SECTION A

To be attempted if you wish to improve your marks in the Lent Term examination. Attempt both questions.

1. (12 marks)

The structure ABCDEF shown in Fig. 1 has pinned supports at B and E. There is an internal hinge at C and a rigid, right-angled bend at D. A vertical concentrated force of 5 kN acts at C, a triangular distribution of maximum intensity 5 kN/m acts on DEF and a couple of magnitude 10 kN.m acts at F.

(a) Determine the horizontal and vertical components of reaction acting on the structure at B and E.

(b) Considering the segment DEF as a free body, draw the bending moment and shearing force diagrams for this segment.

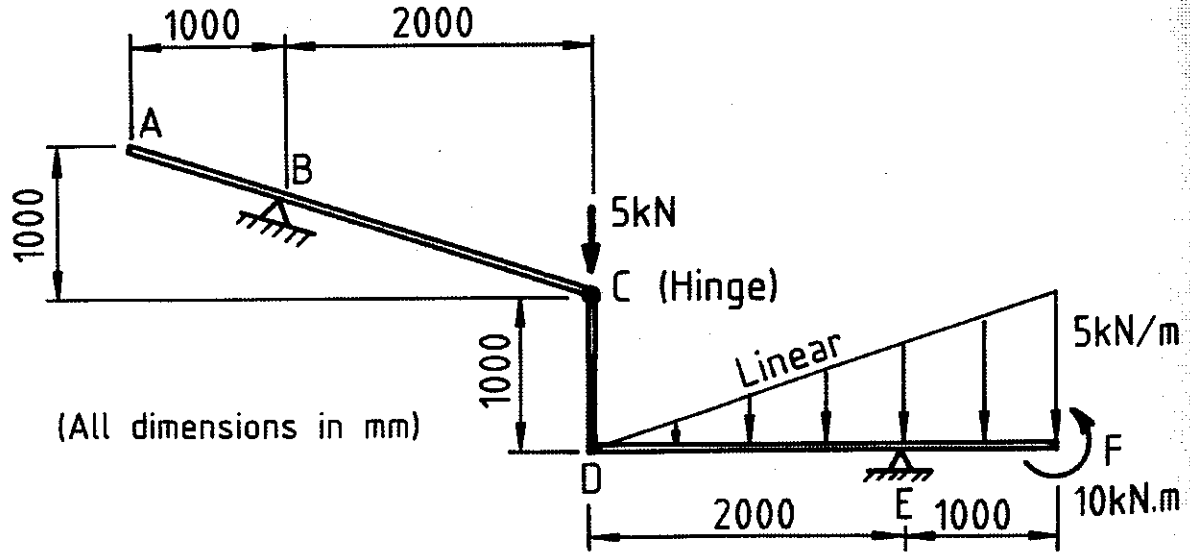


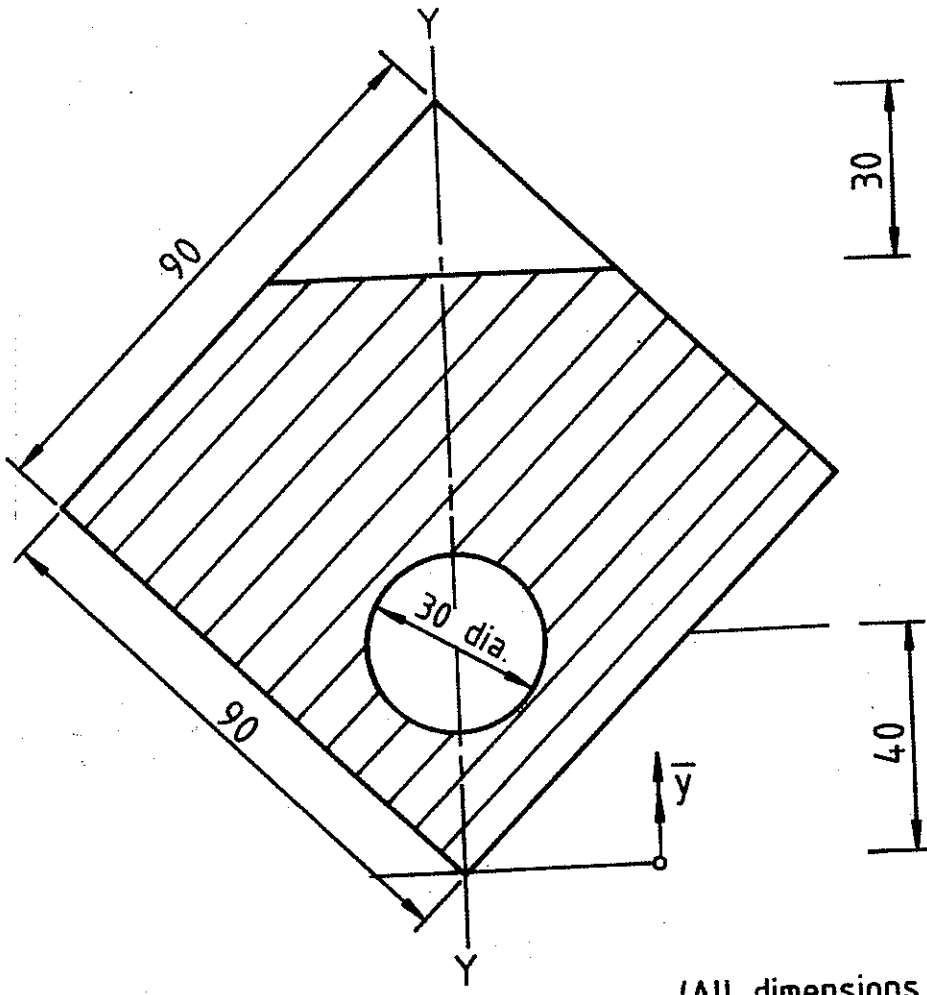
FIG.1

2. (8 marks)

The beam shown in Fig. 2 has a square cross-section of side 90 mm. It has a vertical (YY) axis of symmetry. A triangular corner of depth 30 mm is removed by machining and a hole of 30 mm diameter is drilled at the location shown. For the remaining shaded area, determine

(a) the location $\bar{y}$ of the horizontal centroidal (XX) axis

(b) the second moment of area about the horizontal centroidal axis located in part (a).



(All dimensions in mm)

FIG.2

SECTION B

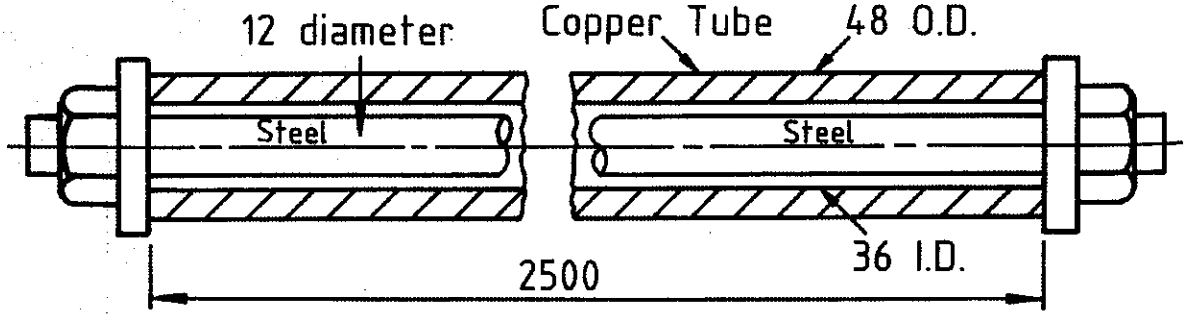
All questions are to be attempted.

3. (6 marks)

A 12 mm diameter steel rod passes centrally through a copper tube of 48 mm external and 36 mm internal diameter and 2.5 m long, as in Fig. 3. The tube is closed at each end by rigid steel washers which are secured by nuts. The nuts are tightened until the copper tube is reduced in length to 2.4995 m and the whole assembly is then heated through 60°C. Calculate the stresses in the copper and steel before and after the temperature rise.

Given: E (steel) = 200,000 MPa
E (copper) = 100,000 MPa

Coefficients of expansion per °C are
12×10^{-6} (steel) and 17.5×10^{-6} (copper)



(All dimensions in mm)

FIG.3