ZIMBABWE

MINISTRY OF HIGHER AND TERTIARY EDUCATION

HIGHER EDUCATION EXAMINATIONS COUNCIL (HEXCO)

NATIONAL DIPLOMA

IN

MECHANICAL ENGINEERING

SUBJECT: Strength of Materials **PAPER NO: 539/S11**

NOVEMBER 2011 EXAMINATION

REQUIREMENTS

Formulate booklet
Graph paper
Scientific Calculator

INSTRUCTIONS TO CANDIDATE

1. **Answer any five questions**
2. **Each question carries 20 marks only**
3. **Start each question on a new page**

This paper consists of 5 printed pages.

PAPER NO: 539/S11 – STRENGTH OF MATERIALS

QUESTION 1

A load of 2 tonnes is placed on a collar at the end of a vertical tie rod of 20mm diameter. Calculate:

a) the static stress induced (9 marks)

b) if the load is dropping from a height of 160mm, calculate the maximum stress induced in the road, given that the rod is 2300mm long and E = 230GN/m^2. (7 marks)

c) What is the maximum stress if the load is not dropped but applied suddenly without impact? (2 marks)

d) If the impact loading in (b) causes an extension at the instant of 0,2mm. Calculate the work done. (2 marks)

QUESTION 2

A closely coiled helical spring is made from a piece of steel wire 1.5m long (excluding amount required for end connection) and 3mm in diameter. The mean diameter of the coils is 75mm when the spring is subjected to an axial load of 10N, find :

a) the shear stress set up in the wire (14 marks)

b) the deflection at the bottom of the helix, if the modulus of rigidity of the material is 80 x 10^{3}N/mm^2. (6 marks)

QUESTION 3

Find the expression for deflection of the beam in terms of x. Refer to Fig 1. (20 marks)

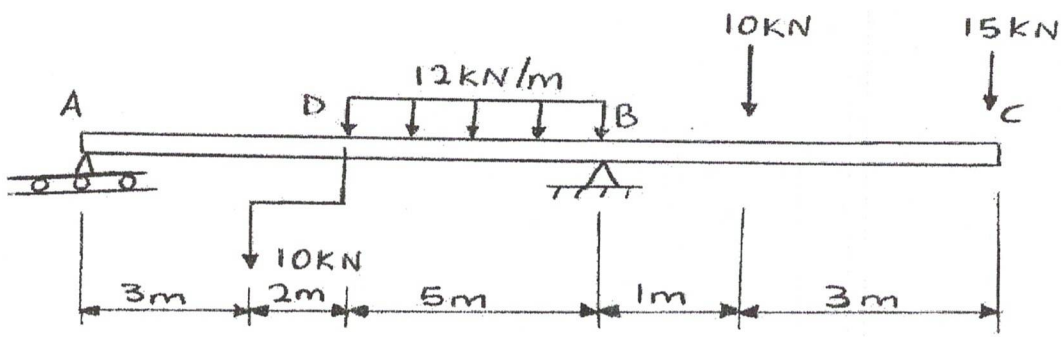


Fig 1.

QUESTION 4

The following strains were measured at a point on a material:

$E_x = 400 \times 10^{-6}$; $E_y = 300 \times 10^{-6}$; $E_{xy} = -600 \times 10^{-6}$.

a) Calculate the principal strain and maximum shear strain. (10 marks)

b) Calculate the linear and shear strain on a plane inclined at an angle 35° clockwise from the positive x – axis
$E = 200GN/m^2$; $\nu = 0,3$. (10 marks)

QUESTION 5

a) An experimental pressure vessel of spherical shape, and 450mm diameter, has to withstand in internal fluid pressure of 7MPa without the stress in the shell material exceeding 70 MPa. Calculate the required thickness of the vessel's shell. (5 marks)

b) If the shell is to be made by bolting together two flanged halves using sixteen bolts:

i) What should be the root area of each bolt?

ii) What is the diameter of each bolt? The tensile stress in the bolts must not exceed 150MPa. (15 marks)

QUESTION 6

a) A compound bar is constructed from three bars 50mm wide by 12mm thick fastened together to form a bar 50mm wide by 36mm thick. The middle bar is of aluminium alloy for which E = 70GN/m^2 and the outside bars are of brass with E = 100GN/m^2. If the bars are initially fastened at 18°C and the temperature of the whole assembly is then raised to 50°C, determine the stresses set up in the brass and the aluminium.

b) What will be he changes in these stresses if an external compressive load of 15KN is applied to the compound bar at the higher temperature?

α_{AL} = 18 X 10^{-6}/°c; α_B = 22 x 10^{-6}/°C (20 marks)

QUESTION 7

Fig. 2

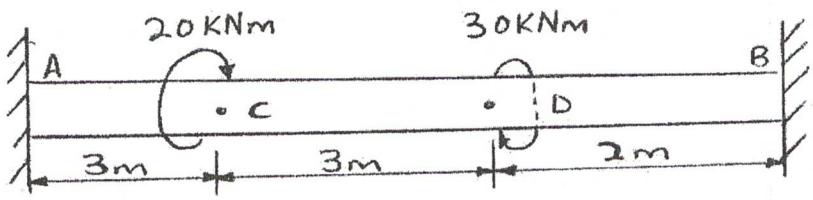
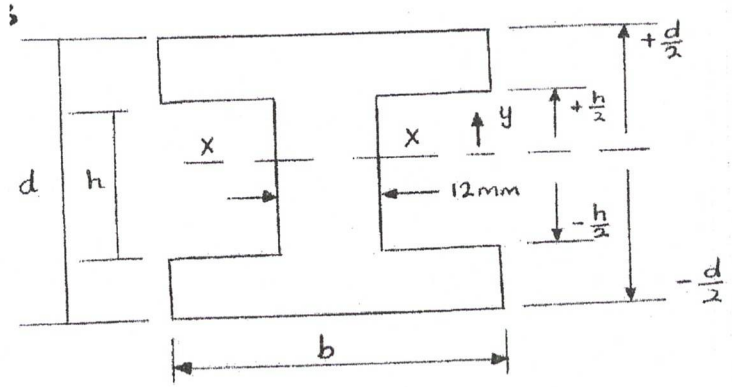


FIG 2 shows a steel shaft 200mm diameter and 8m long which is fixed at its ends. Torques of 20KNm (clockwise) and 30KNm (anticlockwise) are applied at 3m and 6m respectively from end A. Plot a variation of torque, surface shear stress and angle of twist along the shaft length. Take G = 80MPa and arrange answers as follows:

a) Reactions
b) Torques
c) Twists
d) Torque variations

QUESTION 8

Fig 3.



d	=	150mm
h	=	126mm
b	=	80mm
t	=	12mm
Q	=	250KN

Fig 3 shows an I – section in which d = 150mm, h = 126mm, b = 80mm, t = 12mm and Q = 250KN. At any section or given position on the beam of uniform I- section, the beam is subjected to a shear force of 250KN. Calculate:

a) the second moment of area (3 marks)
b) maximum shear in the web (5 marks)
c) minimum shear stress distribution in the web (6 marks)
d) Sketch the shear stress distribution graph for the web given that:

$$T = \frac{Q}{2I}\left[\left(\frac{h^2}{4} - y^2\right) + \frac{Qb}{2It}\left(\frac{d^2}{4} - \frac{h^2}{4}\right)\right]$$

.....*rg/pk*