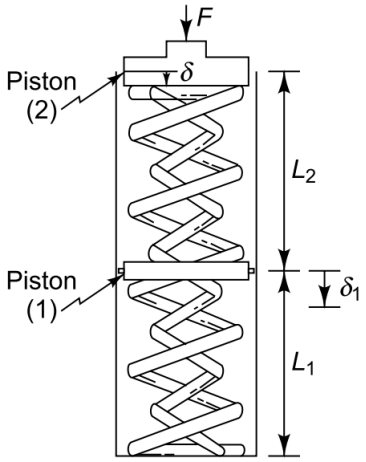
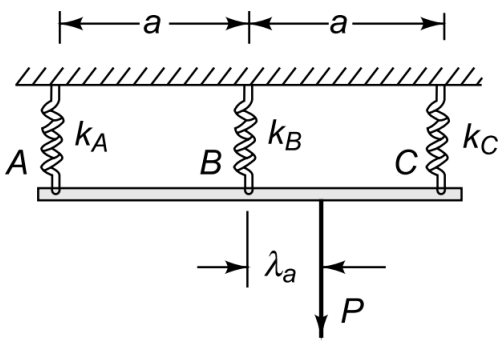
Tutorial 2: Force-deformation and compatibility relations

APL 104 - 2023 (Solid Mechanics)

1. A machine part carrying a load F terminates in a piston that fits into a cavity. Within the cavity are two springs arranged one over the other. Each spring has the characteristic that the force required to deflect it is proportional to the amount of deflection. Consider the stiffness of the spring to be k_A and k_B. Find the effective stiffness and the deflection of the individual springs.

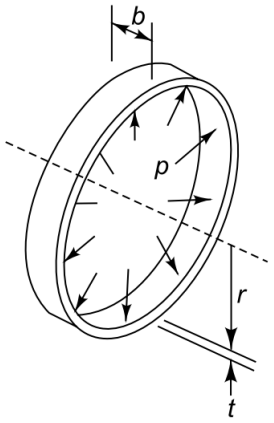


2. A light rigid bar ABC is supported by three springs. Before the load P is applied, the bar is horizontal. The distance from the center spring to the point of application of P is λa, where λ is a dimensionless parameter that can vary between $\lambda = -1$ and $\lambda = 1$. Determine the deflections in the three springs as functions of the load position parameter λ, assuming $k_A = 0.5k$, $k_B = k$, and $k_C = 1.5k$.

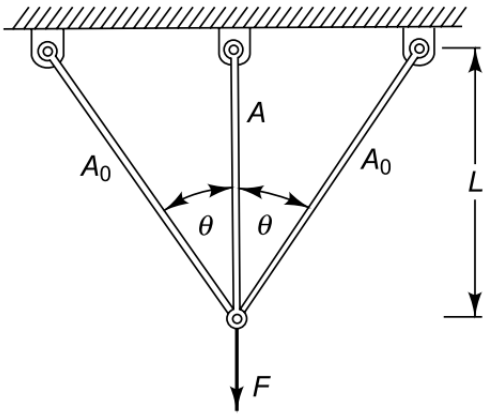


3. A thin ring of internal radius r, thickness t, and width b is subjected to a uniform pressure p over the entire internal surface. Determine the forces in the ring. Also, find the deformation of the ring due to the internal pressure in the radial and circumferential directions.

   What approximations do you get if the thickness $t << r$?

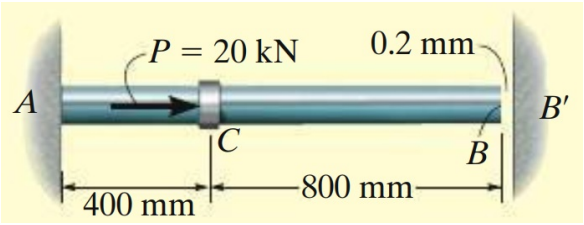


4. Consider the pin-connected framework loaded. Find the axial force in each bar. The two outer bars are identical with a cross-sectional area A_0, the inner bar has a cross-sectional area A. All bars have the same modulus of elasticity E.



5. The steel rod shown in the figure below has a diameter of 10 mm. It is fixed to the wall at A, and before it is loaded, there is a gap of 0.2 mm between the wall at B' and the rod. Determine the reactions at A and B' if the rod is subjected to an axial force of $P = 20$ kN as shown. Neglect the size of the collar at C. Take $E = 200$ GPa.

   Assume that force P is large enough to cause the rod's end B to contact the wall at B'.



6. The rod has a slight taper and length L. It is suspended from the ceiling and supports a load P at its end. Determine the displacement of its end due to this load. Neglect the weight of the material. The modulus of elasticity is E.