1. A bungee cord is hung from two supports at the same height and 15 m apart. The original unstretched length of the bungee cord is 21 m, the diameter is 1.0 cm and the Young’s modulus of the cord is $6.24 \times 10^7$ N/m$^2$. A 100 kg mass is hung 12 m from the left end. Use the relaxation method to find the lengths of the cords, the angles the cords make with respect to the horizontal, and the tensions in the cords when equilibrium is reached by iterating the equilibrium equations until the change in the tensions from one iteration to the next is less than 1 Newton. You may take the strength of the gravitational field to be 9.8 m/s$^2$ and ignore the mass of the cord.

2. A horizontal bridge of mass $M$ and length $D$ is to be suspended from a main cable by vertical cables connecting the bridge to the main cable (see Fig. 5.31 in the text). Assume that the vertical cables are close enough together that the weight of the bridge is continuously and equally distributed along the horizontal axis, i.e., $dF/dx = -Mg/Dy$ is constant, where $dF$ is the force exerted by the vertical cables on a piece of the main cable between $x$ and $x + dx$, and $x$ is measured in the horizontal direction. You may ignore the mass of all cables.

(a) Find an expression for the force per unit length on the main cable, $f = dF/ds$, in terms of $dF/dx$ and the slope of the main cable $dy/dx = y'$. [Hint: use the relationship between $ds$ and $dx$.]

(b) Set up a differential equation for the shape $y(x)$ of the main cable, assuming the system is in equilibrium. Solve the equation by using the endpoint conditions $(x_1, y_1) = (-D/2, 0)$ and $(x_2, y_2) = (D/2, 0)$ and by assuming that the magnitude of the tension in the main cable at its two ends must be $T_0$. [Note that the length of the cable is not fixed, but is being chosen to meet the constant $dF/dx$ condition – you do not need to worry about the length of the cable. Hint: the tension condition can be imposed by considering the system as a whole.]

(c) Find the tension in the main cable at $x = 0$ (i.e., at the middle).

3. A long, thin board of mass $M$, length $L$ and cross sectional area $A$ is clamped at both ends to a vertical wall such that the slope of the board at the ends is horizontal. The two ends of the board are at the same height, $y = 0$. The board material has Young’s Modulus $Y$ and the cross section of the beam has radius of gyration $k$ about a horizontal axis through its centroid. Ignore shear.

(a) Find the function $y(x)$ that describes the position of the board, assuming $x = 0$ at the left end of the board. Also find the support forces and torques at the two ends exerted by the walls on the board. [Hint: don’t forget to use the symmetry of the problem.]

(b) How far below the support points is the middle of the board?

4. Find the atmospheric pressure as a function of altitude if the temperature decreases with altitude according to the equation $T = T_0(1 - az)$. 