Note that impedance (our new complex number notation with resistance + 'reactance') is naturally expressed in rectangular form: \( Z = X + jX \). Voltage and current are naturally expressed as phasors, with a magnitude (the amplitude of the sine wave) and phase angle. This is why we have problems with mixed complex number notation and why you need to be able to manipulate these numbers in any form.

Chapter 9:
Problem 1
Express the following functions in cosine form, and write them as phasors, and plot them (roughly) in the complex plane. (Note that you cannot write them as phasors until they are expressed in cosine form.)

(a) \( 10 \sin (\omega t + 30^\circ) \)
(b) \( -9 \sin (8t) \)
(c) \( -20 \sin (\omega t + 45^\circ) \)

Problem 2
Evaluate this complex expression and report your answer in rectangular form, polar form, as a phasor, and plot the phasor (roughly) in the complex plane.

\[
\frac{60\angle 45^\circ}{7.5 - j10 + j2}
\]

Problem 3
Evaluate this complex expression and report your answer in polar and rectangular form. Be sure to determine which quadrant is the correct quadrant for the angles you find using the \( \tan^{-1} \) function on your calculator.

\[
\frac{(10\angle 60^\circ)(35\angle - 50^\circ)}{(2 + j6) - (5 + j)}
\]

Problem 4
Use phasors (i.e., phasor notation) to find:

\[
20 \sin(400t) + 10 \cos(400t + 60^\circ) - 5 \sin(400t - 20^\circ)
\]

Note: You can only use phasors if the frequency (\( \omega \)) is the same for every sinusoid. Be sure you are comfortable with why this is true.
**Problem 5**
Find the equivalent impedance, $Z_{eq}$, as seen by the source, for the circuit below. Assume $i_s(t) = I_s \cos(200t)$.

Express the answer in rectangular coordinates and plot $Z_{eq}$ in the complex plane.

![Circuit Diagram]

**Problem 6**
Find the equivalent impedance as seen by the source for the circuit below (the circuit use in lab 7). Plot and label the three $Z_{eq}$ for parts (a), (b), and (c) on the same complex plane graph (rectangular coordinates make more intrinsic sense for $Z$ but you can use any form you like):

a) $Z_{eq}$ at a frequency significantly lower than the resonant frequency, $f_0$ (you can select the frequency you want to use. Be sure to express the frequency in radians, $\omega_0$, for the calculations, not in Hz)

b) $Z_{eq}$ at resonant frequency, $f_0$ (again in radians, $\omega_0$, for the calculations)

c) $Z_{eq}$ at a high frequency, significantly larger than $f_0$ (now, and always, in radians, $\omega_0$, for the calculations)

![Circuit Diagram]

**Notes For Lab 7:**

- For April 6, bring THREE complete drafts of your lab report to lab
- The Matlab script to use for plotting the data, and comparing the theory is posted on the web page – follow along the comments in the Matlab script for entering your data from lab, and the “transfer function” of the circuit from lab.