Solution of ECE 316 Test 1 Su07

1. In the circuit below let $R = 10\ \Omega$, $L = 10\ \text{mH}$ and $C = 100\mu\text{F}$ and let

$$\text{H}(j\omega) = \frac{\text{V}_o(j\omega)}{\text{V}_i(j\omega)}.$$

(a) $\text{H}(j\omega)$ can be expressed in the form $\dfrac{A}{(j\omega)^2 + jB\omega + C}$. Find the numerical values of *A*, *B* and *C*.

$$\text{H}(j\omega) = \frac{1/j\omega C}{1/j\omega C + j\omega L + R} = \frac{1}{(j\omega)^2 LC + j\omega(RC) + 1}$$

$$\text{H}(j\omega) = \frac{1/LC}{(j\omega)^2 + j\omega R/L + 1/LC} = \frac{10^6}{(j\omega)^2 + j1000\omega + 10^6}$$

$A = \underline{10^6}$, $B = \underline{1000}$, $C = \underline{10^6}$

(b) Find the numerical value of $\text{H}(0)$. $\text{H}(0) = 1$

(c) Find the numerical value of $\lim_{\omega\to+\infty} \text{H}(j\omega)$.

$\lim_{\omega\to+\infty} \text{H}(j\omega) = 0$

For parts (d), (e), and (f) redefine the frequency response as

$$H(j\omega) = \frac{I_i(j\omega)}{V_i(j\omega)}.$$

(d) $H(j\omega)$ can now be expressed in the form $\dfrac{j\omega A}{(j\omega)^2 + jB\omega + C}$. Find the numerical values of A, B and C.

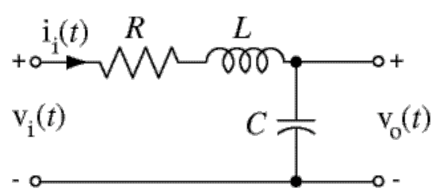
$$H(j\omega) = \frac{1}{1/j\omega C + j\omega L + R} = \frac{j\omega C}{(j\omega)^2 LC + j\omega(RC) + 1}$$

$$H(j\omega) = \frac{j\omega / L}{(j\omega)^2 + j\omega R/L + 1/LC} = \frac{j100\omega}{(j\omega)^2 + j1000\omega + 10^6}$$

$A = \underline{100}$, $B = \underline{1000}$, $C = \underline{10^6}$

(e) Find the numerical value of $H(0)$. $H(0) = \underline{0}$

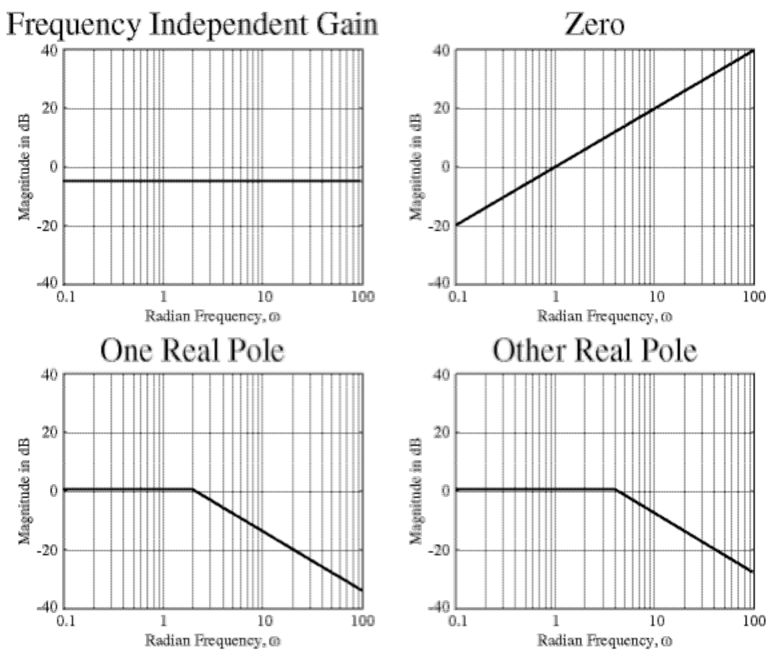
(f) Find the numerical value of $\lim_{\omega \to +\infty} H(j\omega)$. $\lim_{\omega \to +\infty} H(j\omega) = \underline{0}$



2. A system has a frequency response $\mathrm{H}(j\omega) = 5\dfrac{j\omega}{(j\omega+2)(j\omega+4)}$. Draw in the magnitude Bode diagram <u>asymptotes</u> for the frequency-independent gain, the real zero and the two real poles in the spaces below. On each diagram label both the horizontal and vertical axes so that actual numerical values could be read from the diagram.

$$\mathrm{H}(j\omega) = \frac{5}{8}\frac{j\omega}{\left(1-\dfrac{j\omega}{-2}\right)\left(1-\dfrac{j\omega}{-4}\right)}$$

$$(5/8)_{\mathrm{dB}} = -4.0824$$



3. Classify the following discrete-time filter frequency responses as lowpass (LP), highpass (HP), bandpass (BP), bandstop (BS) or unclassifiable (U). For an unclassifiable filter explain why it cannot be classified.

(a) $\mathrm{H}(F) = \dfrac{1 - e^{-j2\pi F}}{1 + 0.9e^{-j2\pi F}}$ Highpass.

(b) $\mathrm{H}(e^{j\Omega}) = \dfrac{1 + e^{-j\Omega}}{1 - 0.9e^{-j\Omega}}$ Lowpass

(c) $\mathrm{H}(e^{j\Omega}) = 1 + e^{-j2\Omega}$ Bandstop

(d) $\mathrm{H}(F) = \dfrac{1 - e^{-j4\pi F}}{1 + 0.64e^{-j4\pi F}}$ Bandpass

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1. In the circuit below let $R = 10\ \Omega, L = 100\ \text{mH}$ and $C = 1000\mu\text{F}$ and let $\text{H}(j\omega) = \dfrac{\text{V}_o(j\omega)}{\text{V}_i(j\omega)}$.

(a) $\text{H}(j\omega)$ can be expressed in the form $\dfrac{A}{(j\omega)^2 + jB\omega + C}$. Find the numerical values of *A*, *B* and *C*.

$$\text{H}(j\omega) = \frac{1/j\omega C}{1/j\omega C + j\omega L + R} = \frac{1}{(j\omega)^2 LC + j\omega(RC) + 1}$$

$$\text{H}(j\omega) = \frac{1/LC}{(j\omega)^2 + j\omega R/L + 1/LC} = \frac{10^4}{(j\omega)^2 + j100\omega + 10^4}$$

$A = \underline{10^4}$, $B = \underline{100}$, $C = \underline{10^4}$

(b) Find the numerical value of $\text{H}(0)$. $\text{H}(0) = 1$

(c) Find the numerical value of $\lim_{\omega\to+\infty} \text{H}(j\omega)$. $\lim_{\omega\to+\infty} \text{H}(j\omega) = 0$

For parts (d), (e), and (f) redefine the frequency response as

$$H(j\omega) = \frac{I_i(j\omega)}{V_i(j\omega)}.$$

(d) $H(j\omega)$ can now be expressed in the form $\dfrac{j\omega A}{(j\omega)^2 + jB\omega + C}$. Find the numerical values of *A*, *B* and *C*.

$$H(j\omega) = \frac{1}{1/j\omega C + j\omega L + R} = \frac{j\omega C}{(j\omega)^2 LC + j\omega(RC) + 1}$$

$$H(j\omega) = \frac{j\omega / L}{(j\omega)^2 + j\omega R/L + 1/LC} = \frac{j10\omega}{(j\omega)^2 + j100\omega + 10^4}$$

$A = \underline{10}$, $B = \underline{100}$, $C = \underline{10^4}$

(e) Find the numerical value of $H(0)$. $H(0) = \underline{0}$

(f) Find the numerical value of $\lim_{\omega \to +\infty} H(j\omega)$.

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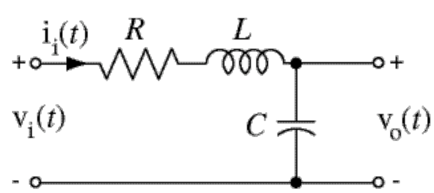
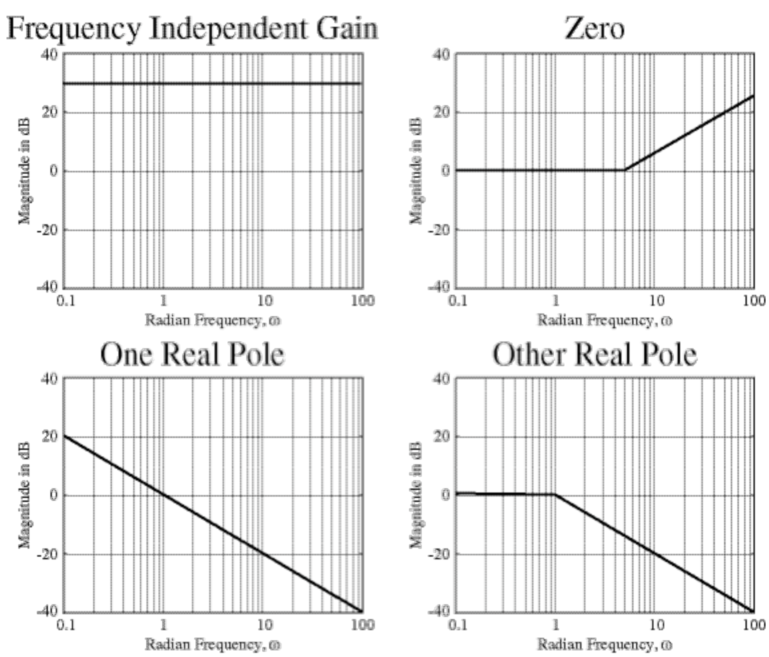


2. A system has a frequency response $\mathrm{H}(j\omega) = 5\frac{j\omega+5}{j\omega(j\omega+1)}$. Draw in the magnitude Bode diagram <u>asymptotes</u> for the frequency-independent gain, the real zero and the two real poles in the spaces below. On each diagram label both the horizontal and vertical axes so that actual numerical values could be read from the diagram.

$$\mathrm{H}(j\omega) = 25\frac{1-\frac{j\omega}{-5}}{j\omega\left(1-\frac{j\omega}{-1}\right)}$$

$$(25)_{\mathrm{dB}} = 27.9588$$



3. Classify the following discrete-time filter frequency responses as lowpass (LP), highpass (HP), bandpass (BP), bandstop (BS) or unclassifiable (U). For an unclassifiable filter explain why it cannot be classified.

(a) $\mathrm{H}\left(e^{j\Omega}\right)=\dfrac{1+e^{-j\Omega}}{1-0.9e^{-j\Omega}}$ Lowpass

(b) $\mathrm{H}\left(e^{j\Omega}\right)=1+e^{-j2\Omega}$ Bandstop

(c) $\mathrm{H}\left(F\right)=\dfrac{1-e^{-j4\pi F}}{1+0.64e^{-j4\pi F}}$ Bandpass

(d) $\mathrm{H}\left(F\right)=\dfrac{1-e^{-j2\pi F}}{1+0.9e^{-j2\pi F}}$ Highpass