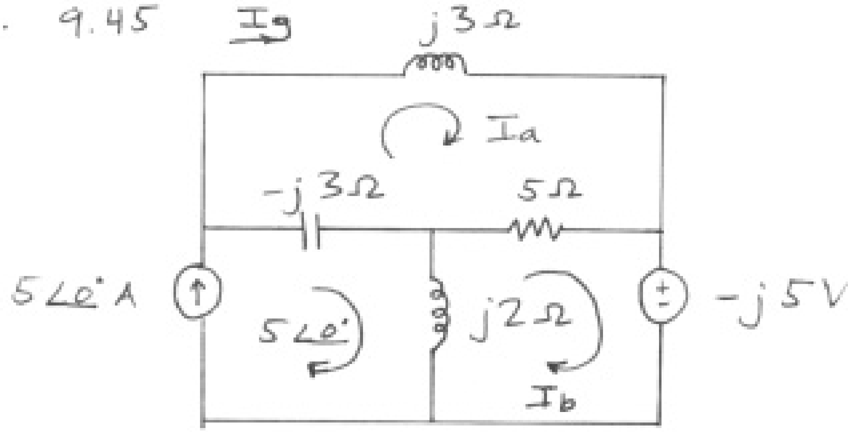
1. 9.45



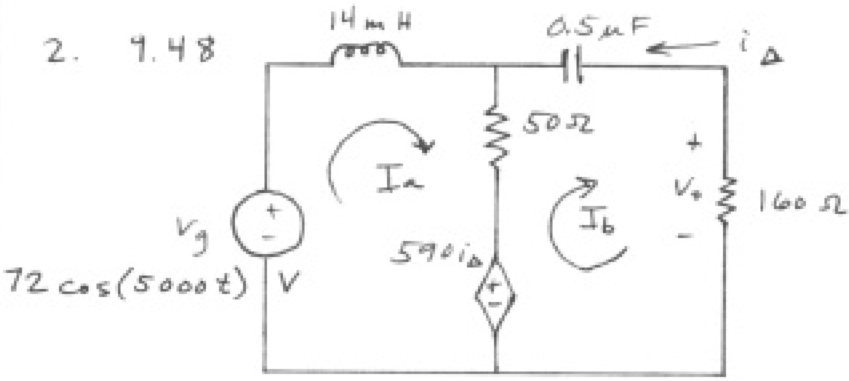
loop A: $j3I_a + 5(I_a - I_b) - j3(I_a - 5) = 0$

loop B: $j2(I_b - 5) + 5(I_b - I_a) - j5 = 0$

Solving: $I_a = -j3\,A \quad I_g = I_a = -j3 = 3\angle{-90^\circ}\,A$

$I_b = 0\,A$

2. 9.48



$$j\omega L = j5000(14\cdot 10^{-3}) = j70\,\Omega$$

$$\frac{1}{j\omega C} = \frac{-j}{(5000)(0.5\cdot 10^{-6})} = -j400\,\Omega$$

loop A: $72\angle 0^\circ = j70I_a + 50(I_a - I_b) + 590(-I_b)$

loop B: $50(I_b - I_a) - j400(I_b) + 160(I_b) - 590(-I_b) = 0$

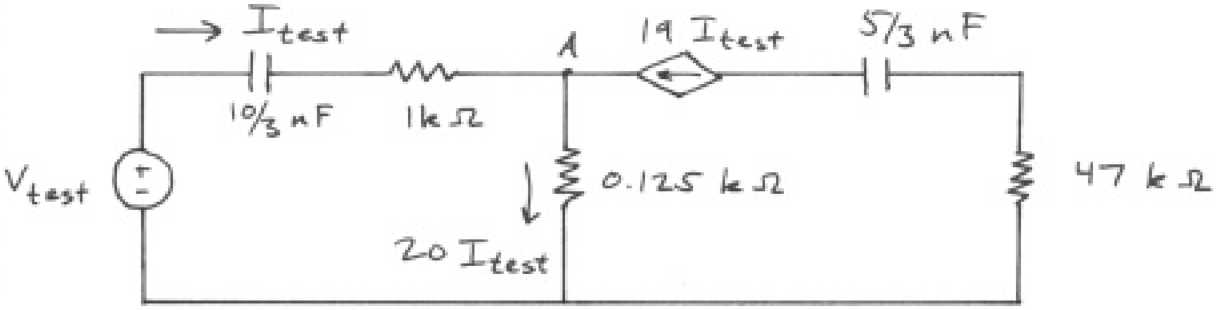
Solving $I_b = (50 - j50)\,mA \quad I_a = 0.4 - j1.2\,A$

$$V_o = 160\,I_b = 8 - j8\,V = 11.31\angle{-45^\circ}\,V$$

$v_o = 11.31 \cos(5000t - 45^\circ)$ V

3. 9.36

$$\frac{1}{j\omega C_1} = \frac{-j}{(25 \cdot 10^3)(10/3 \cdot 10^{-9})} = -j12 \text{ k}\Omega$$



Apply a test voltage

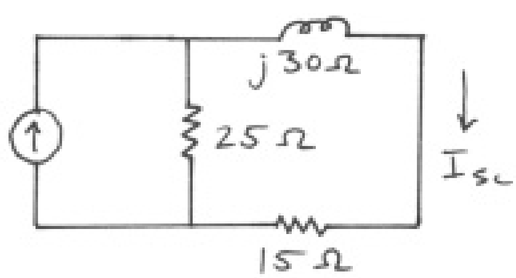
By KCL at node A, I_{test} + 19 I_{test} entering node ⇒ 20 I_{test} must be leaving through 0.125 kΩ resistor.

KVL around left loop:

$$V_{test} = (1 - j12)\text{k}\Omega \, I_{test} + 20 I_{test} (0.125 \text{ k}\Omega)$$

$$Z_{th} = \frac{V_{test}}{I_{test}} = 3.5 - j12 \text{ k}\Omega$$

4 9.39



Apply current divider to determine I_{sc}

$$I_{sc} = \frac{(16\angle 0^\circ)(25\,\Omega)}{25 + 15 + j30} = 6.4 - j4.8 \text{ A}$$

$$Z_{th} = \frac{(-j50)(40 + j30)}{40 + j30 - j50} = 50 - j25\,\Omega$$

5. 9.71

a) $\frac{1}{j\omega C} = -\frac{j}{(2\cdot 10^5)(12.5\cdot 10^{-9})} = -j400\ \Omega$

KCL at − input: $\frac{V_n}{200} + \frac{V_n - V_o}{-j400} = 0$

$$\frac{V_o}{-j400} = \frac{V_n}{200} + \frac{V_n}{-j400}$$

$$V_o = V_n - j2V_n = (1-j2)V_n$$

Voltage divider + input: $V_p = \frac{V_g(1/j\omega C_o)}{500 + (1/j\omega C_o)} = \frac{V_g}{1 + j(500)(2\cdot 10^5)C_o}$

$$V_g = 10\angle 0^\circ\ \text{V}$$

$V_p = \frac{10\angle 0^\circ}{1 + j10^8 C_o} = V_n$ by Golden Rules

$$\Rightarrow \quad V_o = \frac{(1-j2)\,10\angle 0^\circ}{1 + j10^8 C_o}$$

$|V_o| = \frac{\sqrt{5}\,(10)}{\sqrt{1 + 10^{16} C_o^2}} = 10\ \text{V} =$ power supply voltage

Solving: $C_o = 20\ \text{nF}$

b) $V_o = \frac{10(1-j2)}{1+j2} = 10\angle -126.87^\circ$

$$v_o = 10\cos(2\cdot 10^5 t - 126.87^\circ)\ \text{V}$$

6. 10.7

$$\frac{1}{j\omega C} = \frac{-j}{(5000)(80\cdot 10^{-9})} = -j\,2500\,\Omega$$

$$Z_f = 7.5\,k\Omega \,||\, 80nF = \frac{-j\,2500\,(7500)}{7500 - j\,2500}$$

$$= 750 - j\,2250\,\Omega$$

$$Z_i = 1500\,\Omega$$

KCL at inverting input, V_n

$$\frac{V_n - V_g}{Z_i} + \frac{V_n - V_o}{Z_f} = 0$$

$$V_n\,(Z_f - Z_i) - Z_i\,V_o = Z_f\,V_g$$

$V_n = V_p = 0$ by Golden Rules

$$\Rightarrow V_o = -\frac{Z_f}{Z_i}V_g = -\frac{750 - j\,2250}{1500}\,(4V)$$

$$= -(0.5 - j\,1.5)(4V) = -2 + j\,6\ V$$

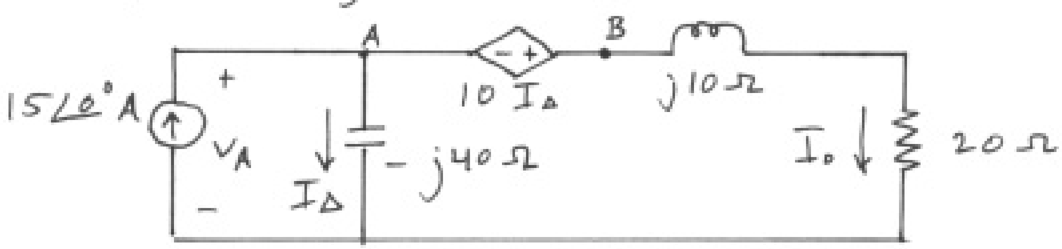
$$= 6.32\,\angle 108.43^\circ\ V$$

$$P = \frac{1}{2}\frac{V_o^2}{R} = \frac{1}{2}\frac{40}{1000} = 20\cdot 10^{-3}\ W = 20mW$$

7. 10.9

$$j\omega L = j\,10{,}000\,(10^{-3}) = j10\,\Omega$$

$$\frac{1}{j\omega C} = \frac{1}{j\,10{,}000\,(2.5\cdot 10^{-6})} = -j\,40\,\Omega$$



Consider the dependent voltage source to be a supernode.

KCL at supernode:

$$-15 + \frac{V_A}{-j40} + \frac{V_B}{20+j10} = 0$$

$$V_B - V_A = 10 I_\Delta = 10\left(\frac{V_A}{-j40}\right)$$

$$V_A = 300 - j100 \text{ V}$$

$$V_B = 325 - j250 \text{ V}$$

$$I_\Delta = \frac{V_A}{-j40} = 2.5 + j7.5 \text{ A}$$

$$I_o = 15\angle 0° - I_\Delta = 15 - 2.5 - j7.5$$

$$= 12.5 - j7.5 = 14.58 \angle -30.9° \text{ A}$$

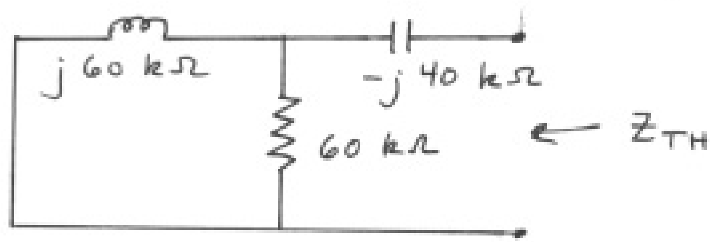
$$P_{20\Omega} = \frac{1}{2}|I_o|^2(20) = 2125 \text{ W}$$

8 10.34

$$j\omega L = j10{,}000(6) = j60 \text{ k}\Omega$$

$$\frac{1}{j\omega C} = \frac{-j}{10000 \cdot 2.5 \cdot 10^{-9}} = -j40 \text{ k}\Omega$$

a) Find Thevenin impedance equivalent of circuit. Turn off indep. voltage source.



$$Z_{TH} = \frac{1}{j\omega C} + \frac{60\,(j60)}{60+j60} = -j40 + 30 + j30 \text{ k}\Omega$$

$$= 30 - j10 \text{ k}\Omega$$

Max power when Z_L is conjugate of Z_{TH}

$\Rightarrow Z_L = 30 + j10 \text{ k}\Omega$

Find Thevenin voltage by finding V_{oc}

V_{oc} is a voltage divider between L and R

$$V_{TH} = V_{oc} = \frac{90 \angle 0° \,(60)}{60 + j60} = 45(1 - j1)$$

$$= 45\sqrt{2} \angle -45° \text{ V}$$

$$I = \frac{45\sqrt{2} \angle -45°}{60 \cdot 10^3} = 0.75\sqrt{2} \angle -45° \text{ mA}$$

$$|I_{rms}| = 0.75 \text{ mA}$$

$$P_L = (0.75 \cdot 10^{-3})^2 \cdot (30 \cdot 10^3) = 16.875 \text{ mW}$$

Equivalent circuit: