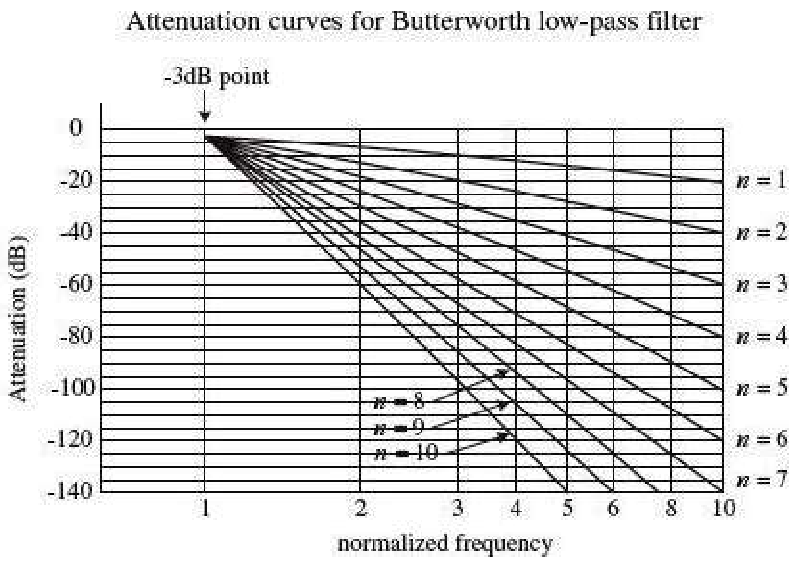
steep transition between the passband and stop band at the expense of ripples present in the passband, while Bessel figured out a way to minimize phase shifts at the expense of both flat passbands and steep falloffs. Later I will discuss the pros and cons of Butterworth, Chebyshev, and Bessell filters. For now, however, let's concentrate on Butterworth filters.

FIGURE 9.5

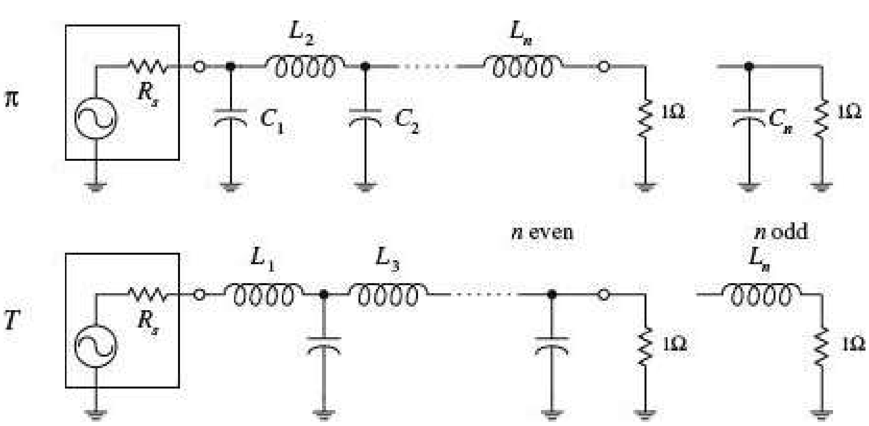
Step 3 (Determine the Number of Poles Needed)



Continuing on with our low-pass filter problem, lef's choose the Butterworth design approach, since it is one of the more popular designs used. The next step is to use a graph of attenuation versus normalized frequency curves for Butterworth low-pass filters, shown in the figure. (Response curves like this are provided in filter handbooks, along with response curves for Chebyshev and Bessel filters.) Next, pick out the single response curve from the graph that provides the desired −25 dB at 3 rad/s, as stated in the problem. If you move your finger along the curves, you will find that the $n = 3$ curve provides sufficient attenuation at 3 rad/s. Now, the filter that is needed will be a third-order low-pass filter, since there are three poles. This means that the actual filter that you will construct will have three *LC* sections.

FIGURE 9.6

Step 4 (Create a Normalized Filter)



Now that you have determined the order of the filter, move on to the next step—creating a normalized *LC* filter circuit. (This circuit will not be the final filter circuit you will use—it will need to be altered.) The circuit networks that are used in this step take on either a π or the *T* configuration, as shown in the figure. If the source and load impedances match, either configuration can be used—though a π network is more attractive because fewer inductors are needed. However, if the load impedance is greater than the source impedance, it is better to use *T* configuration. If the load impedance is smaller than the source impedance, it is better to use the π configuration. Since the initial problem stated that the source and load impedances were both 50 Ω, choose the π configuration. The values of the inductors and capacitors are given in Table 9.1. (Filter handbooks will provide such tables, along with tables for Chebyshev and Bessel filters.) Since you need a third-order filter, use the values listed in the $n = 3$ row. The normalized filter circuit you get in this case is shown in Fig. 9.8.