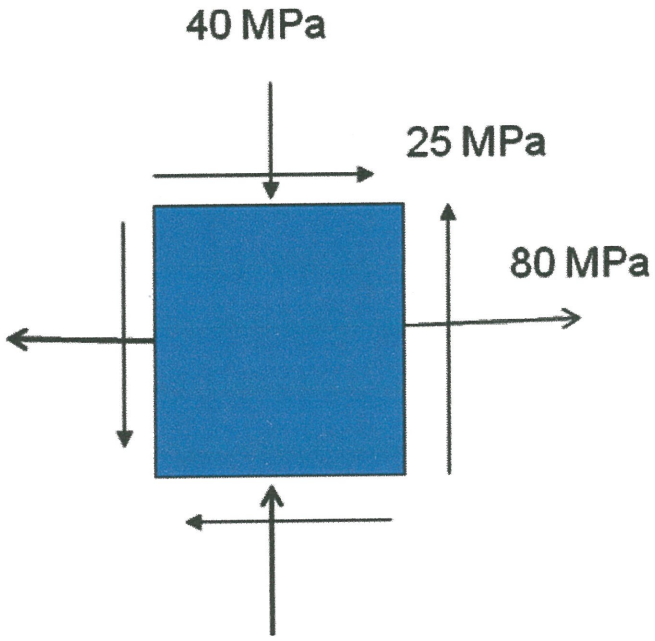

FIGURE 6(c)