



KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (MANUFACTURING ENGINEERING)

SET 302: SOLID AND STRUCTURAL MECHANICS I

DATE: Friday 2nd December 2011

TIME: 2.00p.m -4.00p.m

INSTRUCTIONS:

1. This paper contains **FIVE** questions
2. All questions carry **EQUAL MAXIMUM** marks
3. Attempt any **THREE** questions
4. All symbols have the usual meaning unless specified otherwise.

QUESTION ONE (20 Marks):

- a) Differentiate between the concept of:
 - i) load and stress (2 Marks)
 - ii) Stress and Pressure (2 Marks)
 - iii) Stress and Strength (2 Marks)
- b) A hollow right circular cylinder is made of cast iron and has an outside diameter of 85mm and an inside diameter of 70mm. The cylinder measures 700mm in length and is subjected to axial compression load of 50kN. Neglecting any possibility of lateral buckling of the cylinder, determine the normal stress and shortening in length of the cylinder under this load. Take the Modulus of Elasticity of cast iron to be 100GPa. (5 Marks)
- c) ABCD is a rigid horizontal bar hinged at A and supported in horizontal position by Steel and Aluminum rods – as shown in Figure Question 1 c). If a force of 150kN is applied to the point D. calculate the stress in the Steel rod and Aluminum rod. (9 Marks)

QUESTION FOUR (20 Marks)

a) A hollow propeller shaft of a truck has outside diameter 60 mm, inside diameter 50 mm and is made of steel of shear modulus 80 GPa. During service, the shaft rotates at 620 rpm. The allowable stress at the outside of the shaft is 180 MPa and the allowable angle of twist per unit length is 4° . Determine the maximum power that can be transmitted by the shaft. (5 Marks)

b) A hollow aluminum shaft has outside diameter of 120 mm and inside diameter of 90 mm. The shaft is 3m long and the shear modulus of the material $G=30\text{GPa}$.

i) If a torque is applied on the shaft ends, determine the angle of twist when the maximum shear stress is 60 MPa. (3 Marks)

ii) Determine the diameter 'd' required for a solid shaft to carry the same torque with the same maximum stress. (4 Marks)

c) A hollow marine propeller shaft turning at 110 rev/min is required to propel a vessel at 47 km/h for the expenditure of 6.4 MW, the efficiency of the propeller being 68 per cent. The diameter ratio of the shaft is to be $2/3$ and the direct stress due to the thrust is not to exceed $8\text{MN} / \text{m}^2$.

Calculate: i) the shaft diameters, (4 Marks)

ii) The maximum shearing stress due to the torque (4 Marks)

QUESTION FIVE (20 Marks)

a) A uniform concrete slab weighing 1200 kN has been attached to two rods, whose lower ends are at the same level as shown in Figure Q5 a). One rod is of Aluminum and has a length of 1.5m. The other rod is of steel and measures 2m in length. Make calculations for the ratio of areas of the rods if the slab is to remain horizontal. The modular ratio of steel to Aluminum is 2.86. (7 Marks)

b) Derive an expression for overall deformation in the axial direction of Figure Q5 b). (6 Marks)

c) Two copper rods, one steel rod lie in a vertical plane and together support a load of 50kN as shown in Figure Q5 c). Each rod is 25mm diameter, length of steel rod is 3m and length of each copper rod is 2m. If modulus of elasticity of steel is twice that of copper, make calculations for the stress induced in each rod. It may be assumed that each rod deforms by the same amount. (7 Marks)

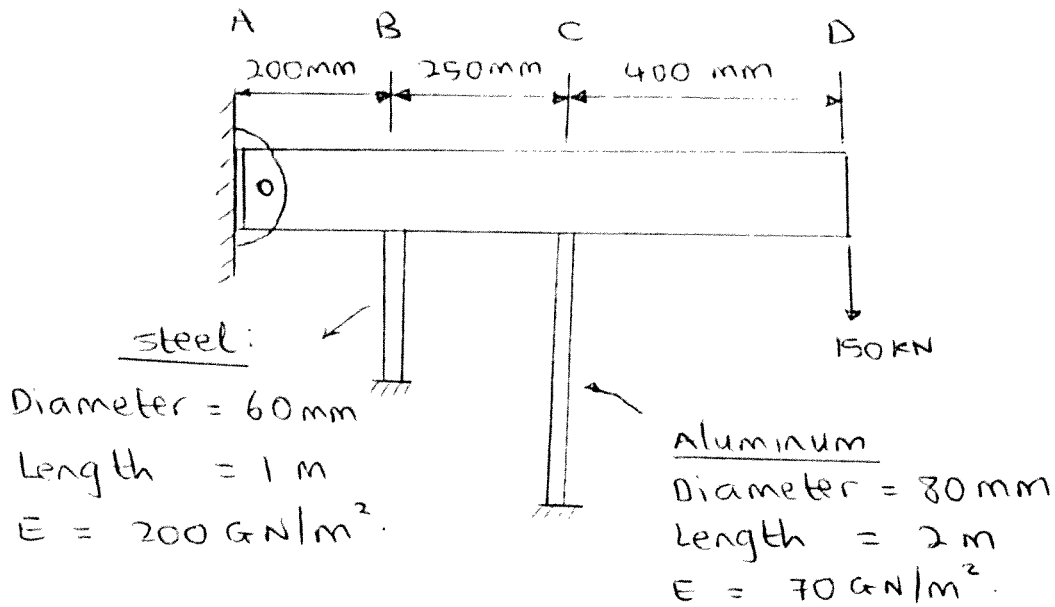


FIGURE Q1 c

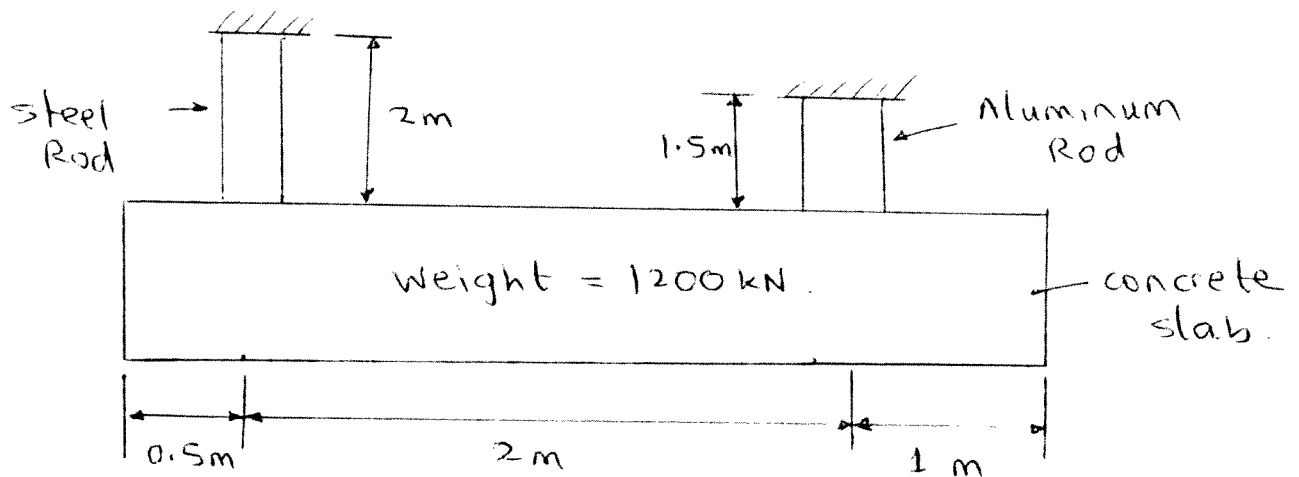


FIGURE Q5 c

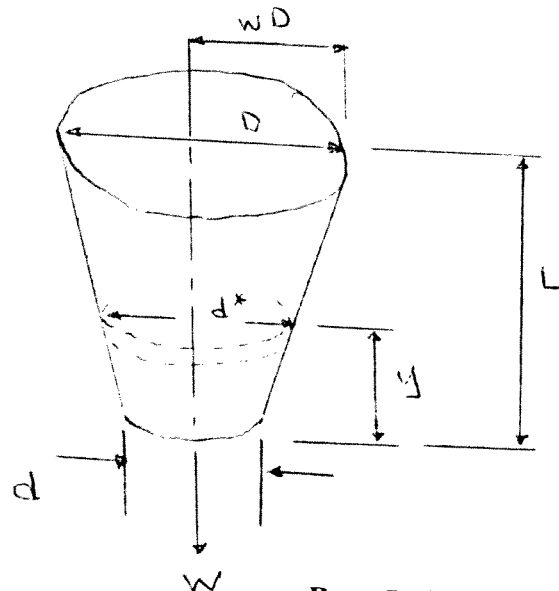


FIGURE Q5 b)

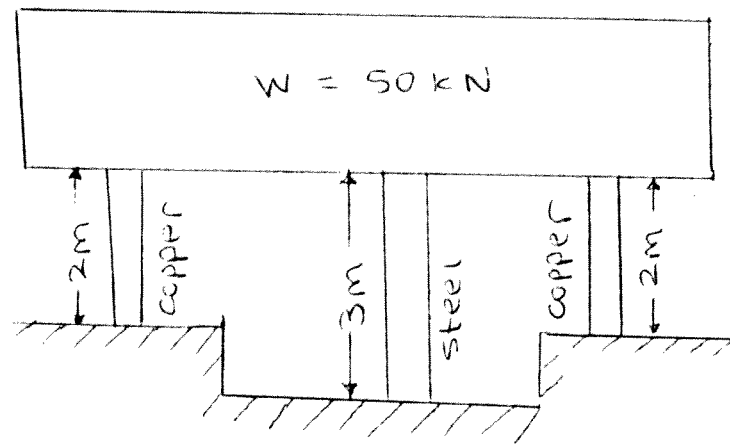


FIGURE Q5 C)