Problem 1
For each frequency response \( H(s) \) shown below, do the following:

1. Sketch the asymptotic magnitude Bode plot for \( H(s) \).

2. Synthesize \( H(s) \) using the RC circuits shown in Table 3.4 of the handout entitled “Tables of 1st order passive/active filters”.

3. Now use magnitude scaling (with appropriate values for \( k_m \)) to achieve practical component values.

4. Use a circuit simulator to verify that the frequency response of your \( k_m \)-scaled circuit matches \( H(s) \). Whenever possible, you should choose the \( k_m \) values to make the final resistor values be in the 1–100kΩ range. Don’t worry if you end up a bit higher or lower than this range.

(a) \( H(s) = \frac{(s + 2\pi30) (s + 2\pi1,000)}{(s + 2\pi300)(s + 2\pi10,000)} \)

(b) \( H(s) = \frac{1,000s(s + 2\pi5,000)}{(s + 2\pi100)(s + 2\pi1,000)(s + 2\pi10,000)} \)

Problem 2
For each frequency response \( H(s) \) shown below, do the following:

1. Sketch the asymptotic magnitude Bode plot for \( H(s) \).

2. Synthesize \( H(s) \) using the RC circuits shown in Tables 3.4, 4.2 and 4.3 of the handout entitled “Tables of 1st order passive/active filters”. Use as few opamps, resistors and capacitors as possible to simplify your design.

3. Now use magnitude scaling (with appropriate values for \( k_m \)) to achieve practical component values.

4. Use a circuit simulator to verify that the frequency response of your \( k_m \)-scaled circuit matches \( H(s) \). Whenever possible, you should choose the \( k_m \) values to make the final resistor values be in the 1–100kΩ range. Don’t worry if you end up a bit higher or lower than this range.

(a) \( H(s) = \frac{15(s + 2\pi50)(s + 2\pi2,000)}{(s + 2\pi500)(s + 2\pi20,000)} \)

(b) \( H(s) = \frac{12s^2(s + 2\pi100)}{(s + 2\pi500)(s + 2\pi1,000)(s + 2\pi5,000)(s + 2\pi10,000)} \)

(c) \( H(s) = \frac{1000(s + 2\pi5,000)}{s^2(s + 2\pi400)(s + 2\pi12,000)(s + 2\pi50,000)} \)

Notes

1. Magnitude scaling a circuit involves either multiplication or division by a factor \( k_m \). For passive elements, the scaling expressions are the following: \( R_{new} = k_mR_{old}, L_{new} = k_mL_{old}, C_{new} = C_{old}/k_m \). Magnitude scaling does not alter the voltage gain frequency response and is done strictly to make the component values more practical.

2. Frequency scaling a circuit involves division by a factor \( k_f \). For passive elements, the scaling expressions are the following: \( L_{new} = L_{old}/k_f, C_{new} = C_{old}/k_f \). Resistor values do not change during a frequency scaling operation. Frequency scaling shifts the voltage gain frequency response up (down) in frequency by a factor \( k_f > 1 \) (\( k_f < 1 \)).

3. Instead of printing the circuit schematics or the plots directly to a printer, consider printing to PDF or use Tools > Copy Bitmap to Clipboard to copy/paste into a word processor.
4. You should experiment with background color to limit ink usage. Go to Tools > Control Panel and click on the Waveforms tab. Click on the Color Scheme item and on the Selected Item dropdown menu choose Background and use sliders to make the RGB colors equal to 255 255 255 to make the background color white. You can also select the colors of the waveforms here. Clicking on Defaults goes back to the original color scheme.