1. The circular propeller shaft ABCD carries the axial loads as shown in Figure. Use the modulus of elasticity $29 \times 10^6$ psi for the propeller, (20%).
   (a) Determine the axial stress (psi) in the part BC?
   (b) Determine the axial strain in the part CD?
   (c) Determine the maximum axial stress (psi) in the shaft?
   (d) Determine the change (in.) in the length of the shaft caused by these loads?

![Diagram of a propeller shaft with forces applied at points A, B, C, and D.]

2. A simply supported beam AC supports a distributed load as shown in the figure. The span is 4 m and the load intensity is 200 kN/m. Neglect the weight of the beam, (20%).
   (a) Derive the expression equation for the transverse shear force.
   (b) Construct the shear force diagram for the beam.
   (c) Derive the expression equation for the bending moment.
   (d) Construct the bending moment diagram for the beam.

![Diagram of a simply supported beam with a distributed load.]

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3. The rotor shaft of a helicopter drives the rotor blades that provide the lifting force to support the helicopter in the air. As a consequence, the shaft is subjected to a combination of torsion and axial loading as shown in the figure. For a 52 mm diameter shaft transmitting a tensile force $P = 120$ kN (producing the tensile stress $\sigma_0$) and a torque $T = 2600$ N.m (producing the shear stress $\tau_0$) on the surface as the figure shown, determine the following stress on the shaft surface, (20%).

(a) Determine the stresses $\tau_0$ and $\sigma_0$ (MPa)?
(b) What is the maximum tensile stress (MPa)?
(c) What is the maximum compressive stress (MPa)?
(d) What is the maximum shear stress (MPa)?

4. A 150 mm diameter steam pipe is laid in a trench at a temperature of $20^\circ$C. When steam passes through the pipe, its temperature rises to $110^\circ$C. The pipe is made of steel with modulus of elasticity 200GPa and coefficient of thermal expansion, CTE $12(10^{-6})$/°C, (20%).

(a) What is the increased dimension (mm) in the diameter if the pipe is free to expand in all directions?
(b) What is the axial stress (MPa) in the pipe if the trench restrains the pipe so that it axial length does not expand?
(c) What is the axial stress (MPa) in the pipe if the trench restrains the pipe so that its length only one-third as much as it would if it could expand freely?
(d) Write the materials which the CTE are smaller than the steam pipe.
5. The cantilevered beam as shown in the figure is subjected to a vertical load $P$ at its free end. It has the axial length $L$, the modulus of elasticity $E$, the rectangular cross section with width $b$ and height $2b$, (20%).

(a) Find the bending moment at distance $x$ from the free end of the beam?
(b) Find the maximum bending stress of the beam?
(c) Determine the equation of the deflection curve of the beam?
(d) Determine the deflection at $x = L/2$?