The University of Zambia
School of Engineering
Department of Civil and Environmental Engineering

CEE 3211 – Mechanics of Materials Test (2023)

Instructions

Attempts all four questions. All Questions Carry equal marks

Duration: 2 hours

Q1. The assembly consists of two 15-mm-diameter aluminium rods AB and CD, a 25-mm-diameter aluminum rod EF, and a rigid bar AEC. With the loads applied as shown, determine the **overall displacement** of end **F** of rod EF. Take E_{al} = 70 GPa.

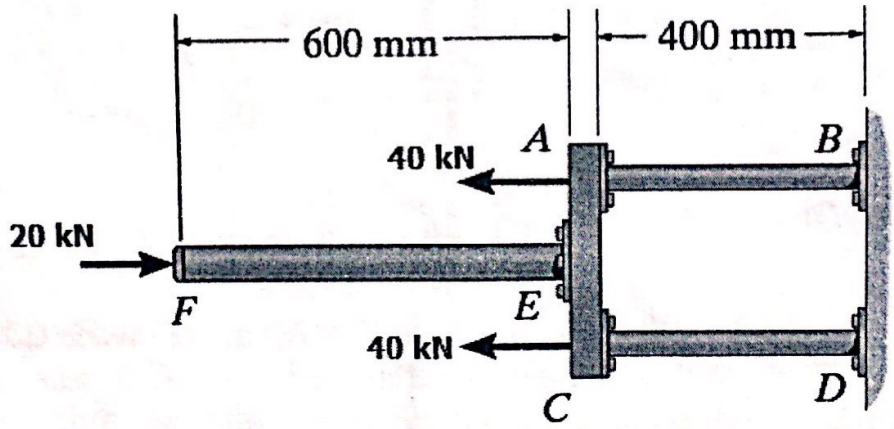

Fig Q1

Q2 A composite cylindrical rod, ABCD consists of bar 1, Bronze (E = 101 GPa) and Bar 2, Cast Iron (E = 84 GPa) fixed at both ends as shown in Figure Q2. The bar has a point load P = 50 kN applied at the collar as shown. The thermal coefficient of expansion for Bronze and Cast Iron coefficient as 17×10^{-6}/°C and 10.8×10^{-6}/°C respectively. The composite rod is subjected to a temperature rise of 130°C. Assuming the rod is initially unstressed:

a. Calculate the **stress induced** in both bars AB and CD

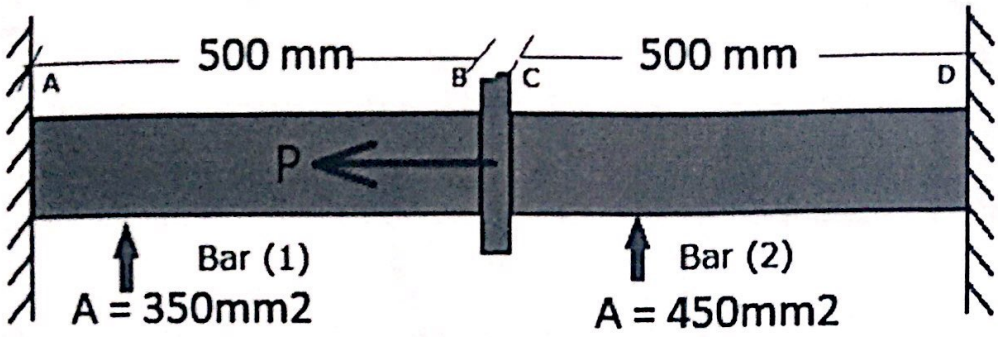

Fig Q2

Q3 A steel beam of 8 m in length has a T cross-section shown in Figure Q3. A positive bending moment M = 25 kN.m is applied to the beam. Calculate the **maximum compressive** and **tensile stresses**. Take E_{st} as 200 GPa.

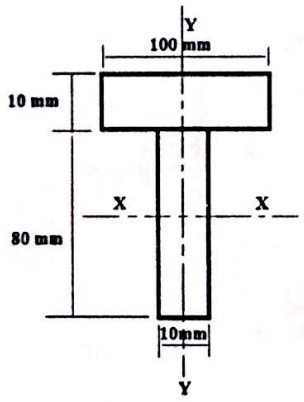

Fig Q3

Q4. A shaft ABCD shown in Fig Q4 is fixed at A and consists of 3 solid circular segments, each with a diameter of 50mm. The shaft is subjected to torques T1, T2, and T3 acting as shown in the figure. All three segments have the same length of 500 mm, but they are made of different materials. Shear Moduli for AB, BC and CD are 26GPa, 37GPa and 76GPa respectively. Calculate the following quantities:

(a) the **shear stress** in each segment
(b) the **angle of twist** (**in degrees**) at end D.

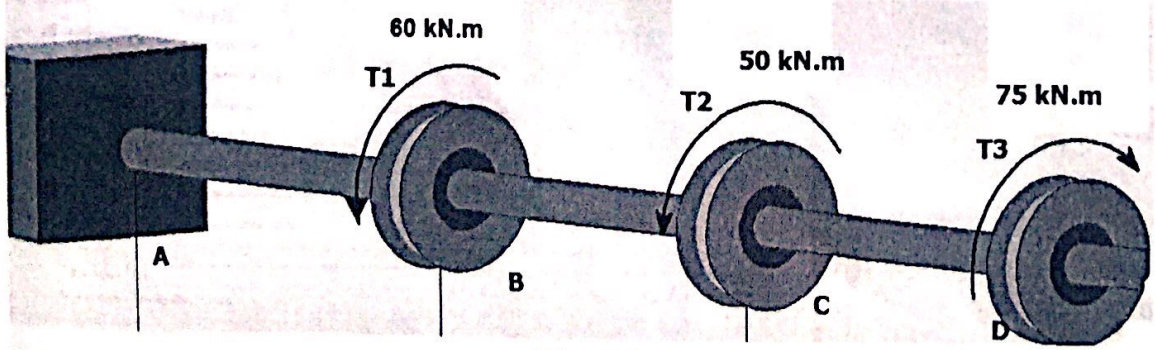

Fig Q4