1. For each circuit below, find the transfer function, \( H(s) = \frac{v_o(s)}{v_i(s)} \), and find a differential equation for \( v_0(t) \). Also, determine whether the circuit is a high pass, low pass, band pass, band reject, or "something else" filter.

a) 

\[ \begin{align*}
& \text{circuit diagram} \\
& v_i \quad R \quad C \quad v_o
\end{align*} \]

b) 

\[ \begin{align*}
& \text{circuit diagram} \\
& v_i \quad C \quad L \quad R \quad v_o
\end{align*} \]

c) 

\[ \begin{align*}
& \text{circuit diagram} \\
& v_i \quad R \quad C \quad v_o
\end{align*} \]

d) 

\[ \begin{align*}
& \text{circuit diagram} \\
& v_i \quad R \quad L \quad C \quad v_o
\end{align*} \]

e) 

\[ \begin{align*}
& \text{circuit diagram} \\
& v_i \quad L \quad R \quad C \quad v_o
\end{align*} \]
2. A passive circuit has the transfer function

\[ H(s) = \frac{V_o(s)}{V_i(s)} = \frac{s^2}{s^2 + 1,414s + 1,000^2} \]

a. What type of filter is this?
b. Find a differential equation for \( v_0(t) \).
c. Find all finite poles and zeros.
d. Sketch the magnitude Bode plot.
e. Find the steady-state response to input

\[ v_i(t) = 120\sin(1,000\ t + 45^\circ) \]
3. Determine the transfer function of each of the circuits below. Find a differential equation for $v_0(t)$. Design the lowpass filter to have a cutoff frequency of 500 rad/s. Design the highpass filter to have a cutoff frequency of 4000 rad/s.
4. Determine the transfer function of each circuit shown below. Find a differential equation for $v_0(t)$ for each case. Design one circuit to have a dc gain of unity, a cutoff frequency of 200 Hz, and a high frequency gain of $-10 \, \text{dB}$. Design the other circuit to have a high frequency gain of unity, a cutoff frequency of 15,000 rad/s, and a low frequency gain of $-30 \, \text{dB}$. Determine the pole and zero frequencies for each case.