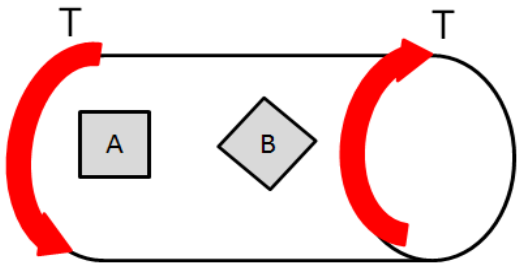
Mechanics of Materials (I)
Exam II (5/26/2021)

1. (16%) (a) If a ductile material fails under pure torsion, please explain the failure mode and describe the observed plane of failure.
   (b) Suppose a prismatic beam is subjected to equal and opposite couples as shown in Fig. 1. Please sketch the deformation and the stress distribution of the cross section.

Fig. 1

   (c) Describe the definition of the neutral axis.
   (d) Describe the definition of the modular ratio.

2. (14%) Consider the two elements *A* and *B* located on the surface of a circular shaft subjected to torsion. The element *A* is orientated at $0°$ to the axis of the shaft while the element *B* is orientated at $30°$ to the axis of the shaft, respectively. Please determine the magnitude of the stresses and sketch the stresses on each element. (The radius of the shaft is denoted by *c*)



3. (12%) If a bending couple as shown in Fig. 2, please obtain the normal stress at point *B*.

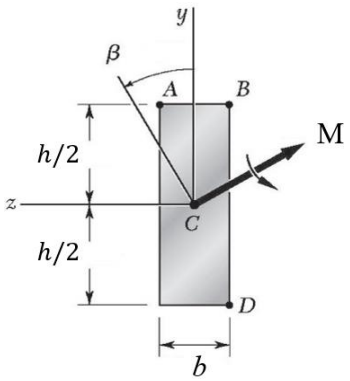
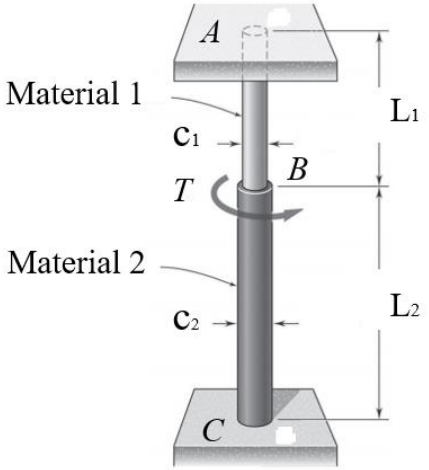
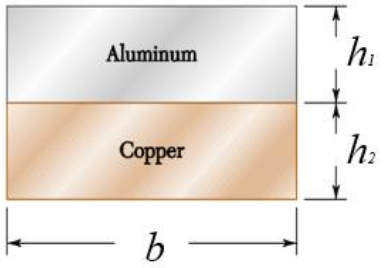


Fig. 2.

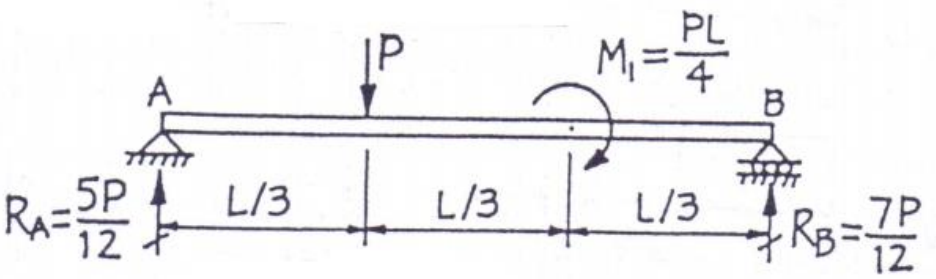
4. (12%) The solid cylinders *AB* and *BC* are bonded together at *B* and are attached to fixed supports at *A* and *C*. Knowing that the modulus of rigidity for the material 1 and material 2 are G_1 and G_2, respectively. Please describe how to determine the internal torque *AB* and *BC*. (List all required equations)



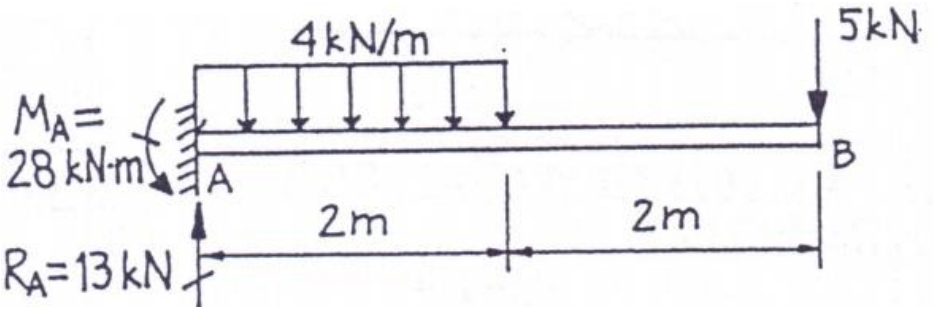
5. (10%) A copper strip (*Ec* = 105 GPa) and an aluminum strip (*Ea* = 75 GPa) are bonded together to form the composite beam shown. Determine the location of the neutral axis.



6. (12%) Draw the shear-force and bending moment diagrams for a simple beam subjected to a concentrated load and a clockwise couple as shown below. (reactions: $R_A = \frac{5}{12}P, R_B = \frac{7}{12}P$)



7. (12%) Draw the shear-force and bending moment diagrams for a cantilever beam subjected to a concentrated load and a distributed load as shown below. (reactions: $R_A = 13kN$, $M_A = 28kN \cdot m$)



8. (12%) The torques shown are exerted on pulleys *A* and *B*. Knowing that the shafts are solid and made of steel, determine the angle of twist between *A* and *C*. The shear modulus of the shaft is denoted by *G*.