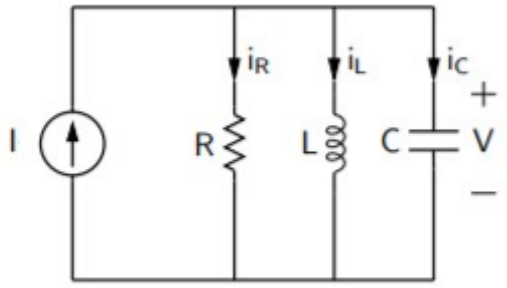
University of Illinois **Fall 2018**

ECE210/ ECE211

Homework # 7

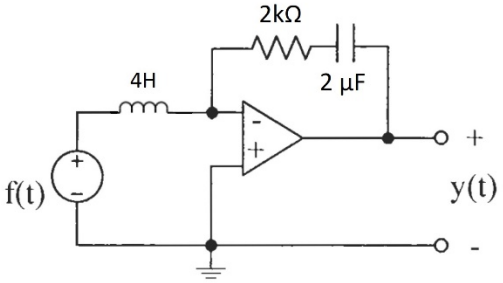
Due: Wednesday, October 17, by 6pm

1. Consider the circuit drawn below, where $R = 1\Omega$; $L = 0.1H$; $C = 0.1\ F$ and the frequency response of the circuit is: $H(\omega) = V/I$.



(a) What is the resonant frequency of the circuit?
(b) Plot | $H(\omega)$ |, and label the resonant frequency on this plot. You may use Matlab, Mathematica, etc.
(c) Plot Re{ $H(\omega)$ } and Im { $H(\omega)$ }. You may use Matlab, Mathematica, etc.
(d) Explain why this circuit might be called a "bandpass" filter.
(e) Repeat (a) and (b) for resistor values of 20Ω and 0.1Ω.
(f) Based on (d), how does the resistor value related the passband of the filter (e.g., does a large value for the resistor give a narrower or wide passband)?

2. Determine the frequency response of $H(\omega)$ of the following circuit.



3. A linear system with input f(t) and output y(t) is described by the ODE

$$\frac{d^2y}{dt^2} - 4\frac{dy}{dt} + 4\,y(t) = \frac{df}{dt} + 2\frac{d^2f}{dt^2}$$

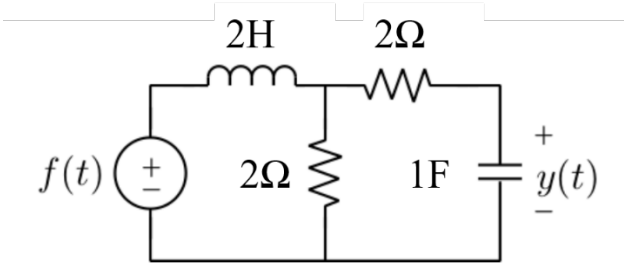
(a) Determine the frequency response *H(ω)* of the system.
(b) Determine and plot the magnitude response | *H(ω)* | for 0<ω< 20 rad/s. You may use Matlab, Mathematica, etc.
(c) Determine if this filter is low pass, bandpass, highpass or none of these, and indicate why.
(d) Determine and plot the phase response $\angle H(\omega)$ for 0<ω< 20 rad/s. You may use Matlab, Mathematica, etc.

4. A linear system with input f(t) and output y(t) is described by the ODE

$$\frac{d^2y}{dt^2} - 6\frac{dy}{dt} + 9\,y(t) = \frac{df}{dt}$$

(a) Determine the frequency response *H(ω)* of the system.
(b) Determine and plot the magnitude response | *H(ω)* | for 0<ω< 40 rad/s. You may use Matlab, Mathematica, etc.
(c) Determine if this filter is low-pass, band-pass, highpass or none of these, and indicate why.
(d) Determine and plot the phase response $\angle H(\omega)$ for 0< ω< 40 rad/s. You may use Matlab, Mathematica, etc.

5. In the following circuit, the input is *f(t) = 4-cos(2t)*. Determine the steady-state output *y(t)* of the circuit.



6. Given an input $f(t) = 2e^{-j2t} + (1+j)e^{-jt} + (1-j)e^{jt} + 2e^{j2t}$ and $H(\omega) = \frac{1-j\omega}{1+j\omega}$ determine the steady-state response *y(t)* of the system $H(\omega)$ and express it as a real-valued signal.