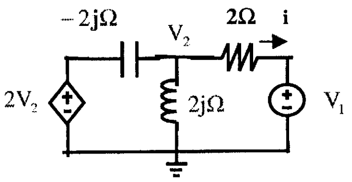
(18)

1

1. In the circuit, if $V_1(t) = 4\cos(1\text{k}\,t)$ V, find $V_2(t)$. The voltage controlled voltage source is in volt and equal to $2V_2(t)$. Find also the value of the inductance in mH. (18)



$$\mathbf{V_1(t) = 4\cos(1kt)V \Rightarrow V_1 = 4\angle 0^\circ V}$$

$$4\angle 0^\circ \mathbf{V}$$

$$\because \frac{2V_2 - V_2}{-2j} = \frac{V_2}{2j} + \frac{V_2 - 4}{2}$$

$$2V_2 - V_2 = -V_2 + (V_2 - 4)(-j)$$

$$V_2 = -V_2 - jV_2 + 4j$$

$$V_2(2 + j) = 4j$$

$$\therefore V_2 = \frac{4j}{2 + j} = \frac{4\angle 90}{\sqrt{5}\angle 26.6}$$

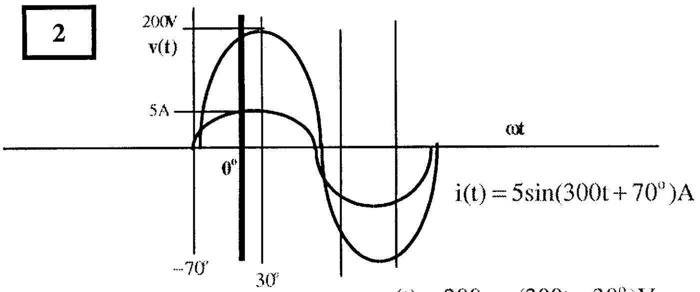
$$\therefore V_2(t) = \frac{4}{\sqrt{5}}\cos(1kt + 63.4^\circ)V$$

$$jL\omega = 2j$$

$$\therefore L = \frac{2}{1k} = 2mH$$

(25)

2



$$v(t) = 200\cos(300t - 30^\circ)V$$

$$i(t) = 5\sin(300t + 70^\circ)A = 5\cos(300t - 20^\circ)A$$

i(t) leads v(t) by 10° *--(1)*

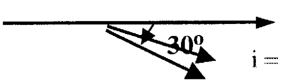
sin a = cos (90° – a)
= cos (a - 90°)

Capacitive element (C in parallel with R)

$$\therefore Z = \frac{V}{I} = \frac{200\angle -30^\circ V}{5\angle -20^\circ A}$$

$$= 40\angle -10^\circ \Omega$$

$$\therefore I_B = 63.6\angle 90^\circ A_{rms}$$



$$i = 5\angle -20^\circ A$$

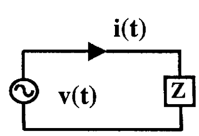
$$v = 200\angle -30^\circ V$$

$$\therefore Y = \frac{1}{40}\angle 10^o S = \frac{1}{R} + jC\omega$$

$$\therefore Y = 0.025(\cos 10^o + j\sin 10^o) = 0.0246 + j0.00434 = \frac{1}{R} + jC\omega$$

$$\therefore R = \frac{1}{0.0246} = 40.62\Omega \;\therefore C = \frac{0.00434}{\omega} = \frac{0.00434}{300} = 14.47\mu F$$

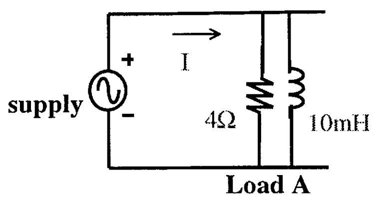
2. In the following circuit, v(t) = 200 cos (300t – 30°) V, i(t) = 5 sin (300t + 70°) A.
(a) Sketch v(t) and i(t) together. Show clearly the phase angles and amplitudes. Find the phase angles between v(t) and i(t). Does v(t) lead i(t)?
(b) Plot v and i in a phasor diagram.
(c) If Z is composed of two elements connected in parallel, find the two elements and the values. Given sin a = cos (a - 90°). (25)



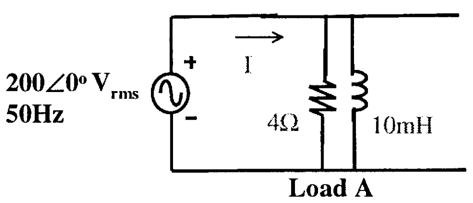
(19)

3

3. Load A is connected in parallel to a 200Vrms, 50 Hz supply as shown.
(a) Explain very briefly the physical meaning of apparent power S, reactive power Q and average power P.
(b) Find the apparent power S, reactive power Q, average power P and power factor PF of load A. (19)



P = real (or average) power dissipated by load
S = power supplied by source to load Z
Q = maximum reactive power stored in Z



For load A

$$\therefore P=\frac{V^2}{R}=\frac{200^2}{4}=10\text{kW}$$

$$\therefore Q=\frac{V^2}{\omega L}=\frac{200^2}{\pi 2(50)10\text{m}}=12.73\text{kVAR(L)}$$

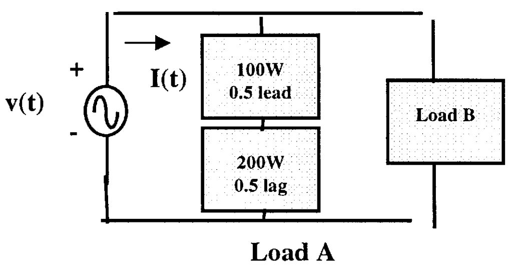
$$\therefore S=\sqrt{P^2+Q^2}=\sqrt{10k^2+12.73k^2}=16.19\text{kVA}$$

$$\therefore PF=\frac{P}{S}=\frac{10k}{16.19k}=0.618\text{ lagging}$$

(27)

4

4. Load A is composed of two loads and is connected in parallel to v(t) as shown. v(t) = 200 √2 cos (300t) V. Load B is now connected in parallel to load A such that the power factor PF of the combined load is 1.
(a) Find the element and value of the load B.
(b) When PF = 1, find I(t). Find also the current flowing in load B in Arms. (27)



$$v(t)=200\sqrt{2}\cos(300t)\text{V}$$

For load A

total P = 200 + 100 = 300W

$$\therefore \text{total } Q=200\tan(\cos^{-1}0.5)-100\tan(\cos^{-1}0.5)$$
$$=173.2\text{VAR(L)}$$

load B is capacitance

$$Q=V^2\omega C$$

$$\therefore C=\frac{Q}{V^2\omega}=\frac{173.2}{200^2(300)}=1.44\text{x}10^{-5}\text{F}$$

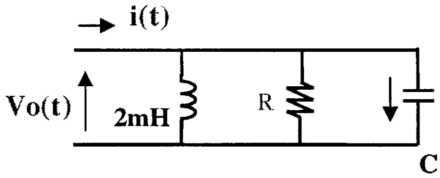
$$\therefore I=\frac{S}{V}=\frac{300}{200}=1.5A_{rms}$$

$$\therefore I(t)=1.5\cos(300t)A_{rms}$$

$$\therefore \text{I in load B }=\frac{Q}{V}=\frac{173.2}{200}=0.866A_{rms}$$

(22)

5



$$f_O = 96.9\text{MHz}$$

$$\therefore \text{BW} = 4\text{MHz}$$

$$\therefore f_2 = f_O + \frac{\text{BW}}{2} = 96.9 + 2 = 98.9\text{MHz}$$

$$\therefore f_1 = f_O - \frac{\text{BW}}{2} = 96.9 - 2 = 94.9\text{MHz}$$

$$\therefore L = \frac{1}{\omega_O{}^2 C} = \frac{1}{(2\pi 96.9\text{M})^2 1\text{pF}} = 2.70\mu\text{H}$$

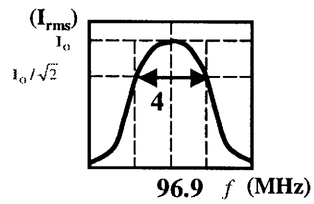
$$\therefore \text{QF} = \frac{f_O}{\text{BW}} = \frac{96.9\text{MHz}}{4\text{MHz}} = 24.225$$

$$\therefore R = \frac{\text{QF}}{\omega_O C} = \frac{24.225}{2\pi(96.9\text{M})(1\text{p})} = 39.8\text{k}\Omega$$

If i received is 0.05 mArms, voltage across the circuit

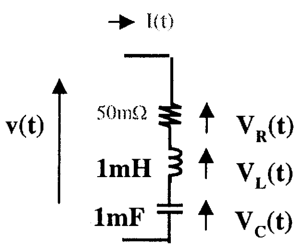
$$\therefore v = iR = 0.05\text{m}(39.8\text{k}) = 1.99\text{Vrms}$$

5. A parallel LCR radio tuner circuit is used to receive radio stations as shown in the tuner curve.
(a) Find in Hz the resonant frequency, bandwidth, upper and lower frequencies of the tuner.
(b) If C is 1pF, find the values of L and R of the tuner circuit.
(c) If the current signal received by the tuner is 0.01 mArms, find the maximum output voltage of the tuner in Vrms. (22)



(22)

6



$$v(t) = 2\sqrt{2}\cos(1000t)\ V$$

$$\therefore \omega_O = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(1\text{m})(1\text{m})}} = 1\text{krad/s}$$

Circuit in resonance

$$\therefore v_R(t) = 2\sqrt{2}\cos(1000t)\ V$$

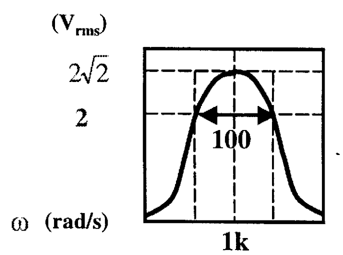
$$\therefore QF = \frac{\omega_O L}{R} = \frac{(1000)1m}{50m} = 20$$

$$\therefore v_L(t) = 40\sqrt{2}\cos(1000t + 90^o)\ V$$

If R becomes 100 mohm,

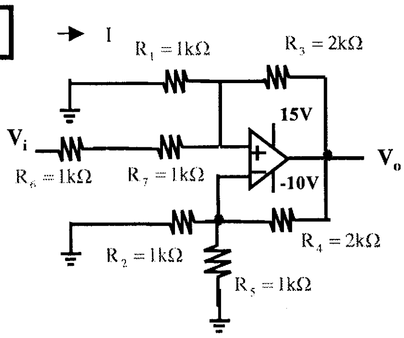
$$\therefore QF = 10$$

$$BW = \frac{\omega_O}{QF} = \frac{1k}{10} = 100$$



6. In the series LCR circuit, v(t) = 2 √2 cos (1000t) V.
(a) Find $V_R(t)$ and $V_L(t)$.
(b) Plot the resonance curve if R becomes 100 mΩ. (22)

7



$$\because V_- = V_+ = v$$

$$\frac{V_i - v}{2k} = \frac{v}{1k} + \frac{v - V_O}{2k}$$

$$\therefore V_i - v = 2v + v - V_O$$

$$\therefore V_i = 4v - V_O$$

$$\frac{V_O - v}{2k} = \frac{v}{1k} + \frac{v}{1k}$$

$$\therefore V_O - v = 2v + 2v$$

$$\therefore v = \frac{V_O}{5}$$

$$\therefore V_i = 4v - V_O = -0.2V_O$$

$$\therefore A_V = \frac{V_O}{V_i} = \frac{1}{-0.2} = -5$$

If Vi = 2V, Vo = -10V

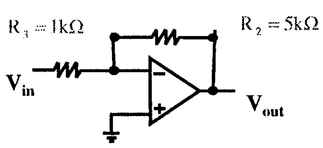
$\therefore$ *If Vi = -3V, Vo = 15V, v = 3V, I = -3mA*

7. Given the ideal op amp circuit. (a) Find Vo when Vi = 2V. (b) Find I if Vi = -3V. (22)

8

using 1-10k Ω resistors and 0.001-1mF capacitors

$\boxed{Vo = -5Vi}$



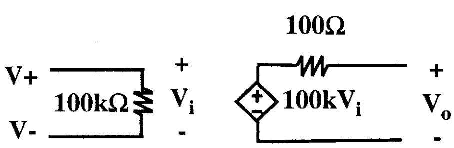


Fig. B

7. (a) Design an op amp circuit that can perform the function: Vi = - 0.2Vo. Vi and Vo are input and output of the circuit. Use 1k to 10k ohm resistors in your design.
(b) In the **real** op amp circuit in Fig.A, find Ii. Given Io >> Ii . Given also the real op amp has the circuit model shown in Fig.B. (24) (Hint: replace op amp in Fig. A by Fig. B, and redraw Fig. A).

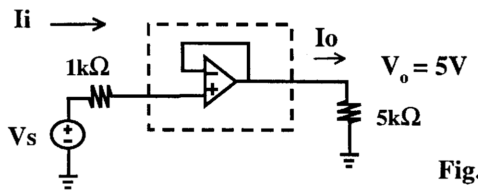
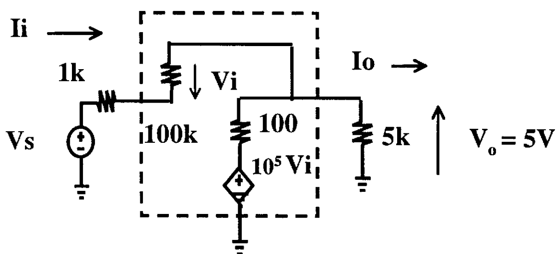


Fig. A



$$I_O = \frac{5V}{5k} = 1mA$$

since Io >> Ii. $\therefore 10^5 Vi \approx Vo + Io(100) = 5 + 1m(100) = 5.1V$

$$\therefore Vi = 5.1V/10^5 = 0.051mV$$

$$\therefore Ii = Vi/100k = 0.051mV/100k = 0.51nA$$