1. The shaft shown is made from a brass tube (1) and a steel core (2). The brass tube (G = 5,700 ksi) has an outside diameter of 1.25 inches and an inside diameter of 1.00 inches. The solid steel core (G = 11,400 ksi) has an outside diameter of 1.00 inches. The brass tube and the steel core are bonded together so that they act as one integral unit. Compute:
   a. The torques $T_1$ and $T_2$ acting in the brass and steel components, respectively. (10 points)
   b. The maximum shear stress $\tau$ in the steel core. (5 points)
   c. The angle of twist $\phi$ at point A. (5 points)
2. The engine of a helicopter delivers 800 hp to its main rotor shaft at 1,500 rpm. Determine the minimum rotor shaft diameter if the allowable shear stress is 11,000 psi. (10 points)
3. A steel box shape (shown on the next page) is used to support the loads shown on the beam diagram below. Note: the wall thickness of the box shape is 20 mm on all four sides.
   a. Compute the beam reactions at A and C. (5 points)
   b. Draw the shear force and bending moment diagrams for the beam, *labeling all key points on each diagram.* (10 points)
c. Compute the moment of inertia for the shape about the z centroidal axis. (5 points)
d. Compute the section modulus for the shape about the z centroidal axis. (5 points)
e. Compute the normal stress on the bottom surface of the beam at B. Indicate clearly whether the stress is tension or compression. (5 points)
4. An aluminum bar ($E = 68$ GPa) is bonded to a steel bar ($E = 204$ GPa) to form a composite beam. The composite beam is subjected to a moment of $M = +50$ kN-m (shown on the side view sketch at right). Use the transformed-area method to compute:

a. The location of the centroid for the composite beam cross section relative to the bottom surface. (5 points)

b. The moment of inertia of the transformed cross section. (5 points)

c. The normal stress in the aluminum bar at the juncture between the two materials (i.e., 100 mm above the bottom of the cross section.  *State whether the stress is tension or compression.* (5 points).

d. The maximum magnitude normal stress in the steel.  *State whether the stress is tension or compression.* (5 points).