THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL

UNIVERSITY SENATE EXAMINATIONS

JUNE 2023

MEC 3351 – STRENGTH OF MATERIALS I

QUESTION PAPER

Read the following instructions carefully before you start writing

1. This examination is Closed Book
2. Time allowed is Three (3) Hours
3. ANSWER any Five (5) questions
4. All questions carry 20 marks each
5. Show all the work leading to the solution

1. The composite bar in Figure Q1 is stress-free before the axial loads P_1 and P_2 are applied. Calculate the stress in each material if P_1 =150kN and P_2 =90kN, given that:

a) Both walls are rigid. **[10 Marks]**

b) The right wall yields by 0.8mm. **[10 Marks]**

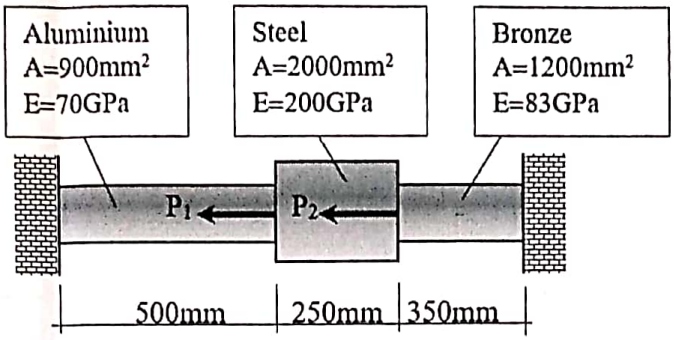


Figure Q1

2. In a lap-joint shown in Figure Q2, two steel flat plates are held together with the help of two symmetrically placed rivets. With the left plate firmly fixed on the left side, the assembly is designed to support a tensile loading of 10kN applied to the joint at point *A* which is located at an eccentricity of 12mm. Determine the minimum diameter of the rivets capable of supporting this joint, given that the rivet material has a maximum allowable shear stress value of 65N/mm^2. **[20 Marks]**

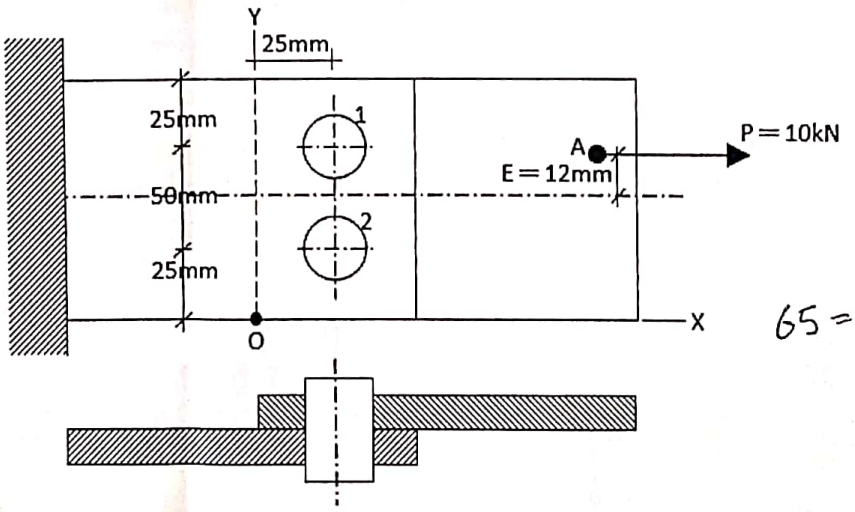
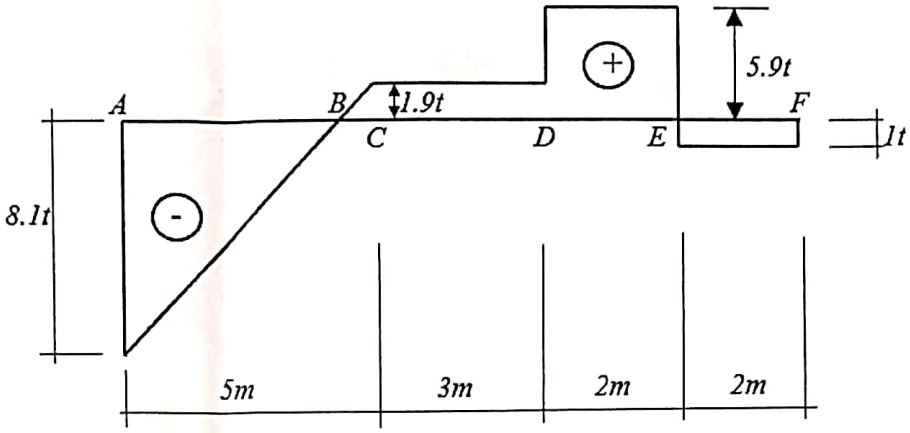


Figure Q2

3. The shear force diagram for a beam ACBDEF, supported at A and at one more point, is represented by Figure Q3. Generate this loaded beam and its corresponding bending moment diagram.

[20 Marks]



Shear Force Diagram

Figure Q3

4. A cylindrical steel pressure vessel 400mm in diameter with a thickness of 20mm, is subjected to an internal pressure of 4.5MN/m^2.

   a) Calculate the tangential and longitudinal stresses in the steel. **[10 Marks]**
   b) To what value may the internal pressure be increased if the stress in the steel is limited to 120MN/m^2? **[8 Marks]**
   c) If the internal pressure were increased until the vessel burst, sketch the type of fracture that would occur. **[2 Marks]**

5. For the loaded beam shown in Figure Q5. Determine the minimum height h of the beam section, given that the allowable stress in the beam is not to exceed 20MPa. **[20 Marks]**

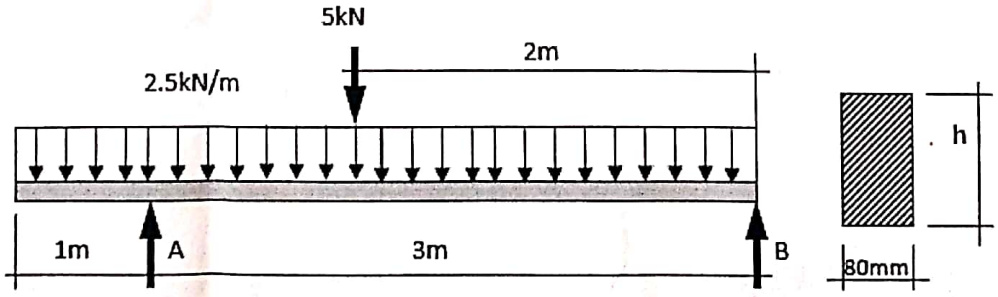


Figure Q5

6. Following a road traffic accident you have been engaged by the Road and Transport Safety Agency (RTSA) to do a stress analysis on the wrecks of motor vehicles to help in establishing the exact cause of the accident. The preliminary finding of stress analysis portrays a stress system as given in Figure Q6.

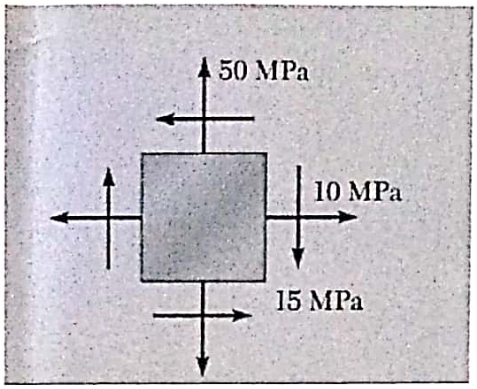


Figure Q6

As part of the research team, you are required to:

(a) Construct the Mohr's cycle and, **[05 Marks]**

(b) Using the Mohr's cycle, determine:

(i) The principal stresses.

(ii) The principal planes.

(iii) The maximum in-plane shear stress. **[12 Marks]**

(c) What is the significance of the findings of the stress analysis? **[3 Marks]**