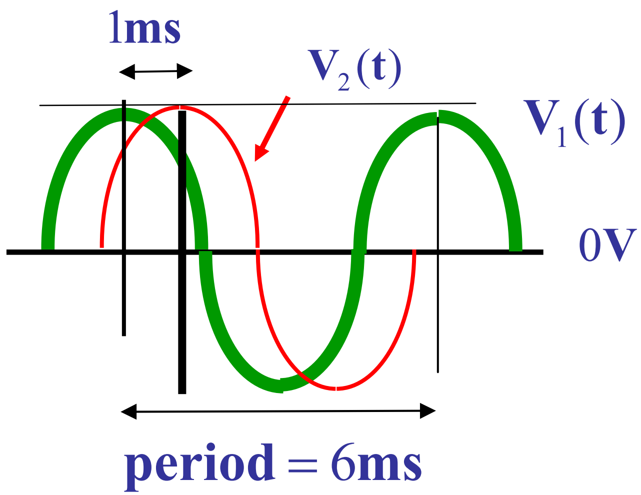
(16)

1

If $V_2(t) = 5\cos\omega t$ V, find $V_1(t)$.
Draw also V1 and V2 in a **phasor diagram**. (16)



If $V_2(t) = 5\cos(\omega t)V$

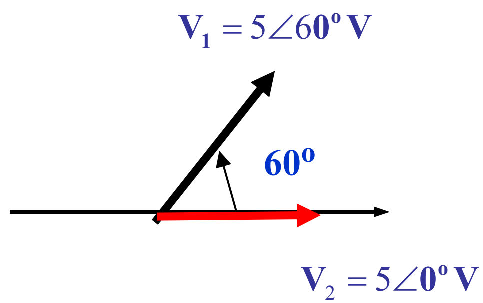
then $\theta = \frac{t}{T} * 360^o = \frac{1ms}{6ms} * 360^o = 60^o$ (4)

then

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{6ms}$$ (4)

$$V_1(t) = 5\cos(\omega t + \theta)V = 5\cos(\pi t/3 + 60^o)V$$

(4)



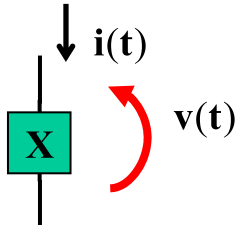
(4)

(12)

2 (12)

(a) If $v(t) = 5\cos(\omega t + 30^{o})V$, $i(t) = 2.5\cos(\omega t + 30^{o})mA$, find X.
Find also the power factor of X and power stored in X.

(a) If $v(t) = 10\cos(\omega t + 30^{o})V$, $i(t) = 5\cos(\omega t - 30^{o})mA$, find X in Ω and power factor of X.



(a)

$$X = 2k\Omega \qquad \textbf{(3)}$$

$$PF = 1 \qquad \textbf{(2)}$$

$$Q_R = 0 \qquad \textbf{(2)}$$

(b)

$$X = j\omega L = j(1k)2m = j2\Omega \qquad \textbf{(3)}$$

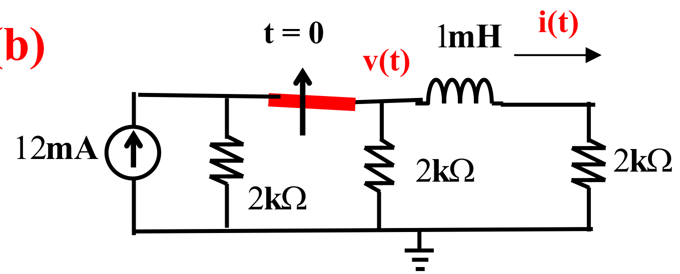
$$PF = 0 \qquad \textbf{(2)}$$

3

(a) Explain briefly why the current in an inductor is continuous with switching.

(b) Circuit is at steady state for $t < 0$. At $t = 0$, the switch is opened. Find $v(<0)$, $v(0)$, $v(10\tau)$ and sketch $v(t)$. (26)

(b)



(a)

$$E_L = \frac{L i_L(t)^2}{2}$$ (8)

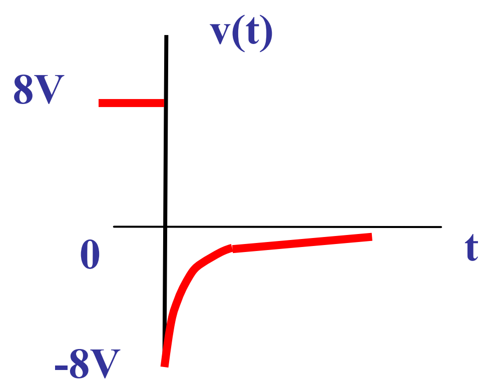
E_L (hence i_L) must be continuous with time

$$i(0) = i(<0) = 12mA * \frac{2k\Omega}{2k\Omega // 2k\Omega + 2k\Omega} * \frac{1}{2} = 4mA$$ (4)

$$v(<0) = 4mA * 2k\Omega = 8V$$ (3)

$$v(0) = -i(0) * 2k\Omega$$
$$= -4mA * 2k\Omega = -8V$$ (4)

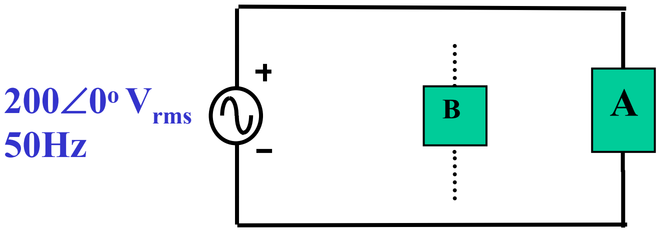
$$v(10\tau) \cong 0V$$ (3)



(4)

(25)

4



(a)

$$Q = P\tan\theta = 6k\tan(\cos^{-1}0.6) = 8kVAR(L)$$ (6)

$$S = P/\cos\theta = 6k/0.6 = 10kVA$$ (5)

(b)

$$\therefore Q_C \text{ required} = 8k - 6k\tan(\cos^{-1}0.9) \cong 5.1kVAR(C)$$

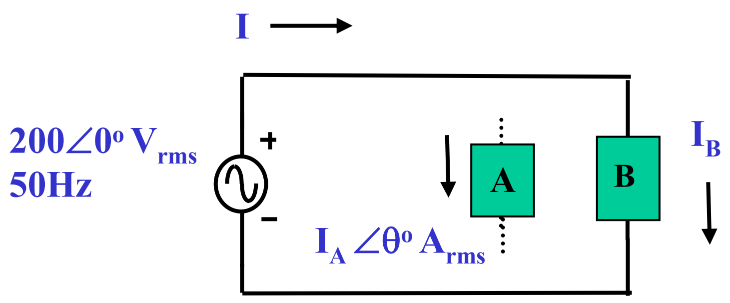
(8)

$$\therefore C = \frac{|Qc|}{V^2\omega} \cong \frac{5.1k}{(200^2)2\pi 50} \cong 0.41mF$$ (6)

For load A, power factor is 0.6 lagging and power consumed is 6kW. (a) Find the reactive power Q and apparent power S of load A.
(b) If load B is connected in parallel to load A such that the power factor of the combined load is <u>0.9 lagging</u>, find the element and value of load B. (25)

(18)

5



$$I_B = \frac{S}{V} = \frac{50kVA}{200V} = 250A_{rms}$$ **(6)**

$$I_A = \frac{Q}{V} = \frac{\sqrt{S^2 - P^2}}{200} = \frac{40k}{200} = 200A_{rms}$$ **(6)**

$$I = \frac{S}{V} = \frac{30k}{200} = 150A_{rms}$$ **(6)**

Power consumed by load B is 30kW. (a) If power supplied by source is 50kVA. Find IB in Arms.
(b) If load A is connected in parallel to load B such that the power factor of the combined load is 1, find I and I_A in Arms.
(18)

(22)

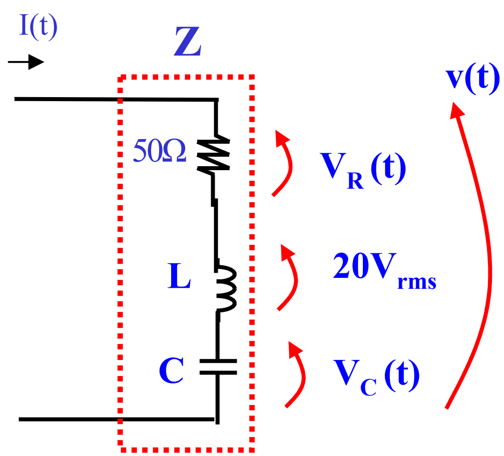
6

In the circuit, $\mathbf{v(t)} = 2\sqrt{2}\cos(1\mathbf{kt})\mathbf{V}$

$\mathbf{I(t)} = 40\sqrt{2}\cos(1\mathbf{kt})\mathbf{mA}$

Find power consumed by Z, power stored by L, and Vc(t) .

Does Vc(t) lag V(t)? . (22)



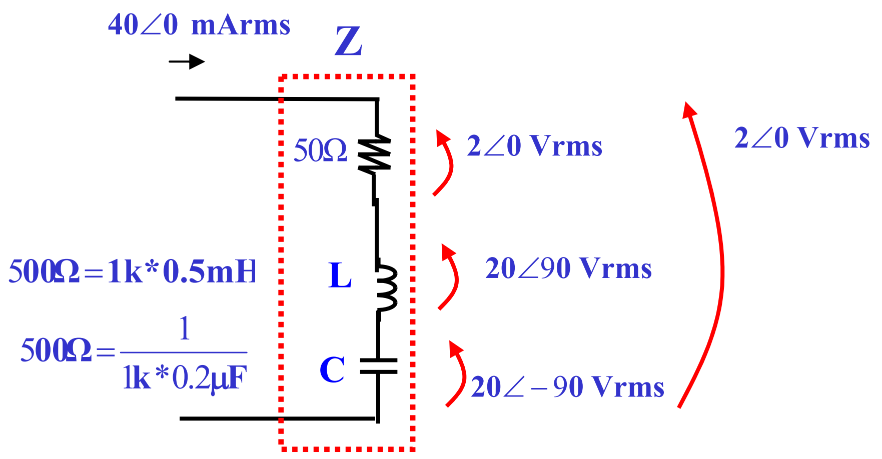
$$\therefore \mathbf{P} = \mathbf{I}^2\mathbf{R} = (40\mathbf{mA}_{\mathbf{rms}})^2 * 50\Omega = 80\mathbf{mW}$$ (6)

$$\therefore \mathbf{Q}_{\mathbf{L}} = \mathbf{VI} = 20\mathbf{V}_{\mathbf{rms}} * 40\mathbf{mA}_{\mathbf{rms}} = 800\mathbf{mVAR(L)}$$ (6)

Since V_R = v, hence Vc = -20V rms

$$\mathbf{V}_{\mathbf{C}}(\mathbf{t}) = 20\sqrt{2}\cos(1\mathbf{kt} - 90^{\circ})\mathbf{V}$$ (7)

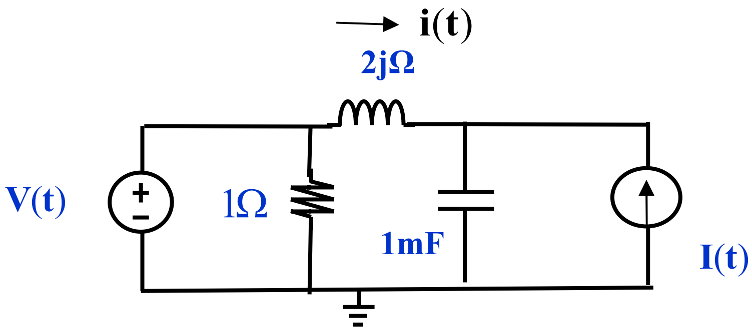
V_C(t) lags V(t) by 90° (3)

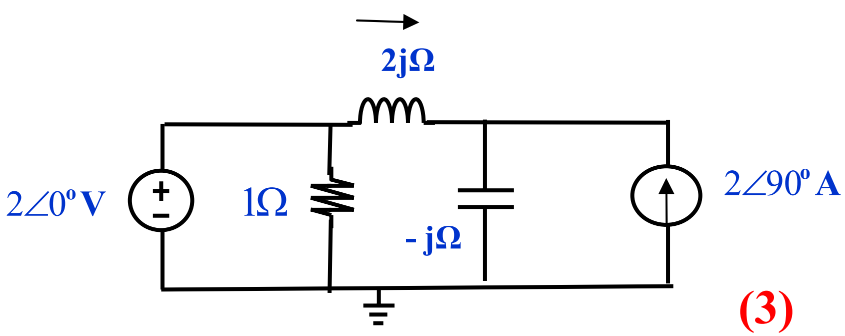


(20)

7

In the circuit, $V(t) = 2\cos(1kt)V$, $I(t) = 2\cos(1kt + 90^o)A$ find i(t). (20)





(3)

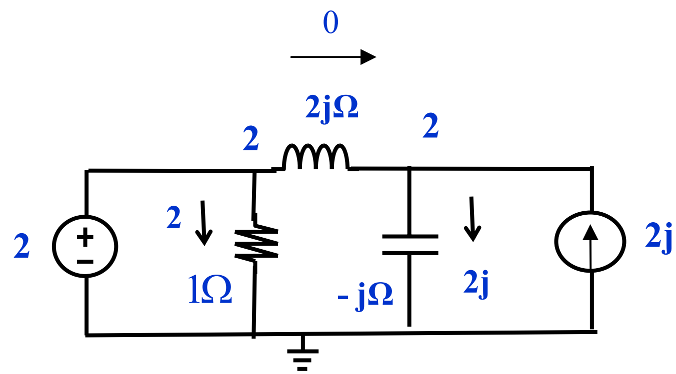
$$\frac{1}{j\omega C} = \frac{1}{j(1k)1mF} = -j\Omega$$ (2)

Use superposition

$$\therefore i_{2V} = \frac{2\angle 0^o V}{j\Omega}$$ (5)

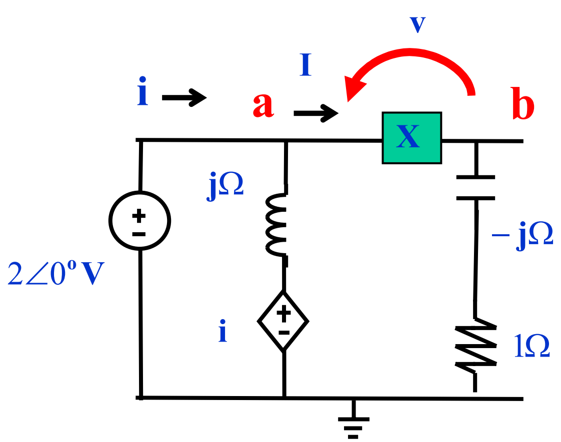
$$\therefore i_{2jA} = -2j * \frac{-j}{2j - j} = 2jA$$ (6)

$$\therefore i = i_{2V} + i_{2jA} = \frac{2\angle 0^o V}{j\Omega} + 2jA = 0$$ (4)

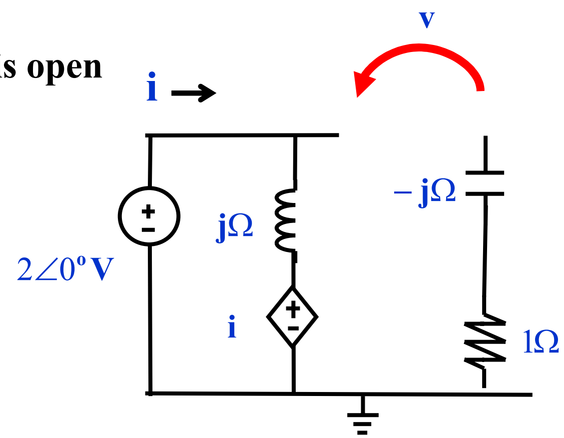


$\boxed{8}$

(a) If X is open, find v. (b) If X = 0 Ω, find I. (c) Find the Thevenin equivalent at termianls ab. (d) If I = $2\angle 0^o$ A, find X. (24)

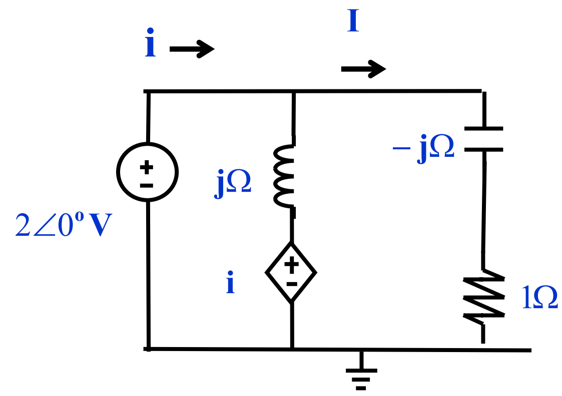


(a) **If X is open**



$\therefore v = 2\angle 0^o$ V **(6)**

(b) **If X = 0 Ω**

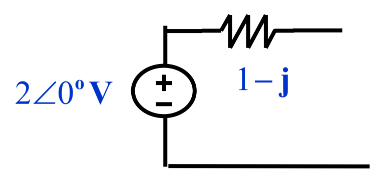


$$\therefore I = \frac{2V}{1\Omega - j\Omega}$$ **(6)**

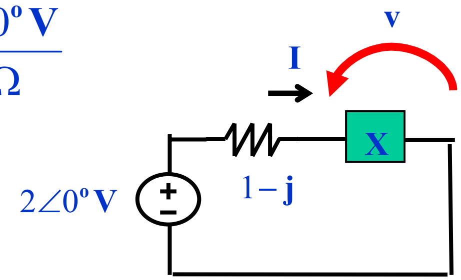
(c)

$$\therefore Zth = \frac{Voc}{Isc} = \frac{v}{I} = \frac{2\angle 0^o}{2\angle 0^o / 1-j} = 1\Omega - j\Omega$$

Thevenin equivalent at terminals ab **(6)**



(d) **If** $I = 2\angle 0^o A = \dfrac{2\angle 0^o V}{1\Omega}$



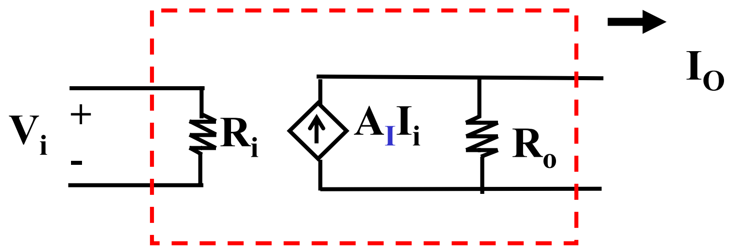
$\therefore X = j\Omega$ **(6)**

(9)

9

(a)
Draw the circuit model for a **conductance amplifier**.
What are the ideal value of the output and input resistance?
(9)

(a)

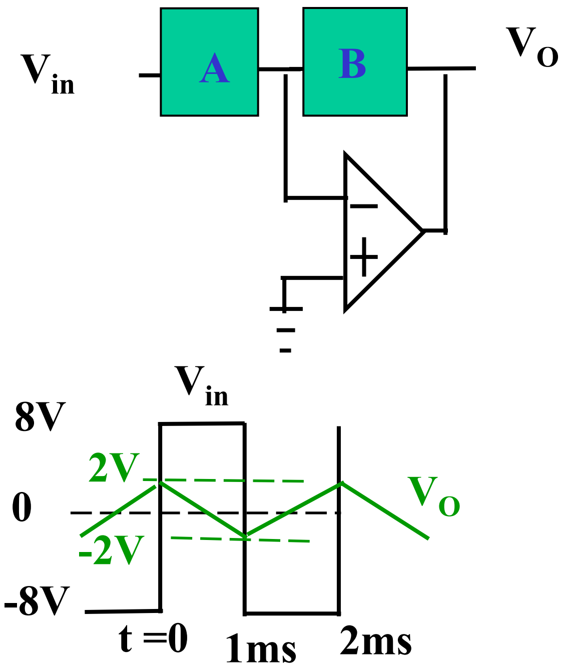


ideal V to I amplifier, Ri = ∞ . Ro = ∞ **(9)**

(18)

9 Find the elements A and B. Given that one element is 1kΩ. (18)

(b)



Circuit is an integrator

$$\therefore \frac{V_{in}-0}{R} = -C\frac{dV_O}{dt}$$

$$\therefore \frac{dV_O}{dt} = -\frac{V_{in}}{RC} \qquad (8)$$

$$\therefore \frac{2V - -2V}{1ms} = -\frac{8V}{RC}$$

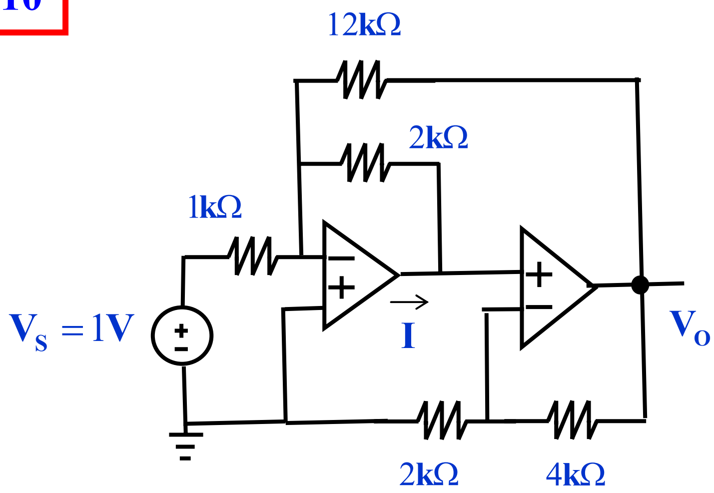
$$\therefore RC = 2ms \qquad (8)$$

$$\therefore A = R = 1k\Omega$$

$$\therefore B = C = 2\mu F \qquad (2)$$

(21)

10



In the amplifier,
find Vo and I. Assume the op amps are ideal. (21)

$$\therefore \frac{V_S - 0}{1k\Omega} = \frac{0 - V_O}{12k\Omega} + \frac{0 - V}{2k\Omega}$$

$$\because V = V_O * \frac{2k\Omega}{4k\Omega + 2k\Omega} = \frac{V_O}{3} \qquad \textbf{(8)}$$

$$\therefore 12V_S = -V_O - 6V = -3V_O$$

$$\therefore \frac{V_O}{V_S} = -4$$

$$\therefore V_O = -4V \qquad \textbf{(5)}$$

$$\therefore I = -\frac{2}{3}mA \qquad \textbf{(8)}$$