Daren Liu

1) $\omega = 4000$ rad/s

$Z_c = \frac{-j}{\omega C} = -j20 \, \Omega$

$Z_L = j\omega L = j \cdot 4000 \cdot 2.5 \cdot 10^{-3} = j10 \, \Omega$

$Z_{eq} = \left(\left(Z_c // 20\right) + 1.\right) // Z_L + 5 = 10 + j10 \, \Omega$

$V_s = 25\sin(4000t) = 25\cos(4000t - 90°)$

$V_s = 25 < -90°$

$I_o = \frac{V_s}{Z_{eq}}$

$i_o(t) = 1.768\cos(4000t - 135°) \, A$

2) a) $V_b = 25 \cdot (2000 - j1000) = 50 - j25 \, V$

$V_a = V_b$

$I_a = \frac{V_a}{500 + j250} = 100 < -53 \, mA$

$-V_b - j50v + I_c \cdot 1000 = 0$

$I_c = 56 < 26.6 \, mA$

$I_g = I_a + I_b + I_c = 145 < 22.1 \, mA$

b) $i_a(t) = 100\cos(\omega t - 53.1) = 100\cos(1500t - 53.1) \, mA$

$i_b(t) = 56\cos(1500t + 26.6) \, mA$

$i_c(t) = 145.8\cos(1500t - 22.1) \, mA$

3) $V_g = 25 \angle 0° \text{ V} \qquad I_n = 5 \angle 90° \text{ V}$

$V_1 = I_n(-j2) = 10 \text{ V}$

$-25 + 10 + (4 - j3) I_1$

$\qquad I_1 = 2.4 + j1.8 \text{ A}$

$I_b = I_1 - I_a = 2.4 - j3.2 \text{ A}$

$V_z = -1 - j12 \text{ V}$

$-25 + (1 + j3) I_3 + V_z = 0$

$\qquad I_3 = \frac{26 + j12}{1 + j3} = 6.2 - j6.6 \text{ A}$

$I_z = I_3 - I_b = 3.8 - j3.4 \text{ A}$

$Z = 1.42 - j1.88 \, \Omega$

4) $Z_{t-p} = \frac{(1+j)(1-j)}{1 + j1 - j} = 1$

$Z_1 = \frac{j1}{1 + j1 - j1} = j1$

$Z_2 = \frac{(-j1)}{1 + j1 - j1} = -j1$

$Z_3 = \frac{(-j1)(j1)}{1 + j1 - j1} = 1$

$Z_4 = -j1$

$Z_5 = 1$

$Z_6 = j1$

$Z_{ab} = -j + \frac{2}{3} + j = \frac{2}{3} \, \Omega$

5) $V = 200 \angle 0° \, V$

$$Z = 50 + 30 + j60 = 80 + j60$$

$$I = 1.6 - j1.2 = 2 \angle 36.86° A$$

$$Z_{eq} = 100 - j50 \, \Omega$$

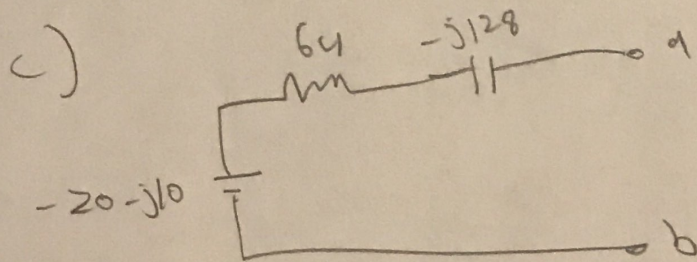**6)** **a)** $Z_c = \dfrac{-j}{400 \cdot 31.25 \cdot 10^{-6}} = -j80$

$$Z_L = j(400)(400 \cdot 10^{-3}) = j160$$

$$Z_p = \frac{(Z_L)(Z_c)}{Z_L + Z_c} = -j160 \, \Omega$$

$$V_{th} = \frac{-j160}{-j160 + 320} \quad 50 \angle 0° = 10 - j20 \, V$$

b) $R_{th} = Z_L \,//\, Z_c \,//\, 320$

$$= 64 - j128$$

c)

$$
\begin{array}{c}
64 \quad -j128 \\
\text{---}\bigwedge\!\bigwedge\text{---}\vert\vert\text{---} \circ \, a \\
\\
-20 - j10 \; \;\rule{}{} \\
\hspace{3cm}\circ \, b
\end{array}
$$

7) $\dfrac{V_1 - 250}{20 + j10} + \dfrac{V_1}{50 - j100} - 0.03 V_0 = 0$

$$\left(\frac{1}{20 + j10} + \frac{1}{50 - j100}\right) V_1 - 0.03 V_0 = \frac{250}{20 + j10}$$

$$V_0 = (0.8 - 0.4j) V_1$$

$V_1 = 500 - 250j$

$V_{th} = \dfrac{-100j}{50 - j100}(500 - 250j) = 300 - 400j \; V$

$i_{sc} = \dfrac{250}{20 + 50 + 10j} = 3.5 - 0.5j \; A$

$Z_{th} = \dfrac{300 - 400j}{3.5 - 0.5j} = 100 - 100j \; \Omega$

8) a) $i_T = \left(\dfrac{1}{1000} + j\left(\dfrac{1-\alpha}{1000}\right)\right) V_T$

$Z_{th} = \dfrac{V_T}{i_T} = \dfrac{\frac{1}{1000} - j\left(\frac{1-\alpha}{1000}\right)}{\left(\frac{1}{1000}\right)^2 + \left(\frac{1-\alpha}{1000}\right)^2}$ $\qquad \alpha = 1$

b) $Z_{th} = \dfrac{\frac{1}{1000}}{\left(\frac{1}{1000}\right)^2} = 1000 \; \Omega$

c) $Z_{th} = 500 - j500 = \dfrac{\frac{1}{1000} - j\left(\frac{1-\alpha}{1000}\right)}{\left(\frac{1}{1000}\right)^2 + \left(\frac{1-\alpha}{1000}\right)^2}$

$\alpha = 0$

d) $0 < \dfrac{-\frac{1-\alpha}{1000}}{\left(\frac{1}{1000}\right)^2 + \left(\frac{1-\alpha}{1000}\right)^2}$

$1 < \alpha < +10$

9)

$\dfrac{V_o - 2.4 I_A}{j4} + \dfrac{V_o}{-j8} + \dfrac{V_o}{5} - 10 - j10 = 0$

$I_A = \dfrac{V_o}{-j8} \; A$

$V_o = j80 \; V$

$V_o = 80 \angle 90° \; V$

10) $\omega = 8000 \text{ rad/sec}$

$Z_L = j\omega L = j1600 \, \Omega$

$Z_C = \frac{-j}{\omega C} = -j1000 \, \Omega$

$V_g = 100 \angle 0° \, V$

$V_o = \frac{500 - j1000}{500 - j1000 + 300 + j1600} \left(100 \angle 0\right) = 111.8 \angle -100° \, V$

$V_o(t) = 111.8 \cos\left(8000t - 100°\right) \, V.$