Name _____

EE 3340
Exam #2

There are four problems attached. Work ***all*** four.

Use any tools you wish, and please be sure to submit all details of each of your solutions. That is:

a. If you use LTspice, you should submit a copy of your netlist, and a copy of the table (or plot) of results from the computer screen. In that table (or plot), you must highlight the answer(s) to the problem.
b. If you use MATLAB, you should submit a copy of everything you enter, and a copy of the results obtained with the answer(s) to the problem highlighted.
c. If you use a calculator, explain what you did. Just copying the answer down onto your paper is insufficient and unacceptable.

If you do not show the details of your method and how you got your answer, full credit will not be given, even if the answer is correct. I must be able to see that you know how to work the problem, not just that you can find the answer somewhere. Lack of complete detail makes it appear that you might not know how to work the problem and may have copied the answer from someone else.

If you need polar or logarithmic graph paper, download it from the class website (at the bottom of the "Miscellaneous Supplements" page.

Your solutions are due by 9:30AM, Tuesday, February 29, 2022. Submit everything as a *single* PDF file with the pages in proper order and consistently oriented.

Solutions must be clean, clear, and complete if you wish to receive credit. Each page must have a clean white background. Dark shadows resulting from poorly-lighted photography make things hard to read, and are unacceptable, especially when you have twelve days to prepare and submit your results.

Each of the four problems is worth a maximum of 25 points.

1. (25 points) A coil with 1.0 mH inductance and 2.0 Ω series resistance is connected in series with a capacitor and a 120V, 5kHz sinusoidal power supply as shown below.
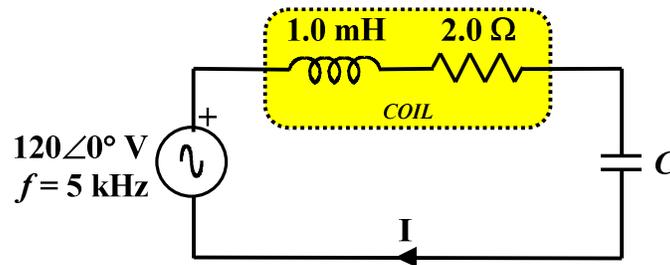

(a) [15 points] Determine the value of capacitance C that will cause the system to be in resonance.

(b) [10 points] Determine the current **I** at the resonant frequency. Express it in polar form.

2. (25 points) Two filter circuits are shown below.
   (a) [15 points] The first is a *passive* bandpass filter. Find the voltage transfer function, and write your result in the form:

$$\mathbf{H}(\omega) \triangleq \frac{\mathbf{V}_{out}(\omega)}{\mathbf{V}_{in}(\omega)} = \frac{jA\omega}{(1 - B\omega^2) + jA\omega}$$

(i.e., define A and B in terms of R, L, and C).
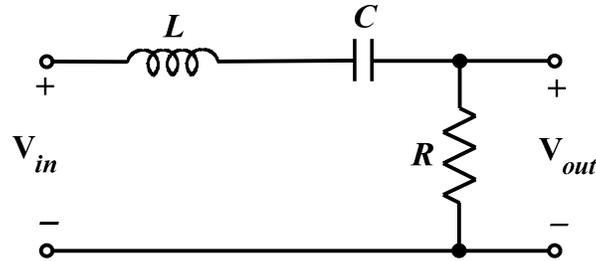
What is $\lim\limits_{\omega \to 0} |\mathbf{H}(\omega)|$ in terms of R, L, and C?

What is $\lim\limits_{\omega \to 0} \angle\mathbf{H}(\omega)$ in terms of R, L, and C?

What is $\lim\limits_{\omega \to \infty} |\mathbf{H}(\omega)|$ in terms of R, L, and C?

What is $\lim\limits_{\omega \to \infty} \angle\mathbf{H}(\omega)$ in terms of R, L, and C?

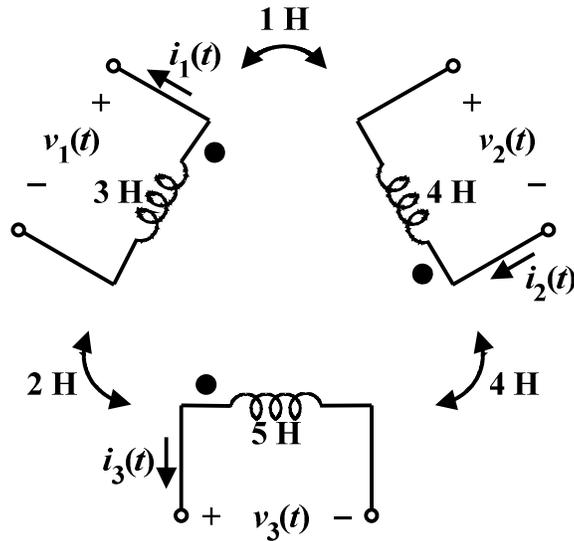Classify the filter as LP, HP, BP, or BS, and explain your reasoning.

(b) [10 points] The second circuit is an *active* filter. If $\mathbf{Z}_1$ is a capacitor C, and $\mathbf{Z}_2$ is a parallel RC circuit, with elements R and C (this C has the same value as the C in $\mathbf{Z}_1$), determine an expression for the voltage transfer function. Write your result in the form:

$$\mathbf{H}(\omega) \triangleq \frac{\mathbf{V}_{out}(\omega)}{\mathbf{V}_{in}(\omega)} = \frac{1+jA\omega}{1+jB\omega}$$

(i.e., define A and B in terms of R and C).
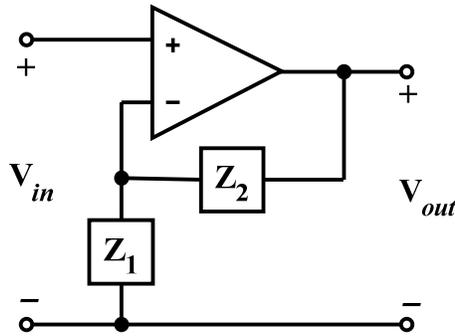
3. (25 points) The currents in the three mutually-coupled inductors shown below are
$i_1(t) = 20\cos 10t$ A, $i_2(t) = 10\sin 10t$ A, and $i_3(t) = 5\cos 10t$ A.

1 H

$i_1(t)$

$+$

$v_1(t)$

$-$ 3 H

$+$

$v_2(t)$

$-$ 4 H

$i_2(t)$

2 H   4 H

$i_3(t)$

5 H

$+$ $v_3(t)$ $-$

(a) [20 points] Determine $v_2(t)$. Express it in terms of the cosine basis function.

(b) [5 points] Determine the effective value of $v_2(t)$.

4. (25 points) A two-port network is shown below.

$i_1(t)$ 1 Ω $i_2(t)$

$v_1(t)$ 1 Ω   1 Ω $v_2(t)$

1 Ω
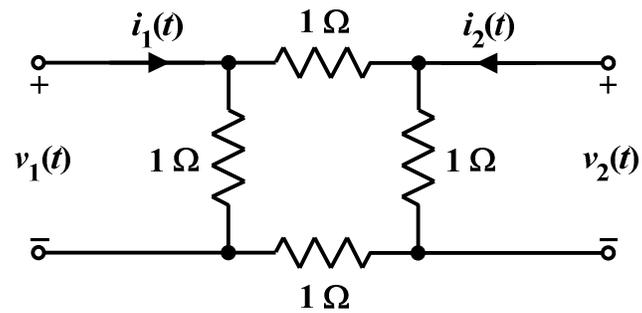
(a) [16 points] Determine the hybrid-parameter (h-parameter) representation and express it in the standard matrix form.

(b) [9 points] Using those hybrid parameters, sketch an equivalent circuit consisting of resistors and dependent sources.