Name _____

EE 3340

Exam #1

There are five problems attached. Pick any ***four***.

Use any tools you wish, but please be sure to submit all details of your solution. 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 unacceptable.

If you do not show/explain your method and your answer, no credit will be given. We must be able to see that you know how to work the problem, not that you can copy the answer from your calculator, from your computer, or elsewhere.

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

Your solutions are due by 9:00AM next Tuesday, February 15, 2022. Submit everything as a single PDF file with pages having a clean white background. Dark shadows resulting from poorly-lighted photography make things hard to read, and are unacceptable at this level – especially when you have five days to prepare and submit your results.

Solutions must be clean, clear and complete if you wish to receive credit.

Submit only the four problems you selected for credit. Each is worth a maximum of 25 points.

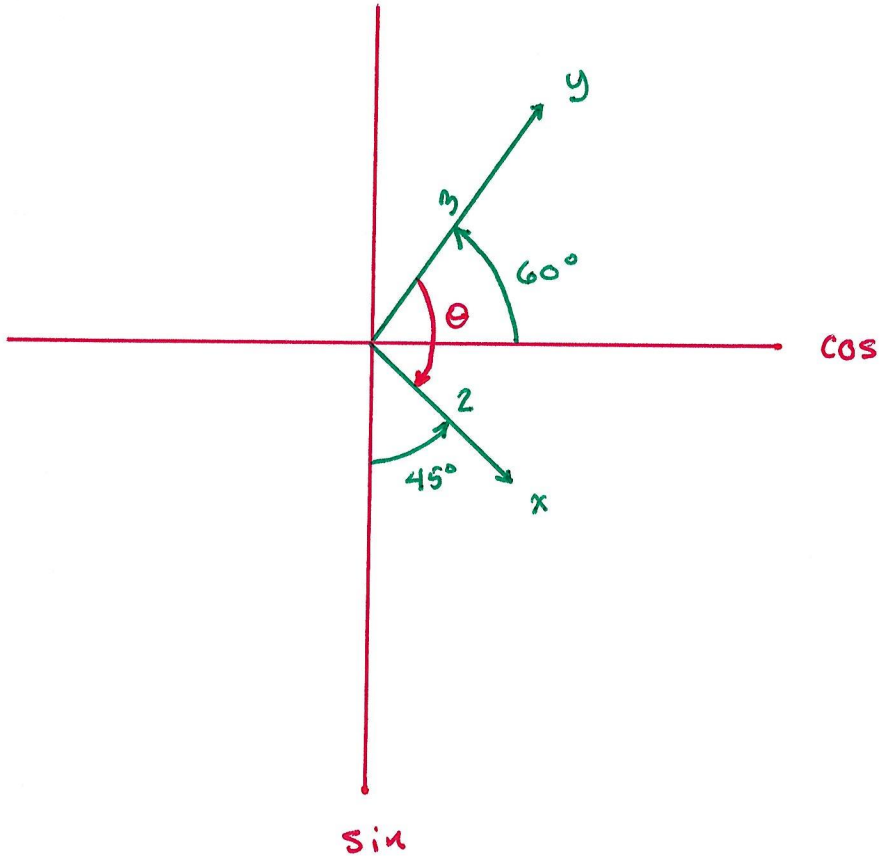
1. [Relationship between Sinusoids and Phasors]

(a) What is the phase angle of $x(t) = 2\sin(\omega t + 45°)$ with respect to $y(t) = 3\cos(\omega t + 60°)$?

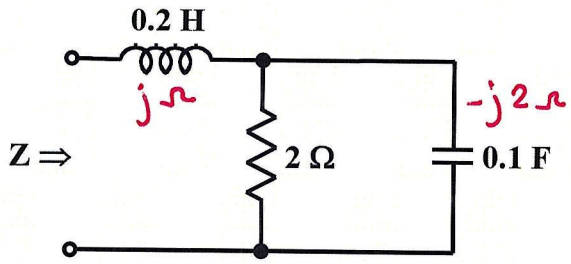
$\theta = -60 - 45$

$= -105°$

(b) Accurately sketch a phasor diagram showing the proper length and orientation of each of these two signals.



2. [Impedance]
Given $\omega = 5$ rad/s, determine the equivalent impedance, **Z**, for the circuit shown. Express your result in rectangular form.



$$Z = j + \frac{(2)(-j2)}{2 - j2}$$

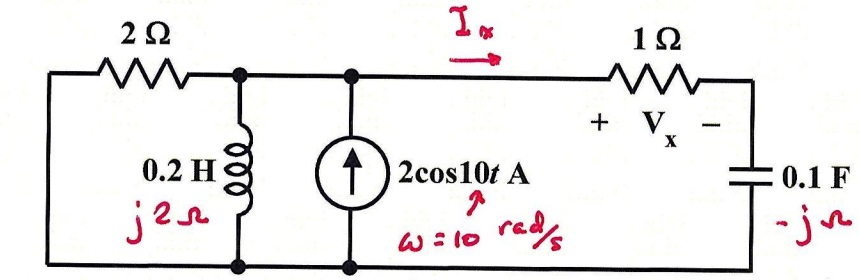
$$= \frac{j(2 - j2) + (2)(-j2)}{2 - j2}$$

$$= \frac{j2 + 2 - j4}{2 - j2}$$

$$= \frac{2 - j2}{2 - j2}$$

$$= 1\ \Omega$$

3. [AC Circuit Analysis]
Determine the steady-state AC value of V_x. Express your result in polar form with the angle in degrees.



$j2\ \Omega$ $\quad -j\ \Omega$

$2\angle 0^\circ$ A

$$Z_1 = \frac{1}{\frac{1}{2} + \frac{1}{j2}} \qquad Z_2 = 1 - j\ \Omega$$

$$= \frac{j2}{j+1} \cdot \frac{j-1}{j-1}$$

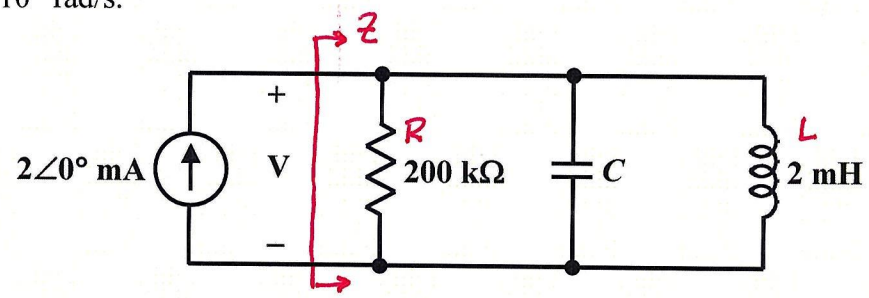
$$= \frac{-2-j2}{-1-1}$$

$$= 1 + j\ \Omega$$

$$I_x = \frac{Z_1}{Z_1 + Z_2} \cdot 2\angle 0^\circ = \frac{1+j}{1+j+1-j} \cdot 2 = 1 + j\ \text{A}$$

$$V_x = (1\ \Omega) I_x = 1 + j\ \text{V} = \sqrt{2}\angle 45^\circ\ \text{V}$$

4. [Resonance]
Given $\omega = 5\times10^6$ rad/s.



(a) What value of C will make the voltage **V** a maximum?

$$Z = \frac{1}{\frac{1}{R} + j\omega C + \frac{1}{j\omega L}}$$

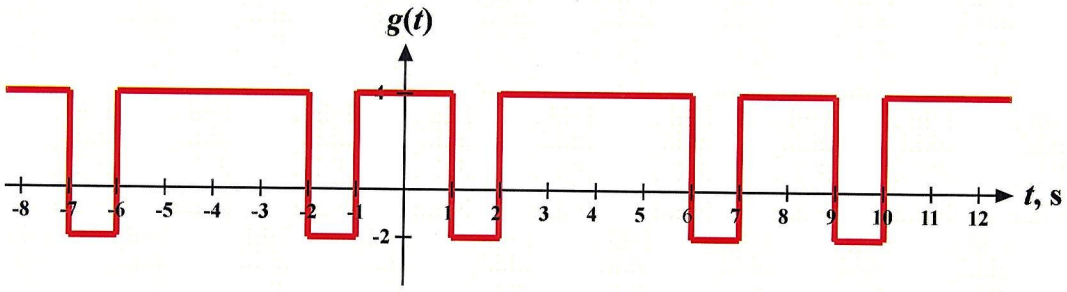
V will be maximum when $|Z|$ is maximum or when $\omega C = \frac{1}{\omega L}$

$$\Rightarrow \quad C = \frac{1}{\omega^2 L} = \frac{1}{(5\times10^6)^2 (2\times10^{-3})} = \frac{1}{50\times10^9} = 20 \text{ pF}$$

(b) With the value of C determined in part (a), what is **V** (in polar form)?

$$V = (200\text{k}\Omega)(2\angle 0^\circ \text{ mA}) = 400\angle 0^\circ \text{ V}$$

5. [Average and Effective Values]
Given the periodic waveform, $g(t)$, shown below:



(a) Determine the average value of the waveform.

$$G_{ave} = \frac{1}{8}\left\{\int_0^1 4\,dt + \int_1^2 (-2) + \int_2^6 4\,dt + \int_6^7 (-2)\,dt + \int_7^8 4\,dt\right\}$$

$$= \frac{1}{8}\left\{4 - 2 + 4(4) - 2 + 4\right\}$$

$$= \frac{1}{8}(20)$$

$$= \frac{5}{2} \text{ or } 2.5$$

(b) Determine the effective value of the waveform.

$$G_{eff} = \frac{1}{8}\left\{\int_0^1 (4)^2\,dt + \int_1^2 (-2)^2\,dt + \int_2^6 (4)^2\,dt + \int_6^7 (-2)^2\,dt + \int_7^8 (4)^2\,dt\right\}$$

$$= \sqrt{\frac{1}{8}\left\{16 + 4 + 16(4) + 4 + 16\right\}}$$

$$= \sqrt{\frac{1}{8}(104)}$$

$$= \sqrt{13}$$

$$\approx 3.61$$