1)a) $3\cos(\omega t) + 4\cos(\omega t) \Rightarrow 3\angle 0° + 4\angle 0° = \underline{7\angle 0° = 7}$

b) $3\cos(\omega t) + 4\sin(\omega t) \Rightarrow 3 - j4 = \underline{5\angle -53.13° = 5\angle -0.9273 \text{ rad}}$

c) $3\cos(\omega t) + 4\sin(\omega t - \pi/2) \Rightarrow 3 - j4e^{j\pi/2} = 3 - j(-j)4 = 3 - 4$

$= -1\angle 0° = \underline{1\angle 180° = 1\angle \pi \text{ rad}}$

d) $3\cos(\omega t + \pi/3) + 4\sin(\omega t - \pi/3) \Rightarrow 3e^{j\pi/3} - j4e^{-j\pi/3} = 3e^{j\pi/3} + 4e^{j(\frac{\pi}{2} + \frac{\pi}{3})}$

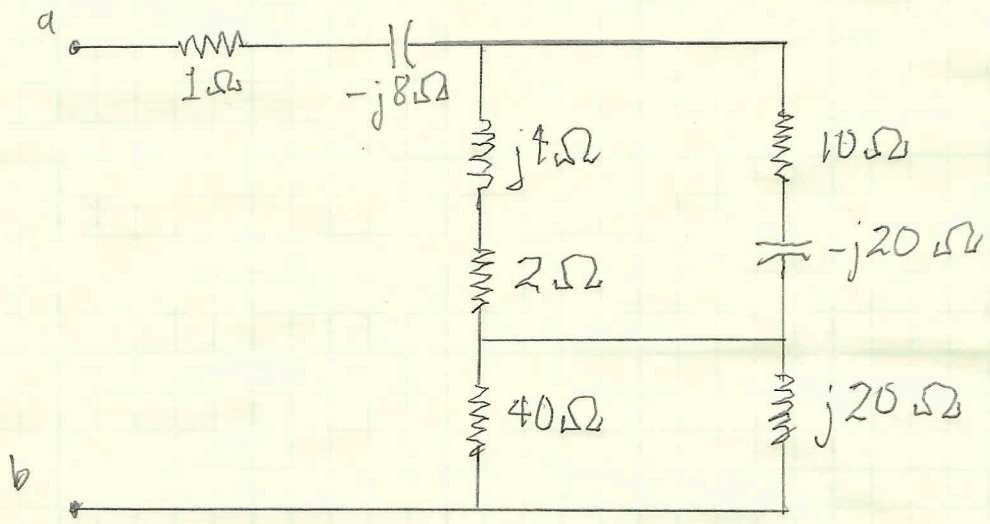
$= 3\left(\cos\left(\frac{\pi}{3}\right) + j\sin\left(\frac{\pi}{3}\right)\right) + 4\left(\cos\left(-\frac{5\pi}{6}\right) + j\sin\left(-\frac{5\pi}{6}\right)\right)$

$= \frac{3}{2} + j\frac{3\sqrt{3}}{2} - 2\sqrt{3} - j2 = \frac{3 - 4\sqrt{3}}{2} + j\frac{3\sqrt{3} - 4}{2} = \underline{2.053\angle 163.1° = 2.053\angle 2.84 \text{ rad}}$

e) $3\cos(\omega t + \pi) + 4\sin(\omega t) = 3e^{j\pi} - j4 = -3 - j4$

$= \underline{5\angle -126.8° = 5\angle -2.214 \text{ rad}}$

2)

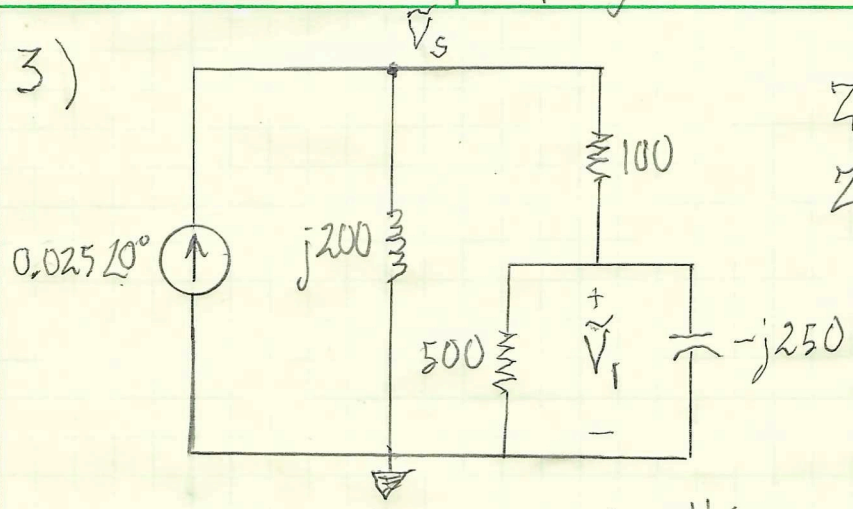


$$Z_{ab} = (1-j8) + (2+j4) \,||\, (10-j20) + 40 \,||\, j20$$

$$= (1-j8) + (3+j4) + (8+j16)$$

$$= \underline{\underline{12 + j12 \ \Omega}}$$

3)



$Z_L = j50000(0.004) = j200\ \Omega$

$Z_C = -j\frac{1}{50000 \cdot 80\times10^{-9}} = -j250\ \Omega$

Impedance seen by source: $j200 \| (100 + 500 \| -j250)$

$= j200 \| (100 + 100 - j200) = j200 \| (200 - j200) = 200 + j200\ \Omega$

$\Rightarrow$ Voltage across source $= (0.025A)(200 + j200\ \Omega) = 5 + j5\ V = \tilde{V}_s$

Can now use voltage division to find $\tilde{V}_1$.

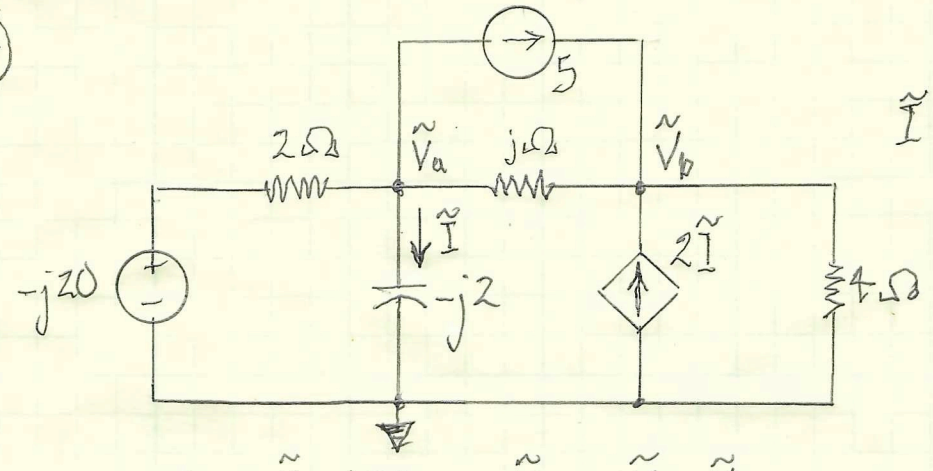
$500 \| -j250 = 100 - j200$

$$\tilde{V}_1 = \frac{100 - j200}{100 + (100 - j200)}\tilde{V}_s = \frac{100 - j200}{200 - j200}(5 + j5) = 5 + j2.5$$

$$= 5.59\angle 26.565° = 5.59\angle 0.4636 \text{ rad}$$

$\Rightarrow$ $v_1(t) = 5.59\cos(50000t + 26.565°) = 5.59\cos(50000t + 0.4636)\ V$

4)



$$\tilde{I} = \frac{\tilde{V}_a}{-j2} = j\frac{1}{2}\tilde{V}_a$$

KCL @ $\tilde{V}_a$: $\dfrac{\tilde{V}_a + j20}{2} + \dfrac{\tilde{V}_a}{-j2} + \dfrac{\tilde{V}_a - \tilde{V}_b}{j} + 5 = 0$

Regroup $\Rightarrow \left(\frac{1}{2} + j\frac{1}{2} - j\right)\tilde{V}_a + j\tilde{V}_b = 5 - j10$

$\Rightarrow \left(\frac{1}{2} - j\frac{1}{2}\right)\tilde{V}_a + j\tilde{V}_b = 5 - j10 \quad (1)$

KCL @ $\tilde{V}_b$: $\dfrac{\tilde{V}_b - \tilde{V}_a}{j} - 2\tilde{I} + \dfrac{\tilde{V}_b}{4} - 5 = 0$

Regroup and use $\tilde{I} = j\frac{1}{2}\tilde{V}_a \Rightarrow \cancel{(j - j)}^{0}\tilde{V}_a + \left(\frac{1}{4} - j\right)\tilde{V}_b = 5$

$\Rightarrow \tilde{V}_b = \dfrac{5}{\frac{1}{4} - j} = 1.1765 + j4.706\ V$

Use this expression for $\tilde{V}_b$ in (1) to obtain $\tilde{V}_a$:

$$\tilde{V}_a = \frac{1}{\left(\frac{1}{2} - j\frac{1}{2}\right)}\left(5 - j10 - j\tilde{V}_b\right) = (10.882 - j11.471)\ V$$

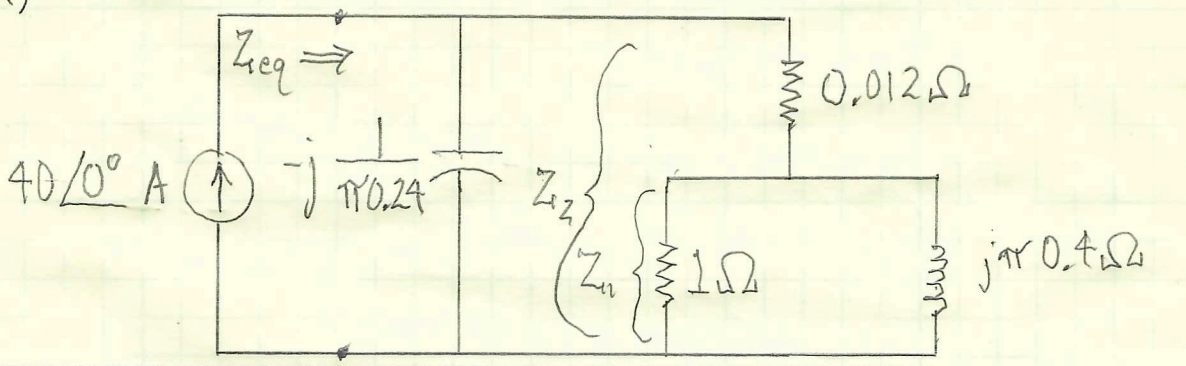
$$\tilde{I} = j\frac{1}{2}\tilde{V}_a = 5.7353 + j5.4412 = \underline{7.9057\angle 43.493^\circ} = \underline{7.9057\angle 0.7591\ rad}\ A$$

5) $f = 50.4\text{kHz} \Rightarrow \omega = 2\pi\, 50\times10^3 \text{ rad/s} = \pi\, 10^5 \text{ rad/sec}$

$L = 4\mu\text{H} \Rightarrow Z_L = j\omega L = j(\pi 10^5)(4\times10^{-6}) = j\pi\, 0.4\,\Omega$

$C = 2.4\mu\text{F} \Rightarrow Z_C = -j\frac{1}{\omega C} = -j\frac{1}{(\pi 10^5)(2.4\times10^{-6})} = -j\frac{1}{\pi\, 0.24}$

a)



b) To find peak voltage find Z_{eq} of all elements then multiply by current into that impedance.

$Z_1 = 1\,\Omega \,||\, j\pi 0.4 = \frac{j\pi 0.4}{1+j\pi 0.4} = 0.6123 + j\,0.4872\ \Omega$

$Z_2 = 0.012 + Z_1 = 0.6243 + j4872\,\Omega$

$Z_{eq} = -j\frac{1}{\pi 0.24} \,||\, Z_2 = 1.004 + j\,0.0232 = 1.0043\angle 1.3214°$

Voltage across capacitor $= \text{Re}\left[1.0043\angle 1.3214° \times 40\angle 0°\ e^{j\omega t}\right]$

$= 40.1712\cos(\omega t + 1.3214°)$ V

$\Rightarrow$ Peak voltage $= 40.1712$ V