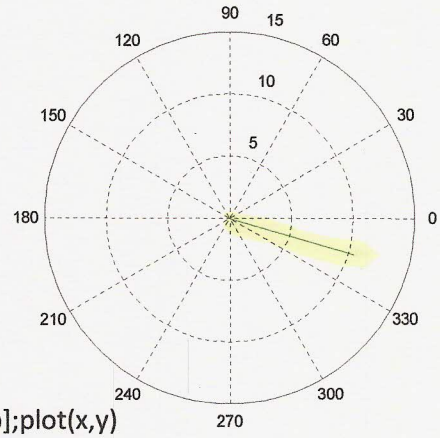
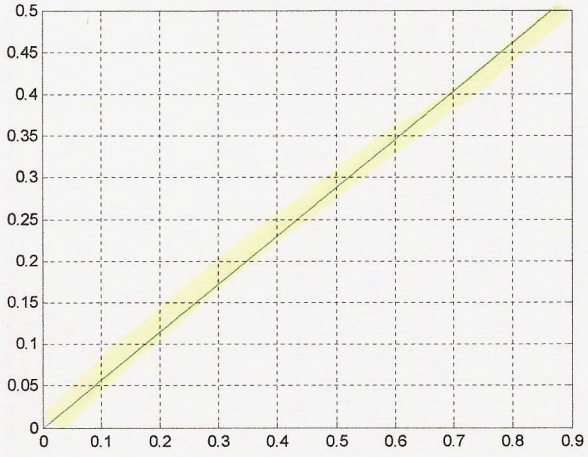
1. Plot each of the following complex numbers as vector in the complex plane:

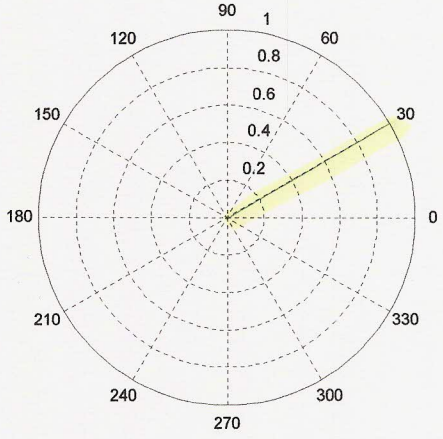
   a. (10-3j) Matlab: [t,r]=cart2pol(10,-3);theta=[0,t];rho=[0,r];polar(theta,rho)



   b. $e^{j\pi/6}$ matlab: [a,b]=pol2cart(pi/6,1); x=[0,a]; y=[0,b];plot(x,y)

   theta=[0,pi/6];rho=[0,1];polar(theta,rho)

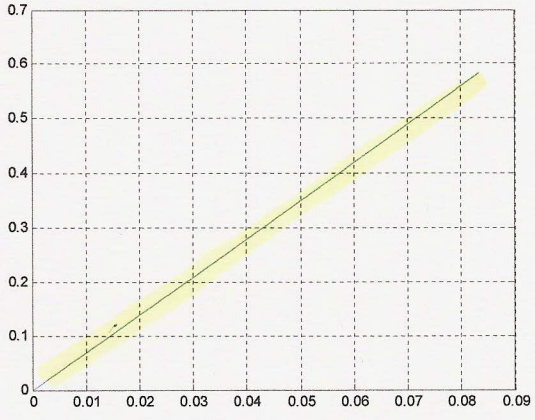


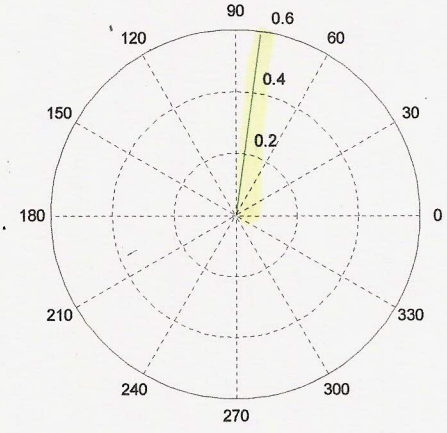


   c. $\frac{2+2j}{6}-\frac{1-j}{4}$ =0.0833 + 0.5833i Matlab: a=real(((2+2i)/6)-((1-i)/4));

   b=imag(((2+2i)/6)-((1-i)/4));x=[0,a]; y=[0,b];plot(x,y)

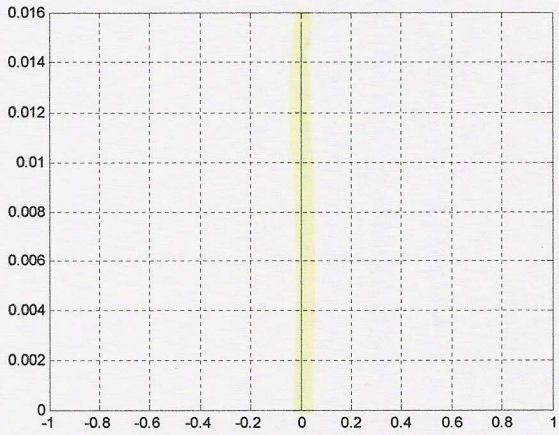
   [t,r]=cart2pol(0.08330,0.5833);theta=[0,t];rho=[0,r];polar(theta,rho)

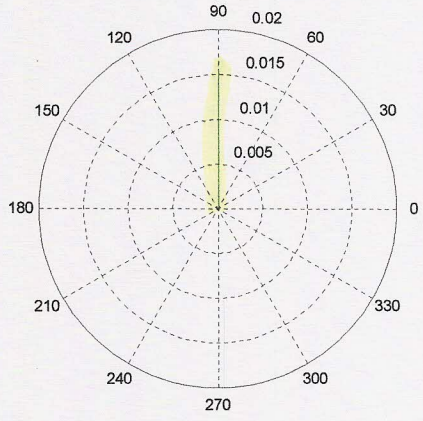




d. $\frac{1}{4j^3}$ which equals 0 + 0.0156i Matlab: a=real(1/(4i^3));b=imag((1/(4i^3)));x=[0,a]; y=[0,b];plot(x,y)

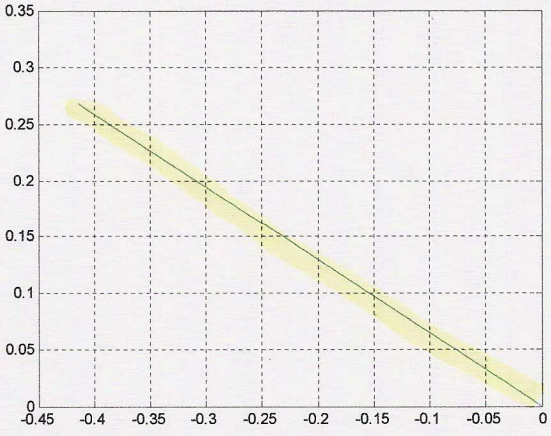
theta=[0,pi/2];rho=[0,0.0156];polar(theta,rho)

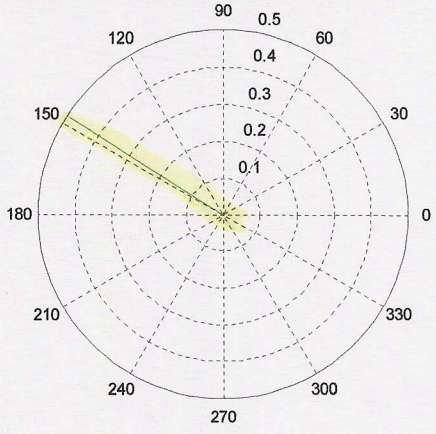




e. $\frac{1-3j}{-5+4j}$ which equals -0.4146 + 0.2683i Matlab: a=real((1-3i)/(-5+4i));b=imag((1-3i)/(-5+4i));x=[0,a]; y=[0,b];plot(x,y)

[t,r]=cart2pol(-.4146,0.2683);theta=[0,t];rho=[0,r];polar(theta,rho)





2. Give numerical answers to each of the following questions:

a. Rationalize $\frac{-30k\cdot(j1k)}{30k+j1k}$. Express your answer in rectangular form.

$$\frac{-30k\cdot(j1k)}{(30k+j1k)}\cdot\frac{(30k-j1k)}{(30k-j1k)}=\frac{-9e11j-3e10}{30k\,\hat{}\,2+1e3\,\hat{}\,2}=-999j-33$$

b. Find the polar form of $\left(e^{j45^o}\right)^*\left(\sqrt{1+\frac{5}{4}}-j\sqrt{1-\frac{5}{4}}\right)^*$ (Note: The asterisk means conjugate.)

$$\left(e^{-j45^o}\right)(1.5+0.5j)=\left(e^{-j45^o}\right)\left(1.58e^{j18.4^o}\right)=1.58e^{-j26.6^o}$$

c. Find the following phasor: $\mathrm{P}\left[8\sin(3kt+115^o)\right]=\mathrm{P}\left[8\cos(3kt+115^o-90^o)\right]$

$8e^{+j25}$

d. Find the magnitude of $\frac{(1-4j)2e^{-j50^o}}{2+2e^{j90^o}}$.

$$\left|\frac{\left(\sqrt{1^2+4^2}e^{-j\tan^{-1}(-4/1)}\right)2e^{-j50^o}}{2+2j}\right|=\left|\frac{\left(4.12e^{-j76^o}\right)2e^{-j50^o}}{2.83e^{j45^o}}\right|=2.9$$

e. Find the imaginary part of $\frac{1-5j}{e^{-j60^o}}$.

$$\mathrm{Im}\left[\frac{5e^{-j79^o}}{e^{-j60^o}}\right]=\mathrm{Im}\left[5e^{-j19^o}\right]=5\sin(-19^o)=-1.6$$

3. a. Write phasors (as both $Ae^{j\phi}$ and $A\angle\phi$) for each of the following signals:

i. v(t)=18cos(5t+80°)V => $18e^{j80^o}$ $18\angle 80^o$

ii. i(t)=4sin(ωt+143°)mA => $4me^{j143^o}$ $4m\angle 143^o$

iii. v(t)=cos(10t+30°)V+7sin(10t-30°)V=

$$e^{j30^o}+7e^{-j120^o}=\cos(30)+\sin(30)j+7\cos(-120)+7\sin(-120)j=-2.6-5.6j=6.1e^{-j115^o}$$

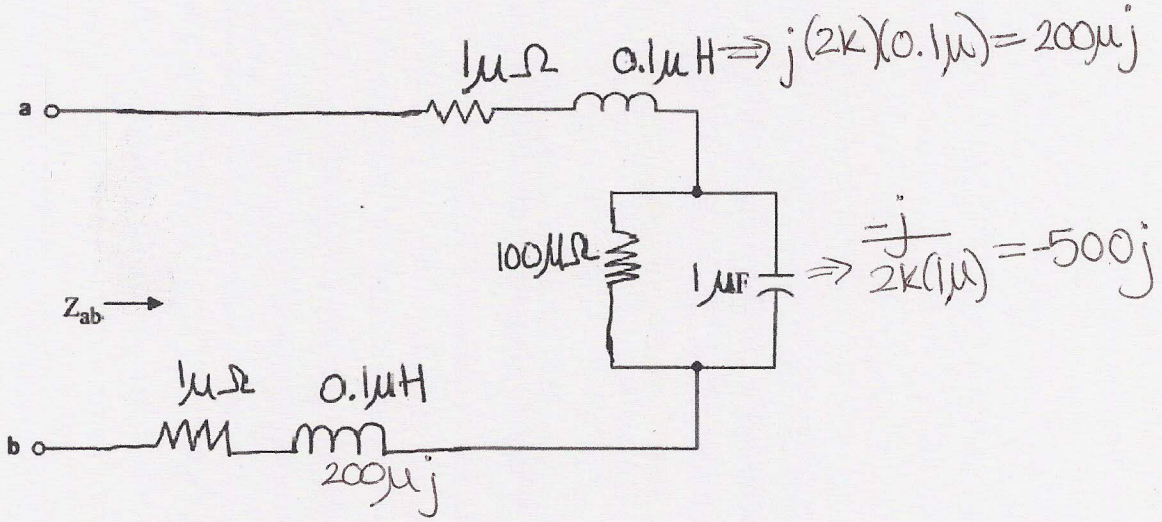
b. Given ω=9krad/sec, write inverse phasors for each of the following signals:

i. $\mathbf{I}=56.8e^{j37^o}$ A => 56.8cos(9kt+37°)

ii. $\mathbf{V}=-5j^3$ V => $5e^{j90^o}$ = 5cos(9kt+90°)

iii. $\mathbf{I}=3e^{+\frac{\pi}{2}-j63^o}=3e^{+\frac{\pi}{2}}e^{-j63^o}$ A=> $3e^{+\frac{\pi}{2}}\cos(9kt-63^o)$

4.



Given $\omega = 2k$ rad/sec, find Z_{ab}.

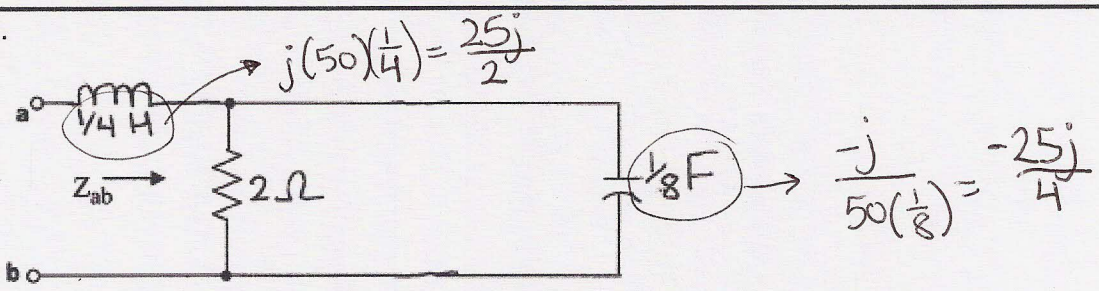
$$Z_{ab} = 1\mu + 200\mu j + (100\mu \| -500j) + 200\mu j + 1\mu = 0$$

$$2\mu + 400\mu j + \frac{100\mu(-500j)}{(-500j + 100\mu j)} \frac{(100\mu + 500j)}{(100\mu + 500j)} =$$

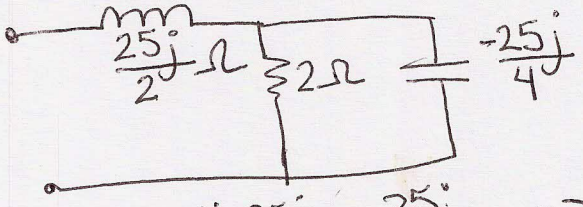
$$= 2\mu + 400\mu j + \frac{-5\mu j + 25j^2}{100\mu^2 + 500^2} = 2\mu + 400\mu j - 2m j + 100\mu$$

$$\boxed{Z_{ab} = 102\mu - 1.6m j}$$

5.



Given $\omega = 50$ rad/sec, find Z_{ab}.



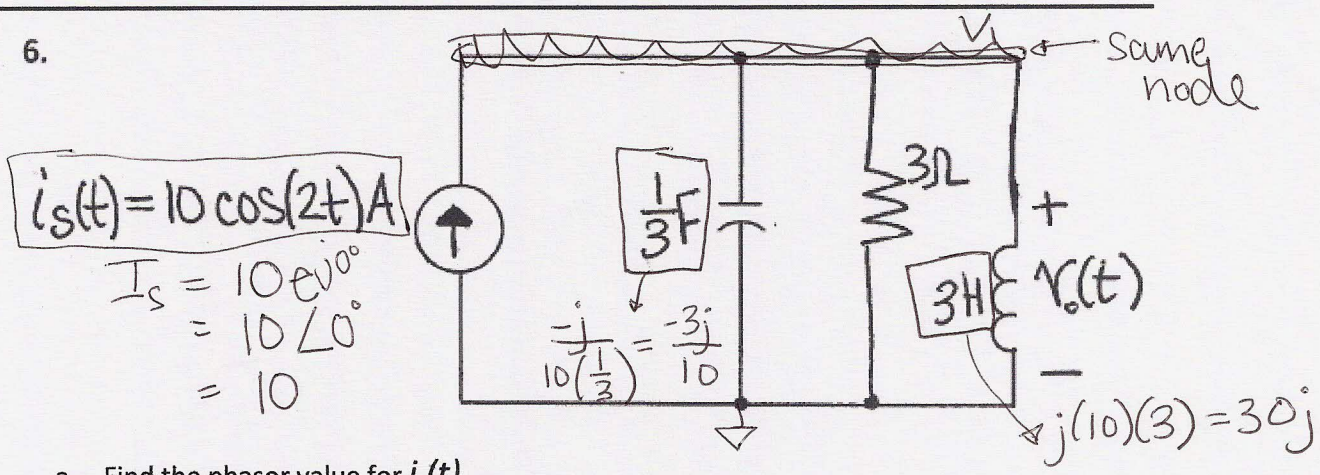
$$Z_{ab} = 2 \| \frac{-25j}{4} + \frac{25j}{2} = \frac{1}{\frac{(2)1}{(2)2} + \frac{-25j}{4}} + \frac{25j}{2} = \frac{4}{2-25j} + \frac{25j}{2}$$

Rationalizing:

$$Z_{ab} = \frac{4(2+25j)}{4+25^2} + \frac{25j}{2} = \frac{2(8+100j)}{2(629)} + \frac{25j(629)}{2(629)} = \frac{16+15925j}{1258}$$

$$Z_{ab} \approx 12.7m + 12.7j$$

6.



a. Find the phasor value for $i_s(t)$.

b. Draw the frequency-domain circuit diagram, including the phasor value for $i_s(t)$ and the impedance values for components.

7. Find the phasor value for $V_o(t)$ from the circuit in Problem 6.

$V_1 = V_o(t)$

$$-10 + \frac{V_1(10)}{-3j} + \frac{V_1}{3} + \frac{V_1}{30j} = 0$$

Use common-denominator of $30j$

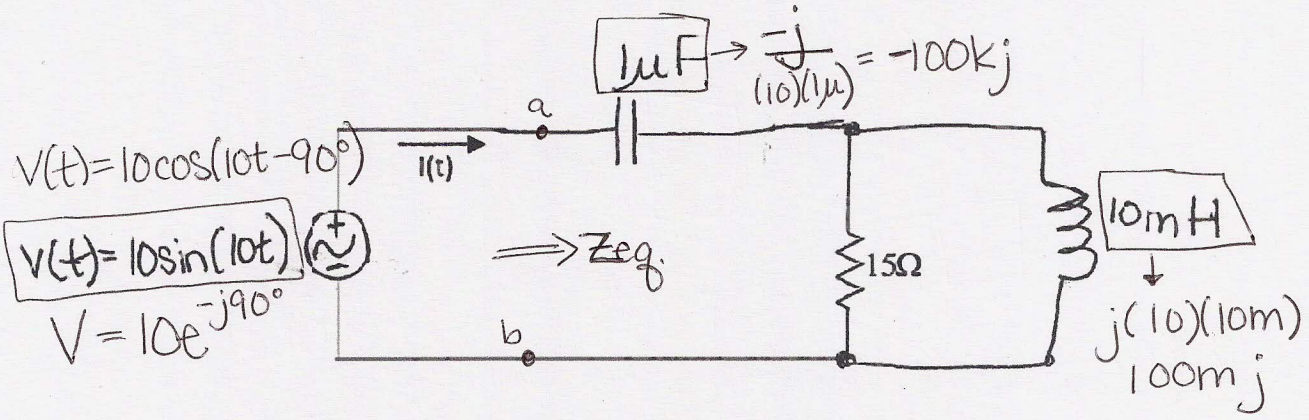
$$-\frac{V_1(10)(10)}{30j} + \frac{V_1(10j)}{30j} + \frac{V_1}{30j} = 10$$

$$V_1\left(\frac{-1{,}000}{30j} + \frac{10j}{30j} + \frac{1}{30j}\right) = 10$$

$$V_1\left(\frac{-999 + 10j}{30j}\right) = 10 \Rightarrow V_1 = \left[\frac{10(30j)}{-999 + 10j}\right]$$

$$V_1 = \frac{10(30j)}{\sqrt{999^2 + 10^2}\, e^{\tan^{-1}\left(\frac{10}{-999}\right)}} = \frac{300j}{999e^{-j0.6}} = \boxed{0.3e^{j90.6} = V_o}$$

8.



a. Find the phasor value for V(t).

b. Draw the frequency-domain circuit diagram, including the phasor value for V(t) and the impedance values for components.

9. Find the phasor value for i(t) for the circuit in Problem 8.

$$I = \frac{V}{Z_{eq}}$$

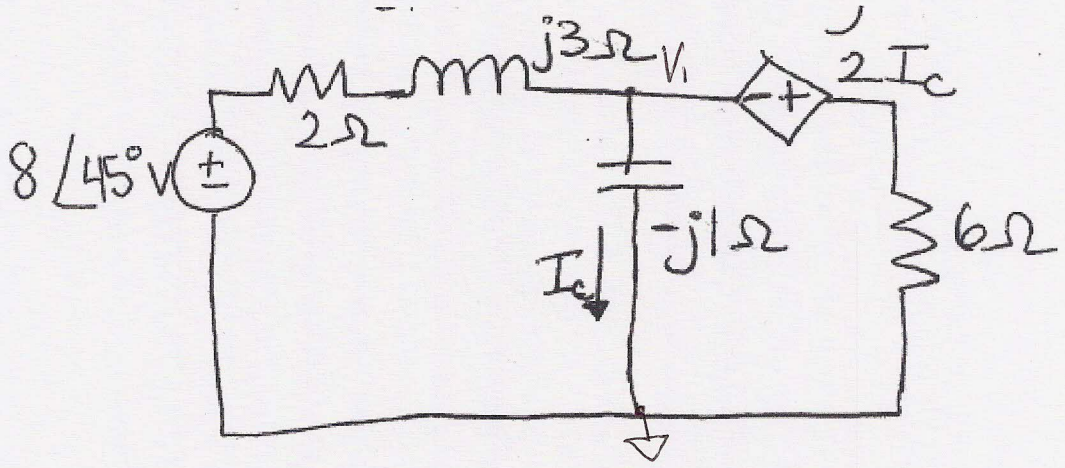
$$Z_{eq} = -100kj + 15 \| 100mj = -100kj + \frac{15(100mj)}{15+100mj}$$

$$Z_{eq} = -100kj + \frac{15(100mj)(15-100mj)}{15^2+100m^2} = \frac{22.5j + 150m}{225+10m} - 100kj$$

$$Z_{eq} \cong 100mj - 100kj + 667\mu \approx -100kj$$

$$\therefore I = \frac{10e^{-j90°}}{+100ke^{j90°}} = 100\mu A$$

10. Determine Ic for the following circuit. Write the answer in phasor form.



Using node-voltage:

$$\frac{V_1 - 8e^{j45^\circ}}{2+3j} + \frac{V_1}{-j} + \frac{V_1 + (+2I_c)}{6} = 0 \quad \text{where} \quad I_c = \frac{V_1}{-j} = V_1 j$$

$$V_1\left(\frac{1}{2+3j} + j + \frac{1}{6} + \frac{2j}{6}\right) = \frac{8e^{j45^\circ}}{2+3j}$$

$$V_1\left(\frac{6 + (2+3j)j6 + (2+3j) + 2j(2+3j)}{6(2+3j)}\right) = \frac{8e^{j45^\circ}}{(2+3j)}$$

$$V_1\left(\frac{6 + 12j + 18j^2 + 2 + 3j + 4j + 6j^2}{6(2+3j)}\right) = \frac{8e^{j45^\circ}}{(2+3j)}$$

$$V_1 \Rightarrow \left(\frac{-16+19j}{6(2+3j)}\right)V_1 = \frac{8e^{j45^\circ}}{(2+3j)} \frac{6(2+3j)}{-16+19j}$$

$$V_1 = \frac{8e^{j45^\circ}}{\sqrt{16^2+19^2}\, e^{j\tan^{-1}\left(\frac{19}{-16}\right)}}$$

$$I_c = V_1 j \cong \frac{8e^{j45^\circ}}{25e^{-j50}} = \boxed{0.32e^{j95^\circ}}$$