NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

INDUSTRIAL AND MANUFACTURING ENGINEERING DEPARTMENT

PART II SEMESTER I (2010-11) EXAMINATION: January 2011

SOLID MECHANICS I **Course Code TIE 2103**

Examination duration 3 hours

INSTRUCTIONS TO CANDIDATE

Answer any FIVE questions out of EIGHT.
Show all working
All Questions carry equal marks (20)

QU1. A beam 10m long rests on two supports placed 5m apart, and overhangs at the right hand support by 3m. It carries a load of 40kN/m run between the supports. In addition, it carries isolated loads of 50kN at the left hand end, 20kN at a point 1m from left-hand end, and 40kN at the right-hand end.

(a) Sketch the bending moment diagram **[7]**
(b) Sketch the shear-force diagram **[7]**
(c) State the value and location of the maximum bending moment **[6]**

QU2. An I-section girder, 200 mm wide by 300 mm deep, with flange and web thickness 20 mm is used as a simply supported beam over a span of 7 m. The girder carries a distributed load of 5 kN/m and a concentrated load of 20 kN at mid-span. Determine:

(a) the second moment of area of the cross-section of the girder, **[10]**

(b) the maximum stress set up. **[10]**

QU3. A decorative structural member, on an events house showroom, is fabricated by connecting a brass rod (E = 100 GPa; α_T = 19 x $10^{-6o}C^{-1}$) and an aluminium rod (E = 70 GPa; α_T = 23.5 x $10^{-6o}C^{-1}$) together. Each rod has an area of 50 cm^2 and is 1m long. If this composite member is attached between rigid supports, as shown on Figure QU3 below, and the temperature drops 50^oC, determine;

(a) the reactions **[10]**

(b) the stress in the member. **[10]**

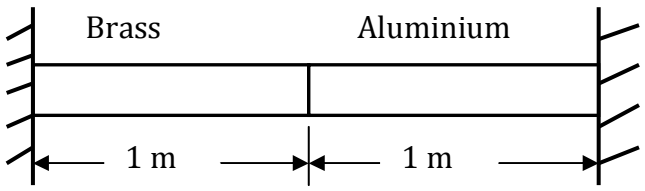

Figure QU3

QU4. (a) A solid shaft, 100 mm diameter, transmits 75 kW at 150 rpm.

(i) determine the value of the maximum shear stress set up in the shaft, and **[5]**

(ii) the angle of twist per meter of the shaft length if G = 80 GN/m^2. **[5]**

(b) If the shaft in (a) were now bored in order to reduce the weight and to produce a tube of 100 mm outside diameter and 60 mm inside diameter,

(i) what torque could be required if the same maximum shear stress is not to be exceeded? **[5]**

(ii) what is the percentage increase in the power/weight ratio effected by this modification? **[5]**

QU5. (a) A steel transmission shaft is 510 mm long and 50 mm external diameter. For a part of its length it is bored to a diameter of 25 mm and for the rest to 38 mm diameter. Find the maximum power that may be transmitted at a speed of 210 rev/min if the shear stress is not to exceed 70 MN/m^2. **[10]**

(b) If the angle of twist in the length of 25 mm bore is equal to that in the length of 38 mm bore, find the length bored to the latter diameter. **[10]**

QU6. Determine the value of the second moment of area about the neutral axis of the stylised 'T' section of a building support beam shown in Figure QU6 below, using the parallel axis theorem. **[20]**

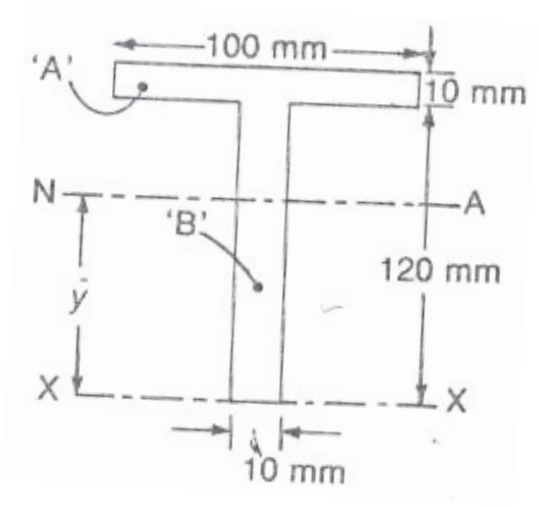

Figure QU6

QU7. A girder of I-section has a depth of 250 mm and a second moment of area of 10^8 mm^4. It is 6 m long, simply supported at its ends and carries a uniformly distributed load of 30 kN/m. Calculate:

(a) the maximum bending moment **[6]**

(b) the maximum stress in the girder **[7]**

(c) the radius of curvature at the point of greatest bending moment. **[7]**

Take E = 205 GN/m^2

QU8. The diagrams below, shown on Figure QU8, relate to a reinforced concrete support beam on a building being proposed for incorporation by the Technicians under your supervision as the projects Engineer, on a workshop construction project which your company is carrying out in Bulawayo city centre. The beam has the specifications outlined as following. It has a width of 240 mm and has 450 mm depth to the centre of the reinforcing steel rods. The steel rods are of total cross-sectional area 1.2×10^{-3} m^2 and the maximum allowable stresses in the steel and concrete are 150 MN/m^2 and 8 MN/m^2 respectively. The modular ratio (steel: concrete) is 16.

(a) Determine the moment of resistance of the beam **[10]**

(b) If, after installation, it is required to up-rate the service loads by 30% and to replace the above proposed beam with a second beam of increased strength but retaining the same width of 240 mm, determine:

(i) the new depth, and **[4]**

(ii) area of steel for tension reinforcement required **[6]**

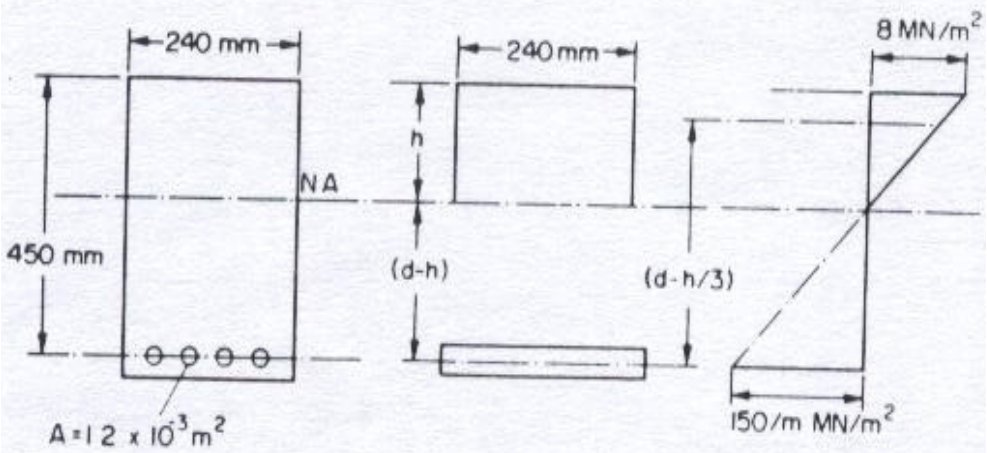

Figure QU8

The End