ECE512 Analog Signal Processing Problems 1

In the Sedra/Smith textbook: Chapter 12.

***12.2** A filter has the transfer function $T(s) = 1/[(s+1)(s^2+s+1)]$. Show that $|T| = \sqrt{1+\omega^6}$ and find an expression for its phase response $\phi(\omega)$. Calculate the values of $|T|$ and ϕ for $\omega = 0.1$, 1, and 10 rad/s and then find the output corresponding to each of the following input signals:

(a) 2 sin $0.1t$ (volts)
(b) 2 sin t (volts)
(c) 2 sin $10t$ (volts)

12.5 A low-pass filter is specified to have $A_{max} = 1$ dB and $A_{min} = 10$ dB. It is found that these specifications can be just met with a single-time-constant RC circuit having a time constant of 1 s and a dc transmission of unity. What must ω_p and ω_s of this filter be? What is the selectivity factor?

12.6 Sketch transmission specifications for a high-pass filter having a passband defined by $f \geq 2$ kHz and a stopband defined by $f \leq 1$ kHz. $A_{max} = 0.5$ dB, and $A_{min} = 50$ dB.

12.7 Sketch transmission specifications for a bandstop filter that is required to pass signals over the bands $0 \leq f \leq 10$ kHz and 20 kHz $\leq f \leq \infty$ with A_{max} of 1 dB. The stopband extends from $f = 12$ kHz to $f = 16$ kHz, with a minimum required attenuation of 40 dB.

12.9 A third-order low-pass filter has transmission zeros at $\omega = 2$ rad/s and $\omega = \infty$. Its natural modes are at $s = -1$ and $s = -0.5 \pm j0.8$. The dc gain is unity. Find $T(s)$.

12.10 Find the order N and the form of $T(s)$ of a bandpass filter having transmission zeros as follows: one at $\omega = 0$, one at $\omega = 10^3$ rad/s, one at 3×10^3 rad/s, one at 6×10^3 rad/s, and one at $\omega = \infty$. If this filter has a monotonically decreasing passband transmission with a peak at the center frequency of 2×10^3 rad/s, and equiripple response in the stopbands, sketch the shape of its $|T|$.