From these values of Q we can calculate the approximate bandwidth of the two filters:

$$B_a = \frac{\omega_n}{Q_a} \approx 10{,}000 \text{ rad/s} \qquad \text{case a}$$

$$B_b = \frac{\omega_n}{Q_b} \approx 100 \text{ rad/s} \qquad \text{case b}$$

The frequency response plots in Figures 6.28 and 6.29 confirm these observations.

Comments: It should be apparent that while at the higher and lower frequencies most of the amplitude of the input signal is filtered from the output, at the midband frequency (4,500 rad/s) most of the input signal amplitude passes through the filter. The first bandpass filter analyzed in this example would "pass" the *midband range* of the audio spectrum, while the second would pass only a very narrow band of frequencies around the **center frequency** of 4,500 rad/s. Such narrowband filters find application in **tuning circuits,** such as those employed in conventional AM radios (although at frequencies much higher than that of the present example). In a tuning circuit, a narrowband filter is used to tune in a frequency associated with the **carrier** of a radio station (e.g., for a station found at a setting of AM 820, the carrier wave transmitted by the radio station is at a frequency of 820 kHz). By using a variable capacitor, it is possible to tune in a range of carrier frequencies and therefore select the preferred station. Other circuits are then used to decode the actual speech or music signal modulated on the carrier wave; some of these are discussed in Chapters 9 and 19.

CHECK YOUR UNDERSTANDING

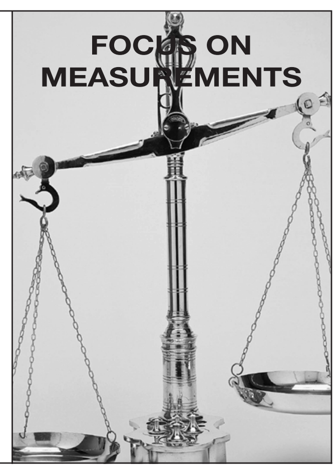
Compute the frequencies ω_1 and ω_2 for the bandpass filter of Example 6.11 (with $R = 1$ kΩ) for equating the magnitude of the bandpass filter frequency response to $1/\sqrt{2}$ (this will result in a quadratic equation in ω, which can be solved for the two frequencies). Note that these are the **half-power frequencies.**

Answer: $\omega_1 = 99.95$ rad/s; $\omega_2 = 200.1$ krad/s

Wheatstone Bridge Filter

LO3

FIND IT ON THE WEB



Problem:

The Wheatstone bridge circuit of Example 2.14 and Focus on Measurements, "Wheatstone Bridge and Force Measurements" in Chapter 2 is used in a number of instrumentation applications, including the **measurement of force.** Figure 6.30 depicts the appearance of the bridge circuit. When undesired noise and interference are present in a measurement, it is often appropriate to use a low-pass filter to reduce the effect of the noise. The capacitor that is connected to the output terminals of the bridge in Figure 6.30 constitutes an effective and simple low-pass filter, in conjunction with the bridge resistance. Assume that the average resistance of each leg of the bridge is 350 Ω (a standard value for strain gauges) and that we desire to measure a sinusoidal

(*Continued*)