Q1/ The figure below shows the cross section of a circular steel tube that is filled with concrete and topped with a rigid cap. Calculate the stresses in the steel and in the concrete caused by the 500 kN axial load. Use $E_{\text{steel}} = 200 \text{ GPa}$ and $E_{\text{concrete}} = 30 \text{ GPa}$.

$$500 \text{ kN}$$

Q2/ The rigid slab of weight $W$, with center of gravity at $G$, is suspended from identical steel wires. Determine the force in each wire.

Q3/ For shown rigid bar $AB$ of negligible weight, there is a gap $D = 4 \text{ mm}$ between the lower end of the left rod and its pin support at $C$. Compute the stress in the left rod after its lower end is attached to the support. The cross-sectional areas are $300 \text{ mm}^2$ for rod $AC$ and $250 \text{ mm}^2$ for rod $BD$. Use $E = 200 \text{ GPa}$ for steel.
Q4/ The homogeneous rod of constant cross section is attached to unyielding supports. The rod carries an axial load P, applied as shown in the figure. Find the reactions.

Q5/ A steel rod is stretched between two walls. At 20°C, the tensile force in the rod is 5000 N. If the stress is not to exceed 130 MPa at -20°C, find the minimum allowable diameter of the rod. Use $\alpha=11.7 \times 10^{-6}/\text{C}$ and $E = 200$ GPa.

Q6/ All members of the steel truss have the same cross-sectional area. If the truss is stress-free at 10°C, determine the stresses in the members at 90°C. For steel, $\alpha =11.7 \times 10^{-6}/\text{C}$ and $E =200$ GPa

Q7/ A pipe carrying steam at 3.5 MPa has an outside diameter of 450 mm and a wall thickness of 10 mm. A gasket is inserted between the flange at one end of the pipe and a flat plate used to cap the end. How many 40-mm-diameter bolts must be used to hold the cap on if the allowable stress in the bolts is 80 MPa, of which 55 MPa is the initial stress?
Q8/ The rigid bars AB and CD shown in Fig. P-214 are supported by pins at A and C and the two rods. Determine the maximum force P that can be applied as shown if its vertical movement is limited to 5 mm. Neglect the weights of all members.

Q9/ A homogeneous bar with a cross sectional area of 500 mm$^2$ is attached to rigid supports. It carries the axial loads $P_1 = 25$ kN and $P_2 = 50$ kN, applied as shown in Fig. below. Determine the stress in segment BC.

Q10/ A bronze sleeve is slipped over a steel bolt and held in place by a nut that is turned to produce an initial stress of 14 MPa in the bronze. For the steel bolt, $A = 450$ mm$^2$, $E = 200$ GPa, and $\alpha = 11.7 \times 10^{-6}$/°C. For the bronze sleeve, $A = 900$ mm$^2$, $E = 12 \times 10^6$ psi and $\alpha = 24 \times 10^{-6}$/°C. After a temperature rise of 30°C, find the final stress in each material.
Q11/ A rigid bar of negligible weight is supported as shown in Fig. below. If \( W = 80 \text{ kN} \), compute the temperature change that will cause the stress in the steel rod to be 55 MPa. Assume the coefficients of linear expansion are 11.7 \( \mu \text{m}/(\text{m} \cdot \degree \text{C}) \) for steel and 18.9 \( \mu \text{m}/(\text{m} \cdot \degree \text{C}) \) for bronze.

Q12/ The cylindrical pressure vessel with hemispherical end-caps is made of steel. The vessel has a uniform thickness of 18 mm and an outer diameter of 400 mm. When the vessel is pressurized to 3.6 MPa, determine the change in the overall length of the vessel. Use \( E = 200 \text{ GPa} \) and \( v = 0.3 \) for steel. Neglect localized bending.

Q13/ The pipe carrying steam at 3.5 MPa has an outer diameter of 450 mm and a wall thickness of 10 mm. A gasket is inserted between the flange at one end of the pipe, and a flat plate is used to cap the end. (a) How many 40-mm-diameter bolts must be used to hold the cap on if the allowable stress in the bolts is 80 MPa, of which 55 MPa is the initial stress? (b) What circumferential stress is developed in the pipe?
Q14/ The spherical gas tank is made of steel (E = 200 GPa, v = 0.3). The inner radius of the tank is 6 m and its wall thickness is 25 mm. (a) If the working stress of the steel is 65 MPa, determine the maximum safe pressure for the tank. (b) Compute the corresponding change in the volume of the tank.

Q15/ The cylindrical portion of the propane tank has an outer diameter of 300 mm and a wall thickness of 3 mm. Calculate the longitudinal and circumferential stresses in the wall of the cylinder when the tank is pressurized to 1.35 MPa.
Q17/

A spherical pressure vessel made of steel has a radius of 100 in. and a wall thickness of 0.25 in. It has an internal pressure of 100 psi. Calculate its stress state and the change in its diameter.

A cylindrical pressure vessel made of steel has a radius of 100 in. and a wall thickness of 0.25 in. It has an internal pressure of 100 psi. Calculate its stress state and the change in its diameter.

Compare the solution for the two vessels.

Q18/ The assembly consists of a bronze tube and a threaded steel bolt. The pitch of the thread is 0.78 mm. (one turn of the nut advances it 0.78 mm). The cross-sectional areas are 900 mm$^2$ for the tube and 450 mm$^2$ for the bolt. The nut is turned until there is a compressive stress of 30 MPa in the tube. Find the stresses in the bolt and the tube if the nut is given one additional turn. Use $E = 90$ GPa for bronze and $E = 200$ GPa for steel.