NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

INDUSTRIAL AND MANUFACTURING ENGINEERING DEPARTMENT

Bachelor of Engineering Honours Degree Industrial and Manufacturing Engineering

PART II END OF SEMESTER I EXAMINATIONS - DECEMBER 2011

SOLID MECHANICS I **COURSE CODE TIE 2103**

Examination duration3 hours

INSTRUCTIONS AND INFORMATION TO CANDIDATE

Answer any FOUR questions out of SIX.

Show all working

All Questions carry equal marks (25) each.

QUESTION ONE

(a) A solid steel cylinder S is encased in a hollow circular copper tube C as shown on Figure Q1.1. They are compressed by force P. The steel cylinder has cross-sectional area A_s and modulus of elasticity E_s. The copper tube has area A_c and modulus E_c. Both parts have length L. Determine the following quantities for the structure:

(i) Compressive force P_s in the steel cylinder and P_c in the copper tube **[5]**

(ii) Compressive stresses **[5]**

(iii) Shortening of the assembly **[5]**

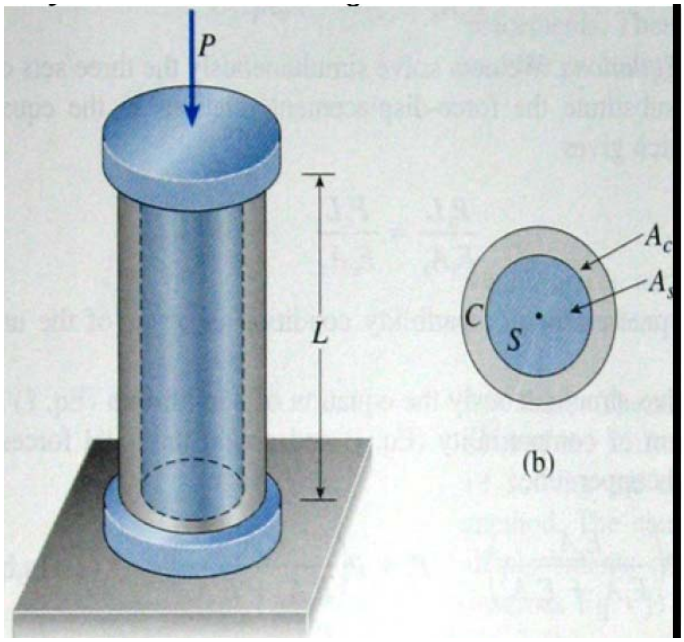


Figure Q1.1

(b) Determine the elongation of the bar due to load P as shown on Figure Q1.2 [10]

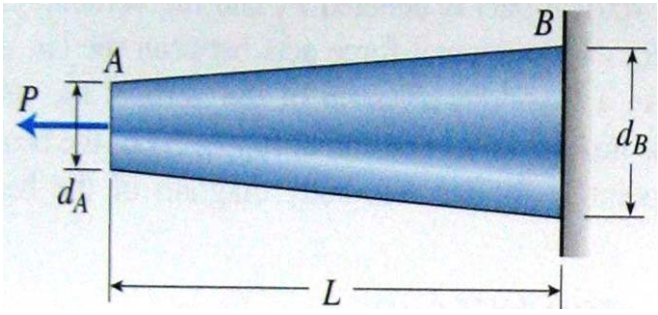


Figure Q1.2

QUESTION TWO

(a) In Figure Q2.1 the rigid bar BDE, is supported by two links AB and CD. Link AB is made of aluminium (E= 70 GPa) and has a cross-sectional area of 500 mm^2. Link CD is made of steel (E= 200 GPa) and has a cross-sectional area of 600 mm^2. For the 30-kN force shown, determine the deflection of:

(i) B, **[5]**

(ii) D, and of **[5]**

(iii) E. **[5]**

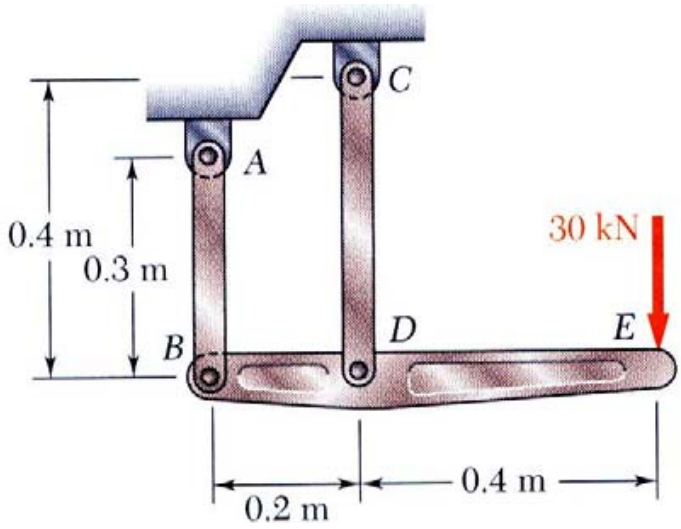


Figure Q2.1

(b) In Figure Q2.1 determine the deformation of the steel rod under the given loads.
E = 200 kPa psi for the material and the diameters are respectively D = 30 mm and d =16 mm.

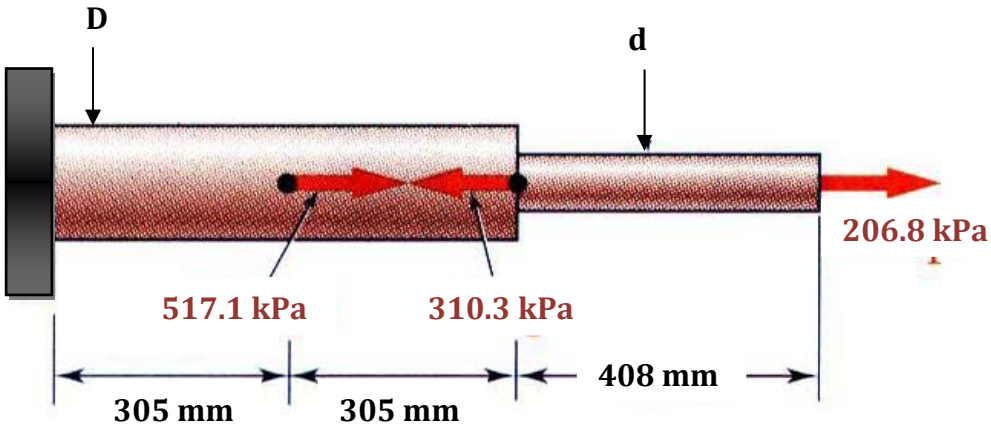


Figure QU2(b)

[QUESTION THREE

(a) Figure Q3.1 below shows two possible configurations for the assembly of a joint on a machine support structure which are to be evaluated. The diameter of the support pin is 1 inch. Determine which joint assembly is preferable in terms of its ability to sustaining greater stress. **[8]**

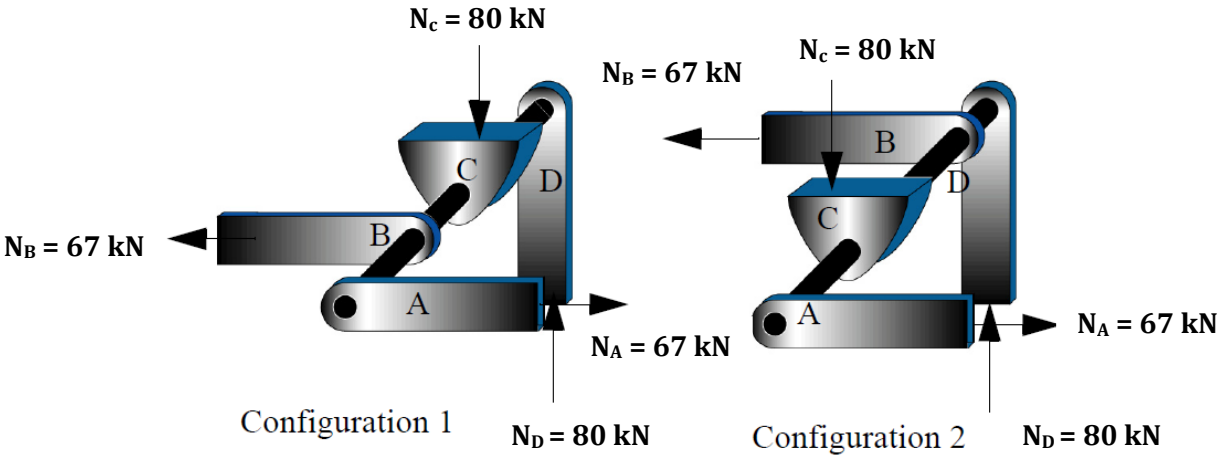
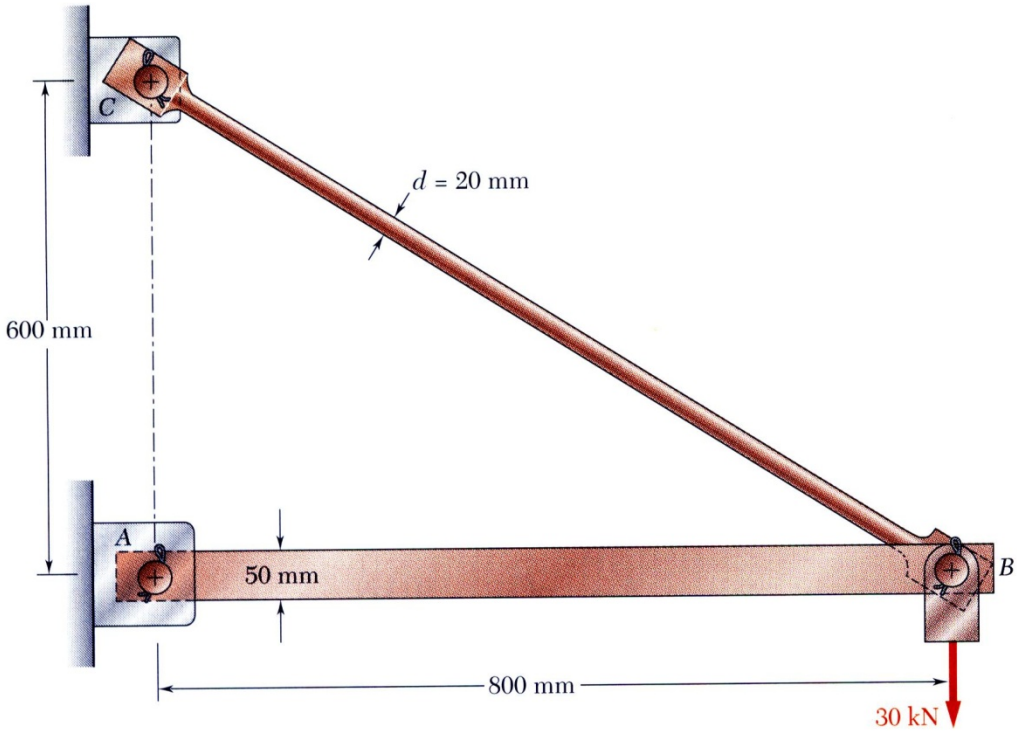


Figure Q3.1



The allowable stress is $\sigma_{all} = 165Mpa$

Figure Q3.2

(b) The structure in Figure 3.2 is designed to support a 30 kN load. The structure consists of a boom and rod joined by pins (zero moment connections) at the junctions and supports.

(i) Perform a static analysis to determine the internal force in each structural member and the reaction forces at the supports. **[9]**

(ii) Can the structure safely support the 30 kN load? **[2]**

(iii) For reasons based on cost, weight, availability, etc., the choice is made to construct the rod from aluminum (s_{all}= 100 MPa). What is an appropriate choice for the rod diameter? **[6]**

QUESTION FOUR

(a) Locate the centroid of the L-shaped area for the L shaped profile shown on Figure QU4. **[4]**

(b) Determine the centroidal moment of inertia I_y for the L-shaped section. **[6]**

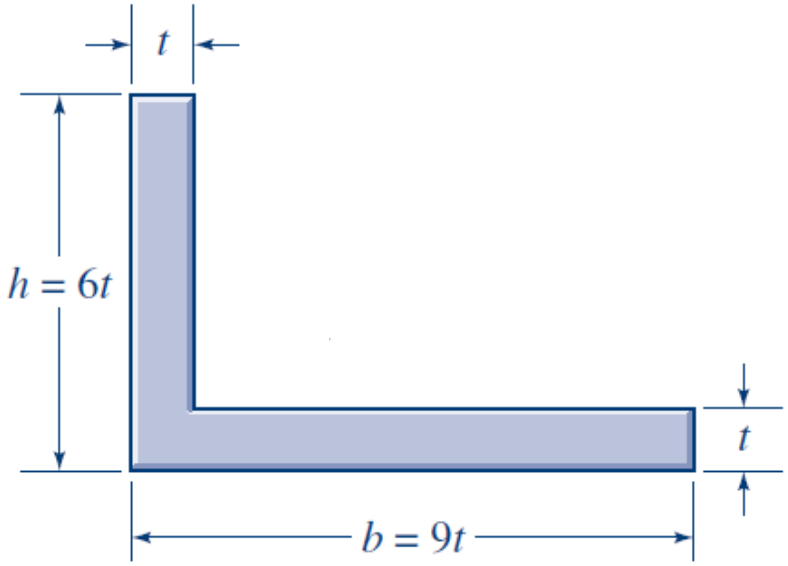


Figure Q4

(c) A beam has a hollow circular cross section 40 mm outer diameter and 30 mm inner diameter. It is made from metal with a modulus of elasticity of 205 GPa. The maximum tensile stress in the beam must not exceed 350 MPa. Compute:

(i) The maximum allowable bending moment. **[8]**

(ii) The radius of curvature **[7]**

QUESTION FIVE

The unequal flange section shown on Figure Q5 is part of the structural support works designed for installation on a soon to be implemented new manufacturing workshop project in Bulawayo Belmont Industrial site.

(a) Determine the stress on the top and bottom of the section when the bending moment is 300 Nm. **[15]**

(b) Sketch and label the stress distribution set up for the structure. **[10]**

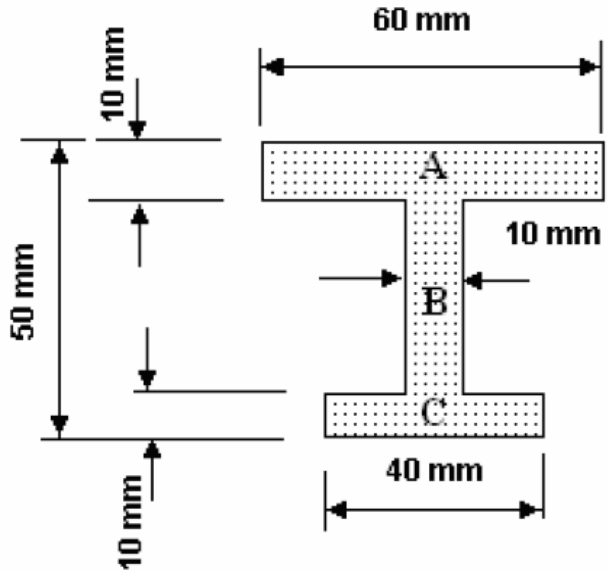


Figure Q5

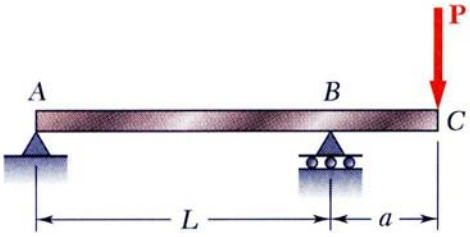
QUESTION SIX

Figure Q6 shows an overhanging beam representing a machine room support structure. For portion *AB* of the overhanging beam:

(*a*) derive the equation for the elastic curve, **[8]**

(*b*) determine the maximum deflection, **[10]**

(*c*) evaluate maximum deflection, (y_{max}). **[7]**



W14 x 68 I = 723 cm4 E = 29 x 106 MN/m2 P = 50 kN L = 180 cm a = 48 cm

Figure QU6

End of Examination