Second Semester Examination
2021/2022 Academic Session

July/August 2022

EAS152 – Strength of Materials

Duration : 2 hours

Please ensure that this examination paper consists of **SEVEN (7)** pages of printed material before you begin the examination.

Instructions: This paper contains **FIVE (5)** questions. Answer any **FOUR (4)** questions.

All questions **MUST BE** answered on a new page.

1. **Figure 1** shows a rigid bar ABC supported by the rod BD. The connection at point A is a single-shear pin while the connections at points B and D are double-shear pin. The diameter of the rod BD is 10 mm. The diameter of all pins is 20 mm. Given the distance AB = 2 m, the distance BC = 1 m, h = 1.5 m, P = 200 kN, and θ = 55°. Details of connections at support A, B and D are shown in **Figure 2**. Determine the following:

(a) Normal stress in Rod BD.

[5 marks]

(b) Shear stress in Pin B.

[5 marks]

(c) Shear stress in Pin A.

[5 marks]

(d) The maximum value of P, if allowable shear stress of all pins and normal stress of rod BD are 520 MPa and 750MPa, respectively.

[10 marks]

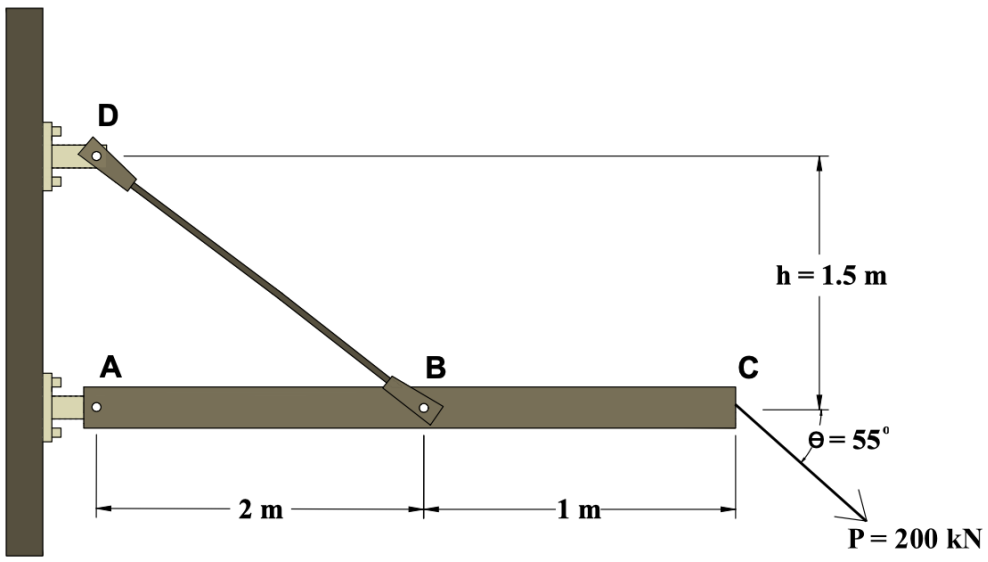

Figure 1

…3/-

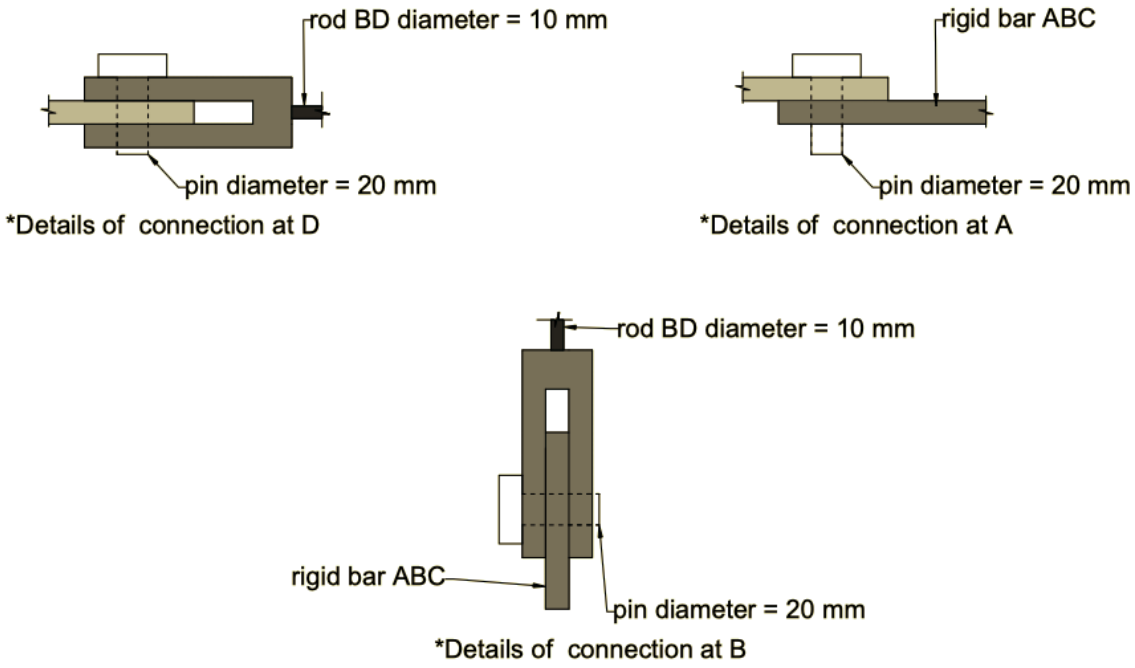

Figure 2

2. **Figure 3** shows a square composite bar consists of three different materials. A solid square copper bar is surrounded by steel and aluminium layers with a thickness of 5 mm and 3 mm, respectively. A compression load 35 kN is applied to the composite bar via a rigid steel plate. Young's Modulus of the copper, steel and aluminium are 90 GPa, 200 GPa and 80 GPa, respectively. Given the cross-sectional area of square copper bar is 400 mm^2, determine:

(a) Compression force in copper, steel and aluminium.

[15 marks]

(b) The corresponding compressive stress for copper, steel and aluminium.

[6 marks]

(c) Shortening for the composite bar.

[4 marks]

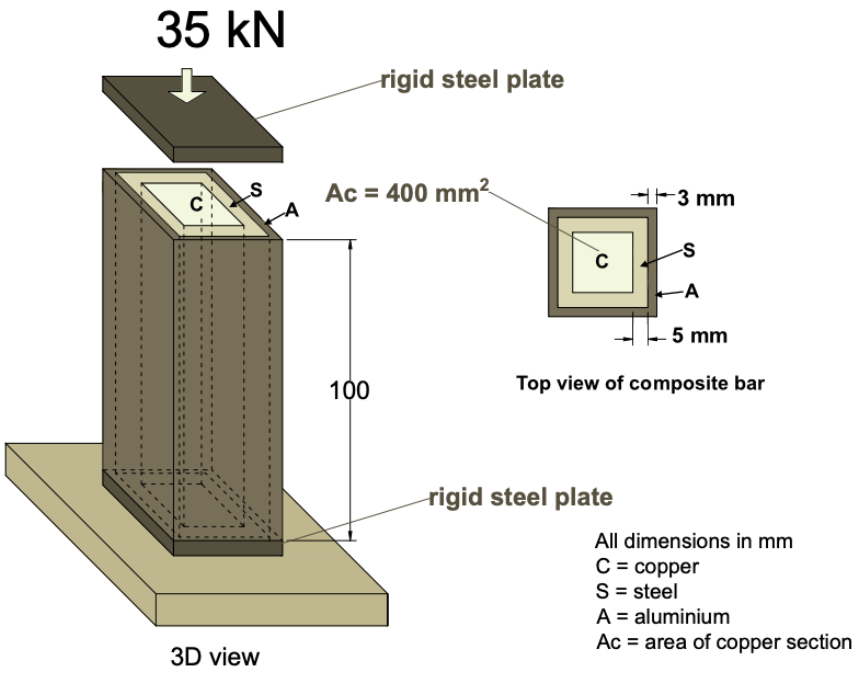

Figure 3

3. **Figure 4** shows a simply supported timber beam AB with 4.5 m long carrying the uniformly distributed load of 50 kN/m at span AC. An additional moment 20 kNm is applied at support B. The cross section of the timber beam is 75 mm x 250 mm.

(a) Determine the equations of shear force and bending-moment using cut section method.

[15 Marks]

(b) Draw the shear force and bending-moment diagrams for the beam AB.

[5 Marks]

(c) Determine the maximum normal stress due to bending and maximum shearing stress of the beams.

[5 marks]

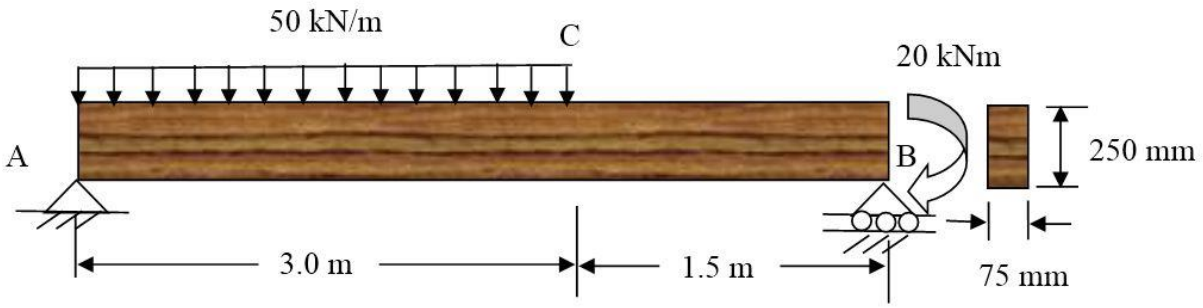

Figure 4

4. (a) **Figure 5** shows two shafts connected by the gears. End A of the shaft is connected to a motor while end D is fixed at the support. When the motor operates, the power from the motor will be transmitted through transmission shafts. Sketch the twisting moment produced by the motor and that transmitted to the machine at gears using curved arrows.

[3 marks]

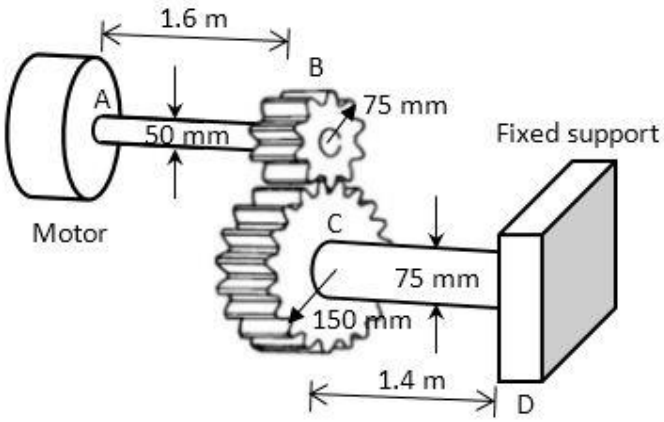

Figure 5

(b) The diameters of shaft AB and CD in **Figure 5** are 50 mm and 75 mm, respectively. The length AB is 1.6 m and the length CD is 1.4 m. Gear at B has a radius of 75 mm and gear at C has a radius of 150 mm. The motor produces 180 kW power at a frequency of 30 Hz. Given the shear modulus of elasticity of the material is 77 GPa.

i) If the shafts are solid shafts, determine the shearing stress in the solid shafts and the angle of twist between A and D.

[10 marks]

ii) If the shafts are hollow shafts, determine the thickness of each shaft so that the allowable shearing stress of 55 MPa and the allowable angle of twist of 2.5^0 for each shaft are not exceeded.

[12 marks]

5. Determine the equivalent state of stress on an element at the same point for the following cases with respect to the element shown in **Figure 6** using Mohr's circle. Nominal stress in x and y directions are 350 N/mm^2 and 200 N/mm^2, respectively, while shear stress is 400 N/mm^2.

Sketch the corresponding element for each result.

(a) The principal stress and the corresponding orientation.

(b) The maximum in-plane shear stress and the associated average normal stress and the corresponding orientation.

(c) The stresses at an angle of 40° in counter clockwise directions.

[25 marks]

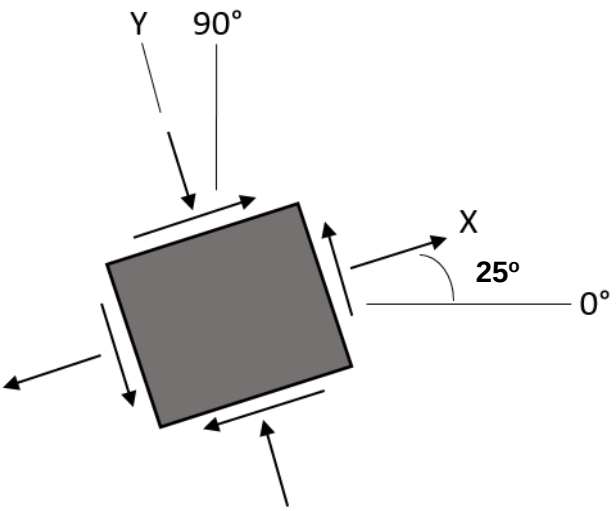

Figure 6

-oooOOOooo-