First Semester Examination
2021/2022 Academic Session

February/March 2022

EMM213 – Strentgh of Materials

Duration : 3 hours

Please ensure that this examination paper contains **SIX (6)** pages and **FIVE (5)** question before you begin the examination.

Instructions : Answer **ALL** questions.

Answer all questions in **English** OR **Bahasa Malaysia** OR a combination of both.

Each question must begin from a new page.

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1. (a) Each of the four vertical links has an 8 mm x 36 mm uniform rectangular cross-section and each of the four pins has a {d} mm diameter. The structure is subjected to load P = {P} kN. Determine

   i. The average shearing stress in the pin B
   ii. The average bearing stress at B in the member BD
   iii. The average bearing stress at B in the member ABC, knowing that this member has a 10 mm x 50 mm uniform rectangular cross section.

*{d} and {P} –wildcard parameter

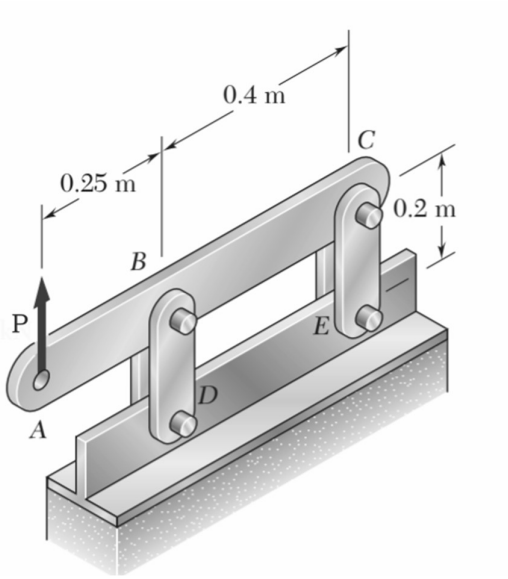

Figure Q1(a)

(40 marks)

1. (b) In the structure shown, a {d_C} mm diameter pin is used at C and {d_B} mm diameter pins are used at B and D. The ultimate shearing stress is 150 MPa at all connections, and the ultimate normal stress in link BD is 400 MPa. Knowing that a factor of safety of {fs} is desired, determine the largest load P that can be applied at A. Note that link BD is not reinforced around the pin holes.

*{d_C}, {d_B] and {fs} –wildcard parameter

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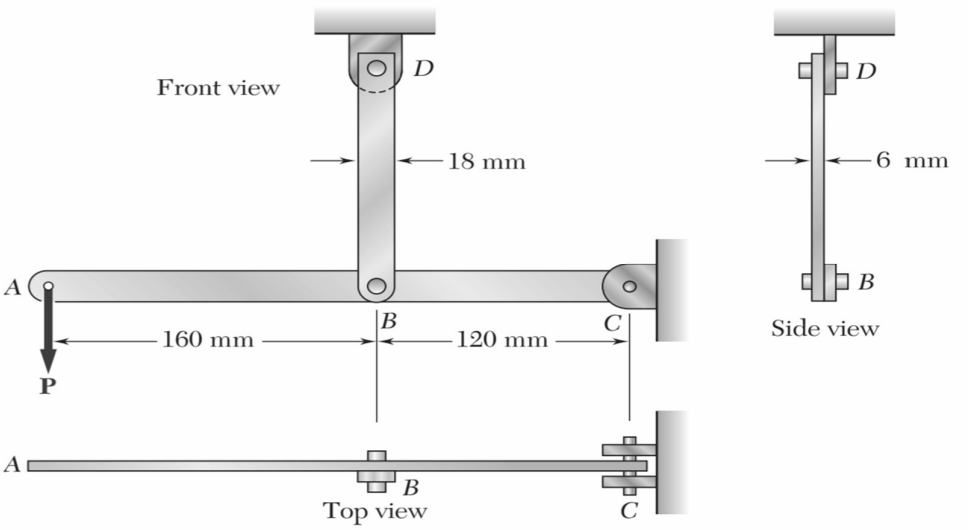

Figure Q1(b)

(60 marks)

2. (a) At room temperature, T_1 = 20°C, a **X**-mm gap exists between the ends of the rods shown in Figure 2 [a]. At a later time when the temperature has reached T_2, determine

(i) the normal stress in the aluminum rod (in MPa, to 1 decimal place),

(ii) the change in length of the aluminum rod (in mm, to 3 decimal places).

*__X__ and T_2 – wildcard

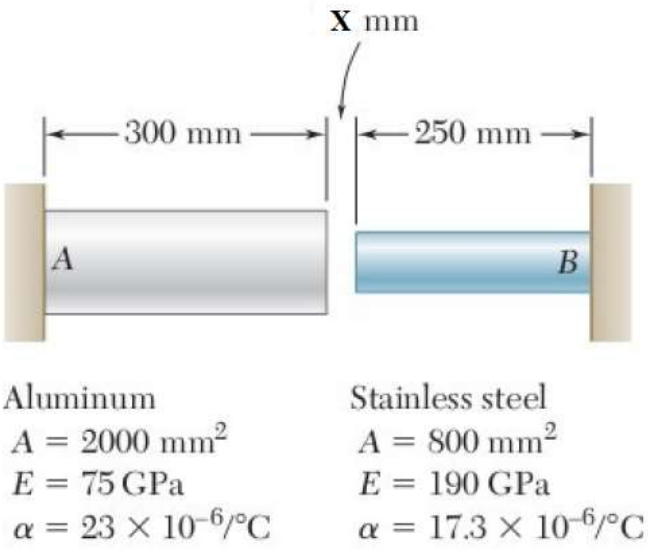

Figure 2 (a)

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(b) A compound shaft, shown in Figure 2 [b], consists of an aluminium alloy tube (1) [G = 26 GPa] and a solid bronze shaft (2) [G = 45 GPa]. Tube (1) has a length of L_1 = 900 mm, an outside diameter of D_1 = 35 mm, and a wall thickness of t_1 = 4 mm. Shaft (2) has a length of L_2 = 1,300 mm and a diameter of d_2 = 25 mm. If an external torque of $\boldsymbol{T_B}$ Nm acts at pulley B in the direction shown, determine the torque $\boldsymbol{T_C}$ required at pulley C so that the rotation angle of pulley C relative to A is $\boldsymbol{\phi}$ º (in Nm, to 1 decimal place).

*$\mathbf{T_B}$ and $\boldsymbol{p}$ - wildcard

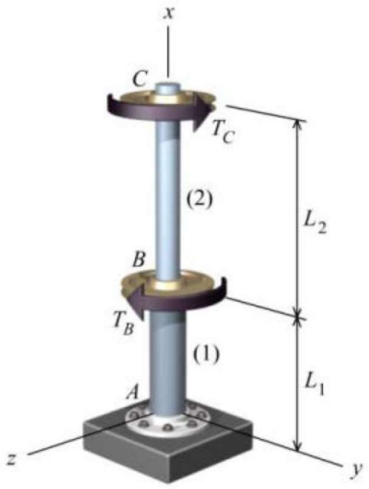

Figure 2 (b)

(50 marks)

3. A simply supported beam supports the loads shown in the Figure 3. The cross-sectional dimensions of the beam with the height of a= 400 mm and width of b= 300 mm.

(a) Plot the shear-force and bending-moment diagrams of the beam.

(6 marks)

(b) At the section of maximum bending-moment, determine the bending stress (MPa) at point H, which is located 75 mm below the top surface of the tube shape. Tip: tension stress is (+) and compression stress is (-).

(5 marks)

(c) At the section of maximum shear force, determine the shear stress (MPa) in the cross section at point H.

(5 marks)

(d) Determine the magnitude and the location of the maximum horizontal shear stress (MPa) in the tube.

(4 marks)

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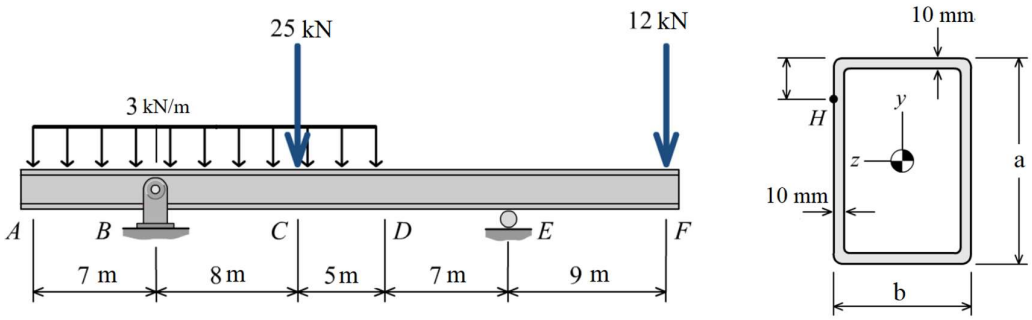

Figure 3

4. A shaft of a 20mm diameter is subjected to an axial tension of F= 5000 N, bending moment M= 200π Nm and at the same time a torque of T= 40πNm as shown in figure Q4 below. The point P is located at the top of the shaft, Q at the middle line of the shaft coinciding with the neutral axis and point R is located at the bottom of the shaft

   (i) Determine the stresses acting at the points P, Q and R

   (30 marks)

   (ii) Draw the Mohr's circle for points P, Q and R and determine the principal stresses and maximum shear stress for each point

   (30 marks)

   (iii) If the allowable tensile stress is 240 MPa, determine the maximum bending moment M that can be applied to the shaft, assuming that the axial tension is F = 5000N and torque is of T = 40πNm.

   (40 marks)

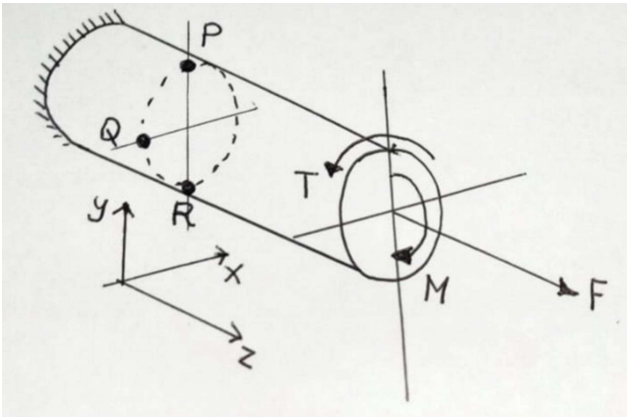

Figure Q4

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5. A rectangular strain rosette with three strain gauges arranged at zero degree (ε_0) at 45 degrees (ε_{45}) and at 90 degrees (ε_{90}) give strain readings of a steel plate as below:

$$\varepsilon_0 = 1000 \times 10^{-6}$$
$$\varepsilon_{45} = 1200 \times 10^{-6}$$
$$\varepsilon_{90} = 1400 \times 10^{-6}$$

a) Draw the Mohr's circle for the strain and determine the principal strains and maximum shear strain

(30 marks)

b) Draw the strain element for the conditions of maximum normal strain and maximum shear strain

(20 marks)

c) If the Young's Modulus is 200 GPa and the Poisson ratio is 0.3, determine the principal stresses for the point

(30 marks)

d) Discuss the importance of strain measurement and state one example of its application in the industry

(20 marks)

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