

Indian Institute of Science

UE 204: Midsemester Test

Date: 1/4/15.

Duration: 10.00 a.m.–11.00 a.m.

Maximum Marks: 15

1. The initial configuration of a circular rod AB of length L and radius R , and two wires each of length L and radius a is as shown in Fig. 1. The end $z = 0$ of the circular rod is fixed to a wall. A rigid bar CD of length $2c$ is fixed to the end $z = L$ as shown. The two wires CE and DF are in the plane $z = L$ and are in an unstressed state in the configuration shown. The temperature of the two wires CE and DF is reduced by ΔT , due to which the wires contract and the circular bar AB gets twisted. The wires and rod are made of the same material, and have shear modulus and Young modulus G and E . Find the angle β made by the rigid bar CD with the horizontal, and the reaction torque exerted by the wall at A in the equilibrium configuration. Assume β to be small so that $\tan \beta \approx \beta$. Using the Mohr's circle corresponding to the state of stress on an element on the surface (see Figure), find the principal stresses. You may or may not use energy methods. In case you do, you may use the following expressions for 1D loading. (15)

$$\begin{aligned}\Pi &= \frac{EAu^2}{2L} - EAu\alpha\Delta T - Pu, \\ \Pi^* &= \frac{P^2L}{2EA} + \alpha PL\Delta T - Pu, \\ \tau &= E(\epsilon - \alpha\Delta T).\end{aligned}$$

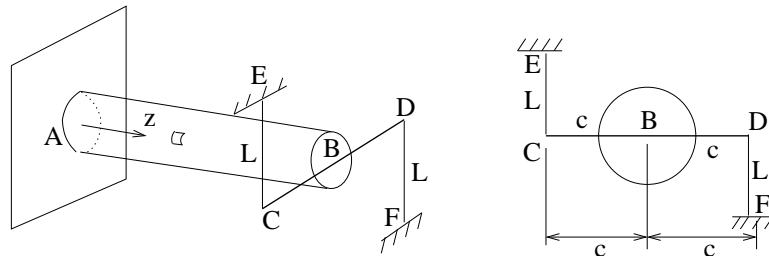


Figure 1: