GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff
School of Mechanical Engineering

Ph.D. Qualifiers Exam - Spring Semester 2004

Mechanics of Materials
EXAM AREA

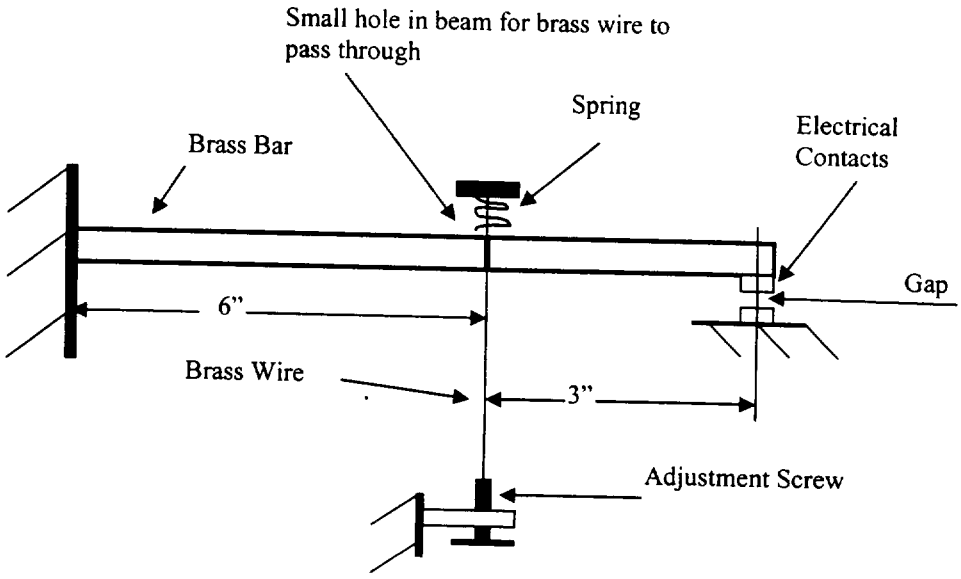
Assigned Number (DO NOT SIGN YOUR NAME)

* Please sign your **name** on the back of this page —

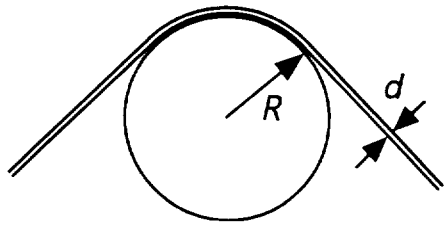
Please **p r i n t** your name here.

The Exam Committee will get a copy of this exam and will not be notified whose paper it is until it is graded.

Problem 1: A fire alarm is set up with a piece of brass wire as the sensitive element, as schematically shown in the figure. If the gap is 0.084 in when there is no tension in the wire, find the number of turns which should be taken on the screw to set the alarm so that the contacts will open at a temperature rise of 100° F. For the brass bar, EI = 6000 psi and the spring constant k = 100 lb/in. The brass wire is 15 ft long, has a cross sectional area of A = 0.01 sq in, a Young's modulus of $E = 15 \times 10^6$ psi, and a coefficient of thermal expansion of $\alpha = 10^{-7}/°F$. The adjusting screw has 20 threads per inch.



Problem 2 A solid steel wire with diameter d is bent around a cylindrical drum of radius R. The deformation response of the steel is elastic-perfectly plastic with the following properties: $E = 200\ GPa$, $\nu = 0.3$, $\sigma_y = 1000\ MPa$. In addition, under cyclic loading the stress amplitude vs. cycles to failure curve (S-N curve) is given by $\sigma_a = 1650\ N_f^{-0.1}$ where σ_a is the stress amplitude in terms of MPa. Answer the following questions pertaining to the section of wire in contact with the drum:



(a) If $R = 0.4\ m$, determine the bending moment in the wire.

(b) Determine maximum bending stress in the wire.

(c) Estimate the number of times that the wire can be moved back and forth over this drum before failure occurs. Neglect axial force in the wire and assume frictionless contact between the wire and the drum.

(d) If $R = 0.2\ m$, what is the stress distribution in a cross section of the wire?

(e) Determine the bending moment in this case. Here, just set-up the equations – you do not need to solve for the numerical answer.

Problem 3: A specimen is subjected to combined compression, torsion, and internal pressure by placing it between two platens (flat plates) and by applying a compressive force, an internal pressure, and a torque. The specimen is a hollow cylinder with an inner diameter of 87mm and an outer diameter of 90mm. The specimen and loading arrangement are shown in Fig. 1.

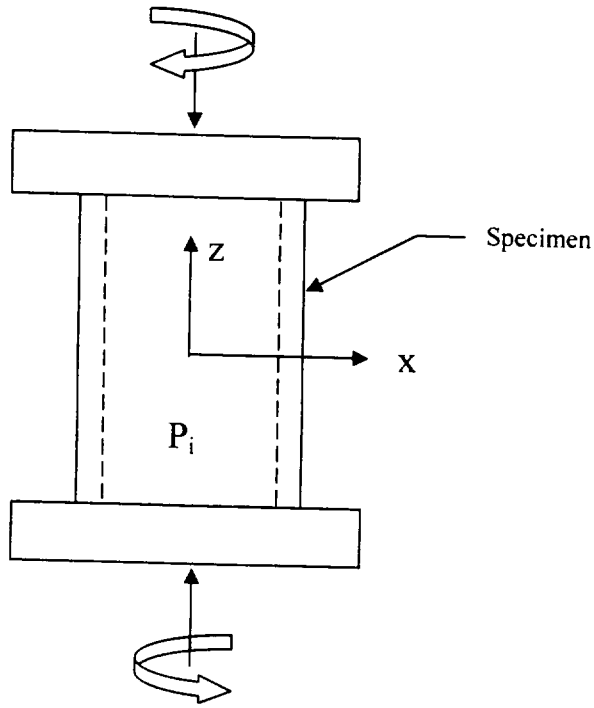


Figure 1. Specimen subjected to combined compression, torsion, and internal pressure

(a) Under the conditions of zero slip boundary conditions, what are the stress components (all nine) if the axial load is 20,000N, the torque is 2,000 Nm, and the internal pressure is 3.4MPa? State clearly the simplifying assumptions you are making.

(b) If the uniaxial yield stress is 250 MPa, will the material yield? (Use the maximum shear stress yield criterion and the Mohr's circle to find the maximum shear stress.)