1. **(30 points)** A shaft is connected to a tube via a rubber insert that is glued to each member as shown in Figure 1. On cylindrical surfaces of the rubber connector concentric with the shaft, what is the shear stress as a function of $r$, the radius of cylindrical surface? The force $P$ is 2000 N. What is the normal stress on cross sections of the tube below the rubber connector? The inside diameter $D$ of the tube is 50 mm, and its thickness $t$ is 3 mm.

2. **(30 points)** A 450,000 N force is applied to member AG which is pinned at A (Figure 2) and which may be considered a rigid body. (a) Find the forces in members DB and FC assuming linear, elastic behavior of these members. Member DB has a modulus elasticity of $7 \times 10^{10}$ Pa, and member FC has modulus of elasticity of $1.75 \times 10^{11}$ Pa. The cross sectional area of each vertical member is $6.25 \times 10^{-5}$ m$^2$. (b) If the yield stress for member BD is $4.2 \times 10^8$ Pa and that of member CF is $7 \times 10^8$ Pa what is the maximum vertical movement of point G for linear elastic behavior of the vertical members? (c) What force is required to cause a vertical movement of point G of 1.5 times the value above? (Neglect the weights of the members, and assume elastic, perfectly plastic behavior.)

3. **(30 points)** Two cylindrical rods, one made of steel ($E_s = 200 \text{ GPa}$, $\alpha_s = 11.7 \times 10^{-6} \text{ / C}$) and the other of brass ($E_b = 105 \text{ GPa}$, $\alpha_b = 20.9 \times 10^{-6} \text{ / C}$), are joined at C as shown in Figure 3. End A of the composite rod obtained in this way is fixed, while a 0.12 mm gap exists between end E and vertical wall. The temperature of the composite rod is raised by $80^\circ \text{C}$. Determine (a) the normal stresses in portions AC and CE, (b) the deformation of portion AC.

4. **(30 points)** An elastic cube with length $a$ is pressed between two rigid plates which are subjected to a force $F$. A clearance of $d/2$ is also allowed between two rigid walls before applying force $F$. (a) Find the magnitude of the force $F$ providing that the elastic cube contacts with two rigid walls. Assume the front and back surfaces of the elastic cube open. (b) Find changes in the dimensions of the elastic cube. Take Young’s modulus $E$ and Poisson’s ratio $\nu$ for the elastic cube.

Assoc. Prof. Dr. M. Kemal Apalak