ECE 209 - COMPLEX EXPONENTIALS - INVESTIGATION 3
BASIC PROPERTIES - PART III

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To do "well" on this investigation you must not only get the right answers but must also do neat, complete and concise writeups that make obvious what each problem is, how you're solving the problem and what your answer is. You also need to include drawings of all circuits as well as appropriate graphs and tables.

The objective of this investigation is for you to get practice using complex exponentials and phasors to solve differential equations for sinusoidal steady state responses

1. Here are some common **mistakes**. Make corrections
   a. $V(j100) = 5e^{j0.4}e^{j100t}$
   b. $V(j100) = \mathrm{Re}\,[5e^{j0.4}e^{j100t}]$
   c. $v(t) = 5e^{j0.4}e^{j100t}$

2. Express $v_o(t) = 5\cos(1000t + \pi/4)$ as the real part of a complex exponential and then find the corresponding phasor $V_o(j1000)$

3. Express the following voltage phasors as complex exponentials
   a. $V(j1000) = \dfrac{5 + j2}{j3}$
   b. $V(j1000) = \dfrac{2e^{j1.2}}{j3}$

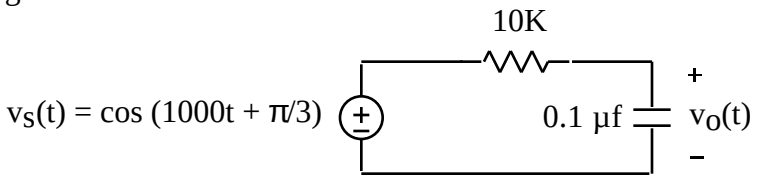
4. Express the following voltages as cosines
   a. $v(t) = \mathrm{Re}\left[\dfrac{5 + j2}{j3}\, e^{j100t}\right]$
   b. $v(t) = \mathrm{Re}\left[\dfrac{2e^{j1.2}}{j3}\, e^{j100t}\right]$
   c. $v(t) = \dfrac{d}{dt}\,\mathrm{Re}\left[2e^{j100t}\right]$

5. Find $V_o(j100)$ and then $v_o(t)$ in each of the following
   a. $\mathrm{Re}\left[(2 + j)V_o(j100)e^{j100t}\right] = \mathrm{Re}\left[5e^{j100t}\right]$
   b. $\mathrm{Re}\left[5V_o(j100)e^{j100t} + (2 + j)V_o(j100)e^{j100t}\right] = \mathrm{Re}\left[5e^{j100t}\right]$
   c. $\dfrac{d}{dt}\,\mathrm{Re}\left[V_o(j100)e^{j100t}\right] + 100\,\mathrm{Re}\left[(2 + j)V_o(j100)e^{j100t}\right] = \mathrm{Re}\left[500e^{j100t}\right]$

6. Find the sinusoidal steady state response of $v_o(t)$ satisfying

$$v'_o + 1550\, v_o = 4000\cos(2000t + \pi/3)$$

7. For the following circuit



   a. Write the differential equation for $v_O(t)$
   b. Solve the differential equation for the phasor $V_O(j10^3)$ and then find the corresponding sinusoidal steady state $v_O(t)$

8. Repeat Problem (7) for a circuit of your own containing a controlled source

9. Find the phasors $V_C(j1000)$ and $I_C(j1000)$ of a $C = 0.1$ μf capacitor with voltage $v_C(t) = 5\cos(1000t - \pi/6)$

10. Find the phasors $I_L(j1000)$ and $V_L(j1000)$ of a $L = 1$ mh inductor with current $i_L(t) = 5\cos(1000t - \pi/6)$

11. Make use of the complex exponential representations of z_1 and z_2 as follows

$$z_1 = r_1 e^{j\theta_1} \quad \text{and} \quad z_2 = r_2 e^{j\theta_2}$$

to show that

a. $|z_1 z_2| = |z_1||z_2|$ b. $\left|\frac{z_1}{z_2}\right| = \frac{|z_1|}{|z_2|}$

Then **memorize** these very simple but useful results.

12. Make use of the results in Problem (11) to find the magnitudes of

   a. $V(j100) = (2+j)(3+j4)$
   b. $V(j100) = \dfrac{2+j}{3+j4}$
   c. $V(j\omega) = \dfrac{j\omega}{j\omega + 1000}$