Name________________________ ECE 3510 Homework 6 Review of Steady-State AC b

If you know how to use the complex math feature of your calculator, you may use that to work the following problems. In that case you may report the answers without showing any work.

1. Convert the following complex numbers to polar form ($m\angle\theta$ or $me^{j\theta}$).
   a) $2.6 + 8.7j$

   b) $3 + 4j$

   c) $-3 - 4j$

2. Convert the following complex numbers to rectangular form (a + bj).
   a) $10 \cdot e^{j \cdot 60 \cdot deg}$

   b) $10 \cdot e^{-j \cdot 45 \cdot deg}$

   c) $20 \cdot e^{j \cdot 120 \cdot deg}$

3. Add or subtract the complex numbers.
   a) $(3 + 2j) + (6 + 9j)$

   b) $(9 - 10j) - (9 + 10j)$

4. Multiply the complex numbers.
   a) $\left(20 \cdot e^{j \cdot 40 \cdot deg}\right) \cdot \left(10 \cdot e^{j \cdot 60 \cdot deg}\right)$

   b) $(-2 - j) \cdot (-6 - 9j)$

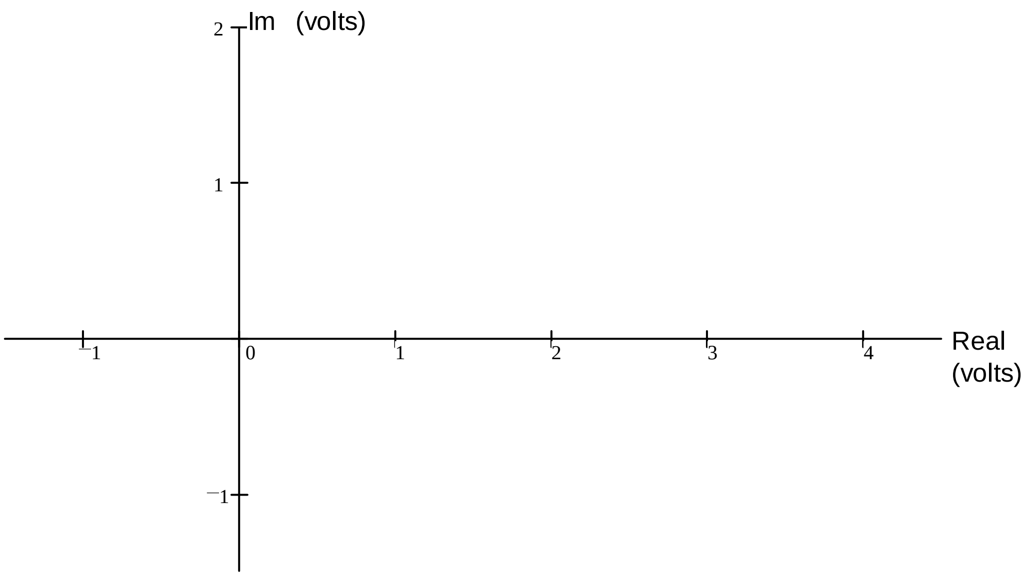
5. Divide the complex numbers.
   a) $\dfrac{20 \cdot e^{j \cdot 40 \cdot deg}}{10 \cdot e^{j \cdot 60 \cdot deg}}$

   b) $\dfrac{12 + 10j}{6 + 9j}$

6. Add and subtract the sinusoidal voltages using phasors. Draw a phasor diagram which shows all 4 phasors, and give your final answer in time domain form.

$v_1(t) = 1.5 \cdot V \cdot \cos(\omega \cdot t + 10 \cdot deg)$ $\qquad$ $v_2(t) = 3.2 \cdot V \cdot \cos(\omega \cdot t + 25 \cdot deg)$

a) Find $v_3(t) = v_1(t) + v_2(t)$



b) Find $v_4(t) = v_1(t) - v_2(t)$ add v_4 to the drawing above

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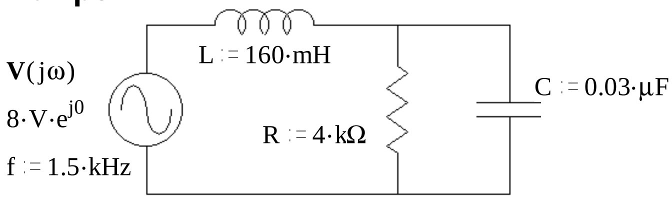
7. a) Find $\mathbf{Z_{eq}}$.



b) Find the current $\mathbf{I_L}(j\omega)$.

8. Find the steady-state magnitude and phase of each of the following transfer functions. $|\mathbf{H}(j\cdot\omega)| = ?$ $\angle \mathbf{H}(j\omega) = ?$

a)

$$\omega := 10\cdot\frac{rad}{sec} \qquad \mathbf{H}(s) = \frac{\frac{40}{sec}\cdot s}{s^2 + \frac{10}{sec}\cdot s + \frac{200}{sec^2}}$$

$$s = j\cdot\omega$$

8, continued b)

$f := 50 \cdot Hz$ $\qquad$ $\mathbf{H}(s) = \dfrac{s^2 + \dfrac{1000}{sec} \cdot s}{s^2 + \dfrac{300}{sec} \cdot s + \dfrac{10000}{sec^2}}$

9. Find the following outputs. Express them in the time domain, first as a cosine with a phase angle and then as a sum of cosine and sine with no phase angles:

a) The input $x(t) = 3 \cdot \cos(10 \cdot t)$ is the input for the transfer function of 8a), above.

b) The input $x(t) = 5 \cdot \sin(2 \cdot \pi \cdot 50 \cdot t)$ is the input for the transfer function of 8b), above.

remember, sine is -j

<u>Answers</u>

1. a) $9.08 \cdot e^{j \cdot 73.4 \cdot deg}$ b) $5 \cdot e^{j \cdot 53.1 \cdot deg}$ c) $5 \cdot e^{-j \cdot 126.9 \cdot deg}$

2. a) $5 + 8.66 \cdot j$ b) $7.071 - 7.071 \cdot j$ c) $-10 + 17.321 \cdot j$ $\qquad$ 3. a) $9 + 11 \cdot j$ b) $-20 \cdot j$

4. a) $200 \cdot e^{j \cdot 100 \cdot deg}$ b) $24.2 \cdot e^{j \cdot 82.9 \cdot deg}$ $\qquad$ 5. a) $2 \cdot e^{-j \cdot 20 \cdot deg}$ b) $1.385 - 0.41 \cdot j$

6. a) $v_1(t) + v_2(t) = 4.67 \cdot \cos(\omega \cdot t + 20.2 \cdot deg) \cdot V$ $\qquad$ b) $v_1(t) - v_2(t) = 1.794 \cdot \cos(\omega \cdot t - 142.5 \cdot deg) \cdot V$

7. a) $1.82 \cdot k\Omega$ $\quad -15.2 \cdot deg$ $\qquad$ b) $4.4 \cdot mA$ $\quad 15.2 \cdot deg$

8. a) $M = 2.828$ $\quad 45 \cdot deg$ $\qquad$ b) $M = 2.544$ $\quad -25.8 \cdot deg$

9. a) $y(t) = 8.484 \cdot \cos\left(10 \cdot \frac{rad}{sec} \cdot t + 45 \cdot deg\right) = 6 \cdot \cos\left(10 \cdot \frac{rad}{sec} \cdot t\right) - 6 \cdot \sin\left(10 \cdot \frac{rad}{sec} \cdot t\right)$

b) $y(t) = 12.72 \cdot \cos(2 \cdot \pi \cdot 50 \cdot t - 115.82 \cdot deg) = -5.54 \cdot \cos(2 \cdot \pi \cdot 50 \cdot t) + 11.45 \cdot \sin(2 \cdot \pi \cdot 50 \cdot t)$