1. Plot each of the following complex numbers as vector in the complex plane:
   a. (-20-5j)
   b. $34e^{j45^o}$
   c. $\frac{2+3j}{6}-\frac{3-2j}{4}$
   d. $\frac{16}{4j^3}$
   e. $\frac{-1+3j}{-5-4j}$

2. Give numerical answers to each of the following questions:
   a. Rationalize $\frac{-10k\cdot(j2k)}{2k-j10k}$. Express your answer in rectangular form.
   b. Find the polar form of $\left(\frac{5e^{j45^o}}{4+4j}\right)^*(30k-j10k)^*$ (Note: The asterisk means conjugate.)
   c. Find the following phasor: $\mathrm{P}\left[3\sin(3kt+75^o)\right]$.
   d. Find the magnitude of $\frac{(3-2j)2e^{-j60^o}}{2+j+4e^{j45^o}}$.
   e. Find the imaginary part of $\frac{1-5j}{e^{-j60^o}(j1k+1k)}$.

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

   i. v(t)=4cos(5kt+60°)V

   ii. i(t)=16sin(ωt-123 °)mA

   iii. v(t)=cos(10t+60 °)V+5sin(10t-30 °)V

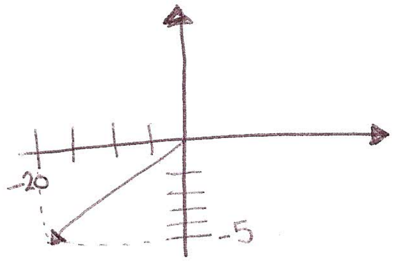
   b. Given ω=3krad/sec, write inverse phasors for each of the following signals:

   i. **I**= $76.8e^{j15^o}$ A

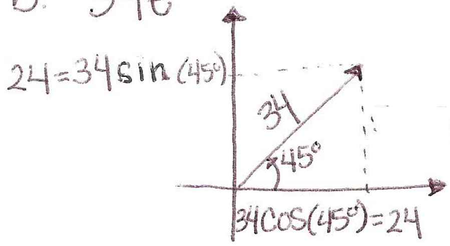
   ii. **V**= $-8j^2$ V

   iii. **I**= $5e^{+\frac{\pi}{2}-j30^o}$ A

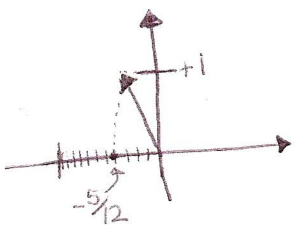
① a. $(-20-5j)$



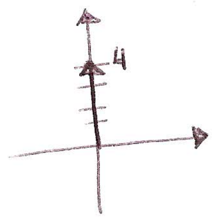
b. $34e^{j45°}$



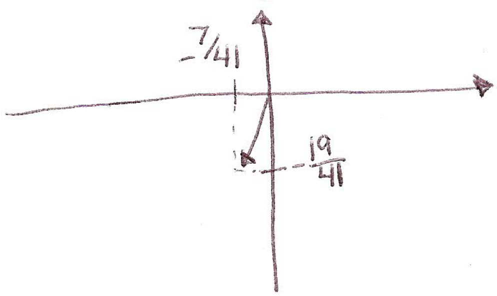
c. $\frac{2}{2}\cdot\frac{(2+3j)}{6} - \frac{(3-2j)}{4}\cdot\frac{3}{3} = \frac{4+6j-9+6j}{12} = \frac{-5+12j}{12}$



d. $\frac{16}{4j^3} = \frac{4}{\cancel{j^2}^{-1}\, j} = -4(-j) = +4j$



e. $\frac{(-1+3j)}{(-5-4j)}\cdot\frac{(-5+4j)}{(-5+4j)} = \frac{+5-4j-15j+12\cancel{j^2}^{-1}}{+25-20j+20j-16\cancel{j^2}_{-1}} = \frac{-7-19j}{\underbrace{25+16}_{41}}$



2 a. $\frac{-10k(j2k)}{(2k-j10k)} \cdot \frac{(2k+10kj)}{(2k+10kj)} = \frac{-20k^2(2kj)-20k^2(10kj^2)}{4k^2+20k^2j-20k^2j-(10k)^2j^2}$

$\frac{+200\times10^9 - 40\times10^9 j}{104\times10^9} = \boxed{\frac{200-40j}{104}}$

b. $\left(\frac{5e^{j45°}}{4+4j}\right)^* (30k-j10k)^* = \frac{5e^{-j45°}}{4-4j} \cdot (30k+j10k) =$

$\frac{5e^{-j45°}}{\sqrt{4^2+4^2}\, e^{j\tan^{-1}(\frac{-4}{4})}} \cdot \sqrt{(30k)^2+(10k)^2}\, e^{j\tan^{-1}(\frac{10k}{30k})} \cong \frac{5e^{-j45°}\sqrt{1\times10^9}\, e^{j18.4°}}{\sqrt{32}\, e^{-j45°}}$

$\boxed{\frac{5\cdot\sqrt{1\times10^9}}{\sqrt{32}} \cdot e^{j18.4°}}$

c. $\mathbb{P}[3\sin(3kt+75°)] = \mathbb{P}[3\cos(3kt+75°-90°)] = \boxed{3e^{j15°}}$

d. $\left|\frac{(3-2j)2e^{j60°}}{2+j+4e^{j45°}}\right| = \frac{\sqrt{3^2+2^2}\, e^{j\tan^{-1}(\frac{-2}{3})}\, 2e^{-j60°}}{2+j+4\cos(45°)+4\sin(45°)j} = \frac{2\sqrt{13}\, e^{j(-60°-34°)}}{4.8+3.8j}$

$\frac{2\sqrt{13}\, e^{-j94°}}{\sqrt{4.8^2+3.8^2}\, e^{j\tan^{-1}(\frac{3.8}{4.8})}} = \frac{2\sqrt{13}}{\sqrt{37.5}}\, e^{-j94°-38.4°} \cong \left|1.2e^{-j132.4°}\right| = \boxed{1.2}$

e. $\frac{(1-5j)}{e^{-j60°}(j1k+1k)} = \frac{\sqrt{1^2+5^2}\, e^{j\tan^{-1}(\frac{-5}{1})}}{e^{-j60°}\sqrt{1k^2+1k^2}\, e^{j\tan^{-1}(1)}} = \frac{\sqrt{26}}{\sqrt{2\times10^6}}\, e^{-j78.7+60°-45°}$

$\mathrm{Im}\left[\frac{\sqrt{26}}{\sqrt{2\times10^6}}\, e^{-j63.7°}\right] = \frac{\sqrt{26}}{\sqrt{2\times10^6}}\sin(-63.7°) = \boxed{-3.2m}$

③ a. i. $\boxed{4e^{j60^\circ} \text{ or } 4\angle 60^\circ}$

ii. $16\sin(\omega t - 123^\circ)m = 16m\cos(\omega t - 123^\circ - 90^\circ)$

$\boxed{16m\, e^{-j213^\circ} \text{ or } 16m\angle -213^\circ}$

iii. $\cos(10t + 60^\circ) + 5\sin(10t - 30^\circ) = \cos(10t + 60^\circ) + 5\cos(10t - 30^\circ - 90^\circ)$

$\cos(60^\circ) + \sin(60^\circ)j + 5\cos(-120^\circ) + 5\sin(-120^\circ)j =$

$0.5 + 0.866j - 2.5 - 4.33j = -2 - 3.5j = \sqrt{2^2 + (+3.5)^2}\, e^{j\tan^{-1}\left(\frac{-3.5}{-2}\right)}$

$4e^{j(60^\circ + 180^\circ)} = \boxed{4e^{j240^\circ} \text{ or } 4\angle 240^\circ}$

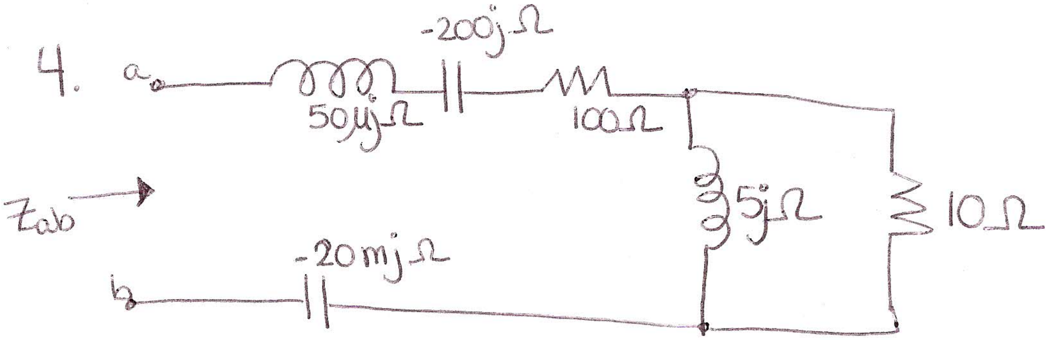
b. $\omega = 3k\,\text{rad/sec}$

i. $I = \boxed{76.8\cos(3kt + 15^\circ)A}$

ii. $\mathbb{V} = -8j^2 = +8;\ V = \boxed{8\cos(3kt)\,V}$

iii. $\mathbb{I} = 5(e^{90^\circ})e^{-j30^\circ};\ \boxed{I = 5e^{90^\circ}\cos(3kt - 30^\circ)A}$

4.



$j5k(10n) = 50\mu\,\Omega j$ $\qquad j(5k)(1m) = 5j\,\Omega$

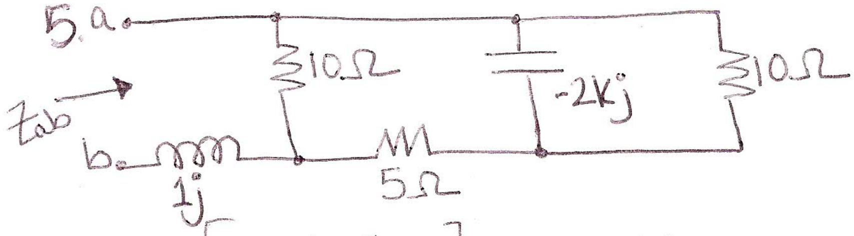
$\frac{-j}{5k(1\mu)} = -200j\,\Omega$ $\qquad \frac{-j}{5k(10m)} = -0.02j\,\Omega = -20mj$

$$Z_{ab} = 50\mu j - 200j + 100 + [5j \| 10] + -20mj$$

$$\frac{5j(10)}{(5j+10)} \cdot \frac{(10-5j)}{(10-5j)} = \frac{500j - 250j^2}{50j - 25j^2 + 100 - 50j} = \frac{(500j + 250)}{100+25}$$

$$Z_{ab} = 50\mu j - 200j - 20mj + 100 + \underbrace{\frac{500j}{125}}_{4j} + \underbrace{\frac{250}{125}}_{2} \approx \boxed{-196j + 102}$$

5.



$j(100)(10m) = 1j$

$\frac{-j}{5\mu(100)} = -2kj$

$$Z_{ab} = [[-2kj \| 10] + 5] \| 10 + 1j$$

$$\frac{-2kj(10)}{-2kj+10} = \frac{-20kj(10+2kj)}{(-2kj+10)(10+2kj)} = \frac{-200kj - 40k^2j^2}{100 + 4k^2j^2} = -0.05j + 10$$

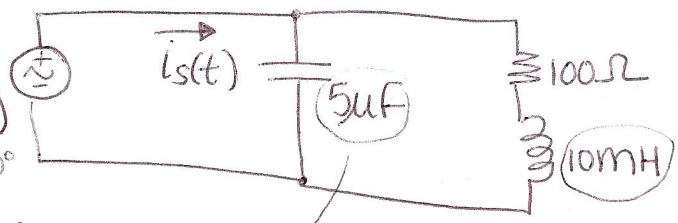
$$Z_{ab} = [(-0.05j + 10 + 5) \| 10] + j = \frac{(-0.05j+15)(10)}{(-0.05j+25)} \cdot \frac{(25+0.05j)}{(25+0.05j)} + j$$

$$Z_{ab} = \frac{-12.5j + 0.025 + 3750 + 7.5j}{(\cancel{-1.25j} + 2.5m + \cancel{1.25j} + 625)} + j = \boxed{6 + 0.99j}$$

6.

$v_1(t) = 10\cos(2kt)$

$\mathbb{V}_1 = 10e^{j0°}$



$\rightarrow j(2k)(10m) = 20j\ \Omega$

$\frac{-j}{(2k)(5u)} = -100j\ \Omega$

7. $\mathbb{I}_s = \frac{\mathbb{V}_1}{\underbrace{-100j \parallel [100+20j]}}$

$$\frac{-100j\cdot(100+20j)}{[-100j+20j+100]}\cdot\frac{(100+80j)}{(100+80j)} = \frac{(-1\times10^6 j)+2\times10^5+8\times10^5+(1.6\times10^5 j)}{10{,}000+6{,}400} =$$

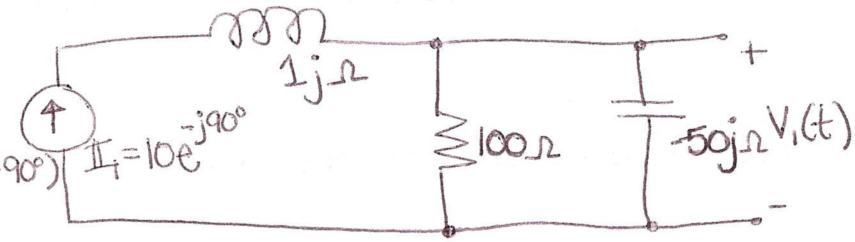
$$\mathbb{I}_s \cong \frac{10\cdot(61+51j)}{(61-51j)(61+51j)} = \frac{10(61+51j)}{3721+2601} \cong 96.5m + 80.7mj$$

$$\mathbb{I}_s = \sqrt{(96.5m)^2+(80.7m)^2}\ e^{j\tan^{-1}\left(\frac{80.7m}{96.5m}\right)} \cong 126mA\ e^{j40°}$$

$$\boxed{i_s(t) = 126m\cos(2kt+40°)A}$$

8.

$I_1(t) =$
$10\cos(1kt - 90°)$



$\frac{-j}{1k(20\mu)} = -50j \qquad j(1k)(1m) = 1j$

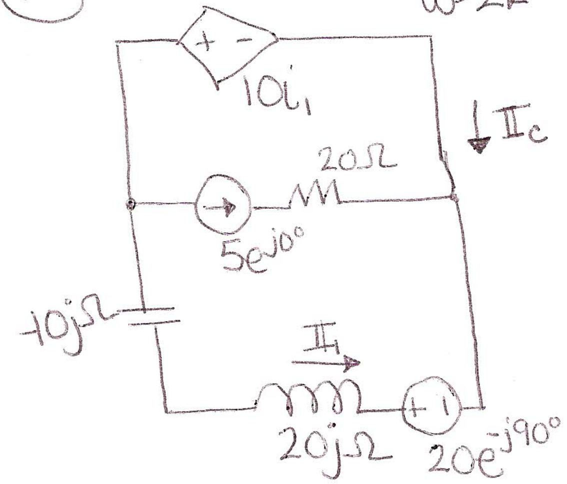
9. $\mathbb{V}_1 = \mathbb{I}_1 \cdot (100 \| -50j) = 10\cancel{e^{-j90°}}^{\,-j} \dfrac{(100)(-50j)}{(100-50j)} \cdot \dfrac{(100+50j)}{(100+50j)} = \dfrac{2.5\times10^6 - 5\times10^6 j}{12{,}500}$

$\mathbb{V}_1 = -400 - 200j = 447\, e^{-j153°}$

$\boxed{V_1(t) = 447\cos(1kt - 153°) \text{ or } 447\cos(1kt + 207°)\,V}$

10.

$\omega = 2K\ \text{rad/sec}$



$$j(2K)(10m) = 20j\,\Omega$$

$$\frac{-j}{(2K)(50\mu)} = -10j\,\Omega$$

$$-I_c - 5 - I_1 = 0$$

$$I_1 = \frac{0-(-10I_1)-20(-j)}{-10j+20j} \Rightarrow +10jI_1 = +10I_1 + 20j$$

$$(10j-10)I_1 = +20j$$

$$I_1 = \frac{+20j}{(10j-10)} \cdot \frac{(-10-10j)}{(-10-10j)} = \frac{-200j - 200j^{\cancel{2}\,-1}}{-\cancel{100}j - 100j^2 + 100 + \cancel{100}j}$$

$$I_1 = \frac{+200-200j}{100+100} = 1-j$$

$$I_c = -5-1+j = -6+j = \sqrt{36+1}\; e^{j\tan^{-1}\left(\frac{1}{-6}\right)}$$

$$I_c = \sqrt{37}\, e^{-j9.5°}$$

$$\boxed{I_c = \sqrt{37}\cos(2Kt - 9.5°)}$$