1. (25 points) For an extruded beam having the cross section shown, determine (a) the location of the shear center \( O \), (b) the distribution of the shearing stresses caused by the vertical shearing force \( V \) shown applied at \( O \).

2. (25 points) For the beam and loading shown, determine (a) the reaction at the roller support, (b) the deflection at point B using singularity-functions.

3. (20 points) A hollow brass shaft has the cross section shown. Knowing that the shearing stress must not exceed 80 MPa and neglecting the effect of stress concentrations, determine the largest torque which may be applied to the shaft.

4. (20 points) The solid cylinders AB and BC are bonded together at B and attached to fixed supports at A and C. Knowing that AB is made of steel \((G = 77 \text{ GPa})\) and BC of brass \((G = 39 \text{ GPa})\), determine for the loading shown (a) the reaction at each support, (b) the maximum shearing stress in AB, (c) the maximum shearing stress in BC.

5. (25 points) An aluminum column of length \( L \) and rectangular cross section has a fixed end B and supports a centric load at A. Two smooth and rounded fixed plates restrain end A from moving in one of the vertical planes of symmetry of the column, but allow it to move in the other plane, (a) Determine the ratio \( a/b \) of the two sides of the cross section corresponding to the most efficient design against buckling. (b) Design the most efficient cross section for the column, knowing that \( L = 500 \text{ mm} \), \( E = 70 \text{ GPa} \), \( P = 20 \text{ kN} \), and that a factor of safety of 2.5 is required.

Prof. Dr. M. Kemal Apalak