PE 14

Complex Numbers Worksheet

(Updated 13 Jul 2009)

A Practical Exercise Name:_____ Section: _____

I. Purpose.

1. Review sinusoidal voltage and current equations.
2. Review phasors and their use in representing sinusoidal voltages and currents.
3. Introduce the graphical representation of rectangular and polar complex numbers.
4. Introduce conversion between rectangular and polar forms using geometrical properties.
5. Introduce manual addition, subtraction, multiplication, and division of complex numbers.
6. Introduce complex equation solving with a calculator.

II. Equipment.

TI-86 or equivalent scientific calculator.

III. Preparation.

IV. Lab Procedure.

Step One: Review of sinusoidal voltage and current equations:

☐ Express the following AC voltage sources as sinusoidal equations, e.g. $v(t) = V\sin(\omega t+\theta)$.

a. 25-kHz voltage source lags 67° where $V_{RMS} = 5$ V.

$$\mathbf{V_1(t) =} \_\_\_\_\_$$

b. 30-Hz voltage that leads 125° where $V_{PP} = 25$ V.

$$\mathbf{V_2(t) =} \_\_\_\_\_$$

☐ Express the following AC current sources as sinusoidal equations, e.g. $i(t) = I\sin(\omega t+\theta)$.

c. 100 Hz current source that leads 45° where $I_{RMS} = 3.5$ A.

$$\boldsymbol{I_1(t) =} \_\_\_\_\_$$

d. 13 kHz current that lags 36° where $I_{PP} = 36$ mA.

$$\boldsymbol{I_2(t) =} \_\_\_\_\_$$

Step Two: Review of phasors that represent sinusoidal voltages and currents:

☐ Express the voltage and current sources from step one as phasors.

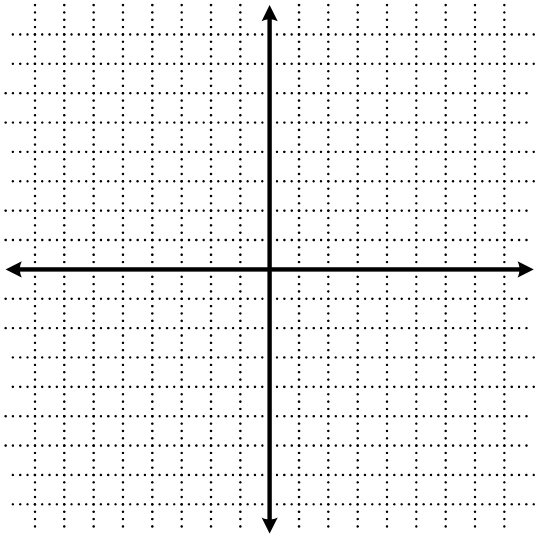
$\mathbf{V_1}$ = _____

$\mathbf{V_2}$ = _____

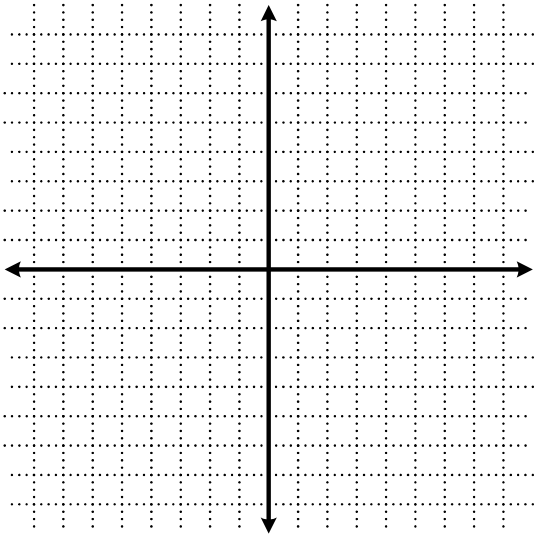
$\mathbf{I_1}$ = _____

$\mathbf{I_2}$ = _____

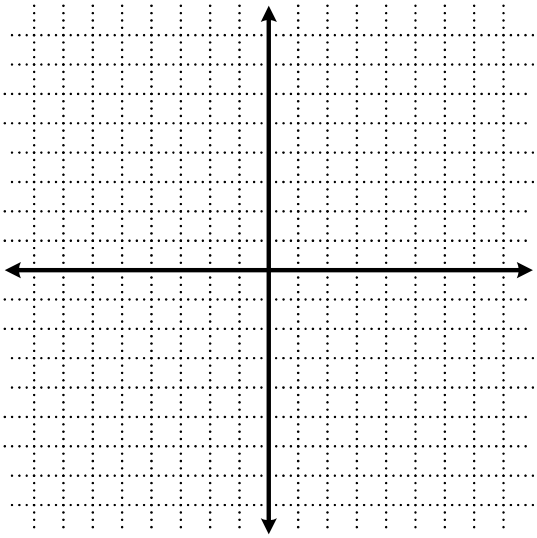
☐ Graph the above voltage and current **phasors**.



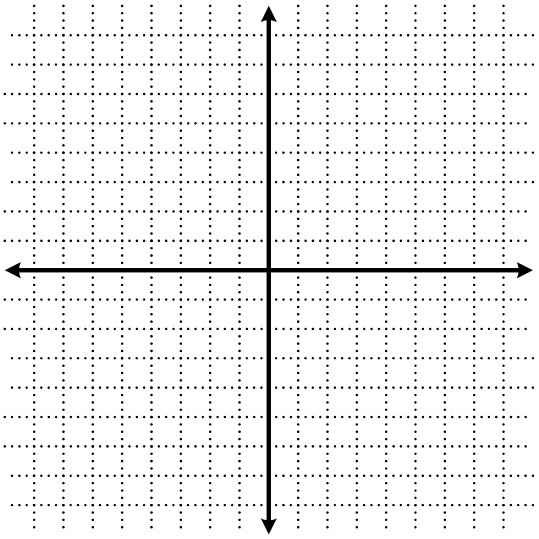
V_1



V_2



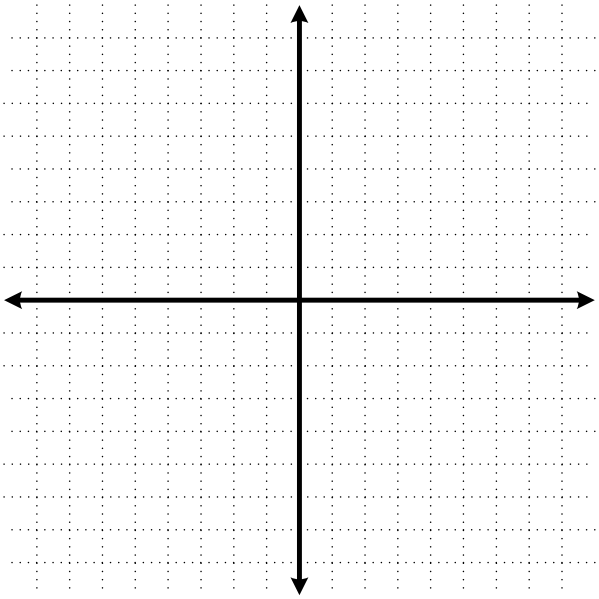
I_1



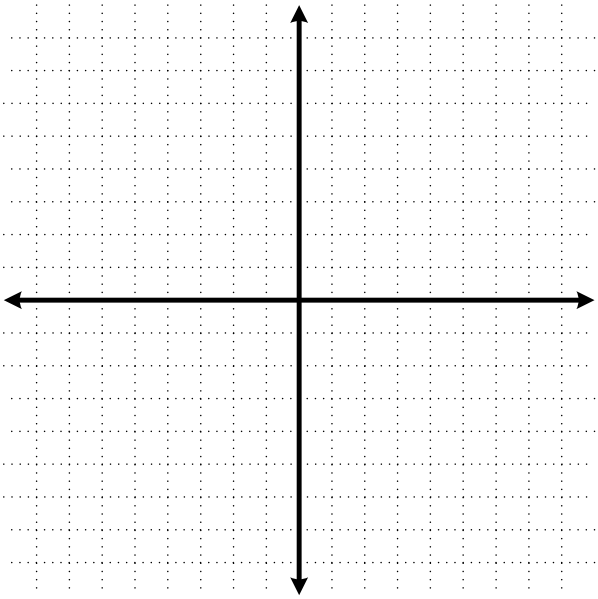
I_2

Step Three: Graphical representation of complex numbers in rectangular form:

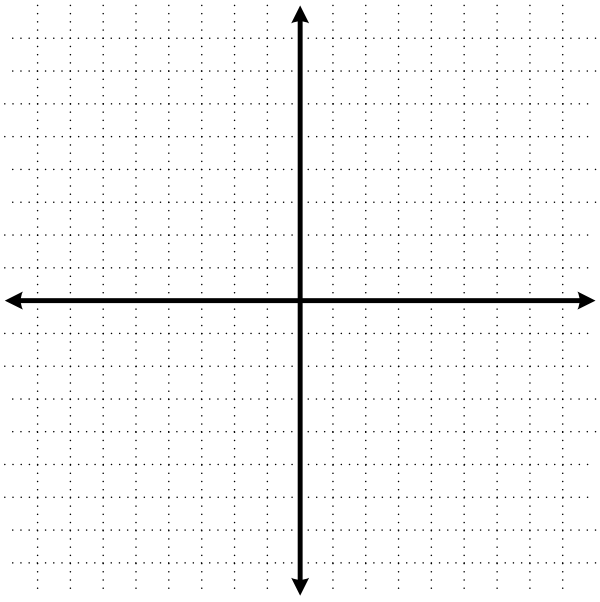
☐ Graph the following complex numbers as phasors.



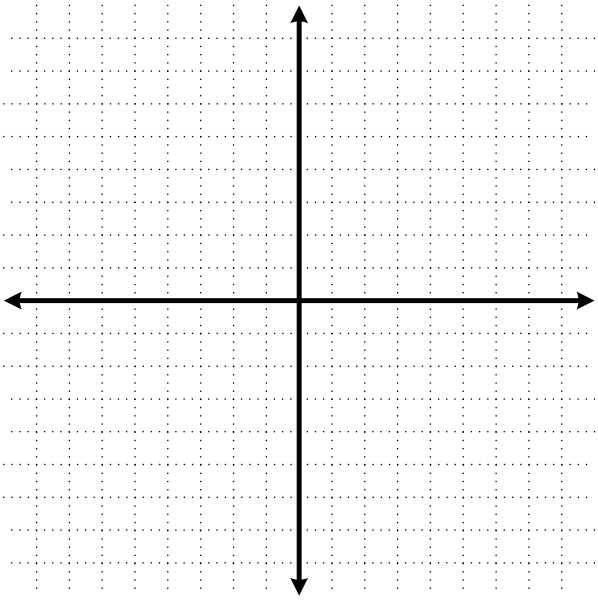
W = -8 + j7



X = 4 – j3



Y = -2 – j5



Z = 4 + j8

Step Four: Conversion between rectangular and polar forms using geometric properties.

☐ Use geometric properties to convert the above complex numbers (**W**, **X**, **Y**, and **Z**) to polar form. Note – round magnitudes to the first decimal place and round angles to the nearest degree.

W = _____ **X = _____**

Y = _____ **Z = _____**

Step Five: Manual addition, subtraction, multiplication, and division of complex numbers:

☐ Use the complex numbers expressed in steps three and four determine the sum, difference, product, or quotient of the following equations. **Note – do not use the complex abilities of your calculator**. Express your answer in polar or rectangular form.

a. **W + Z + Y = _____**

b. **Y - X = _____**

c. **Z · W = _____**

d. **W / X = _____**

Step Six: Equations with complex numbers.

☐ Use a calculator to solve the following equations and express your answers in **rectangular form**.

a. $(50 \angle 0°)(0 + j\,6) =$ _____

b. $\dfrac{(0.04 \angle 60°)^2(300 \angle 40°)}{3 + j9} =$ _____

c. $\dfrac{(4 + j\,3) + (6 - j8)}{(3 + j3) - (2 + j3)} =$ _____

☐ Use a calculator to solve the following for **A** and express your answers in **polar form**. Note: CSOLVE function can solve it as written, or rearrange it and solve for A.

d. $(35 \angle 0°) + A = (145 \angle -80°)$

A = _____

e. $(15 \angle 135°) = \dfrac{A^2}{(4 - j\,7)}$

A = _____

f. $(5 - j5)\,A = (20 \angle 60°)$

A = _____