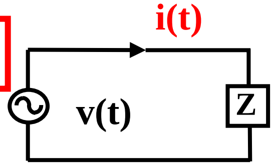
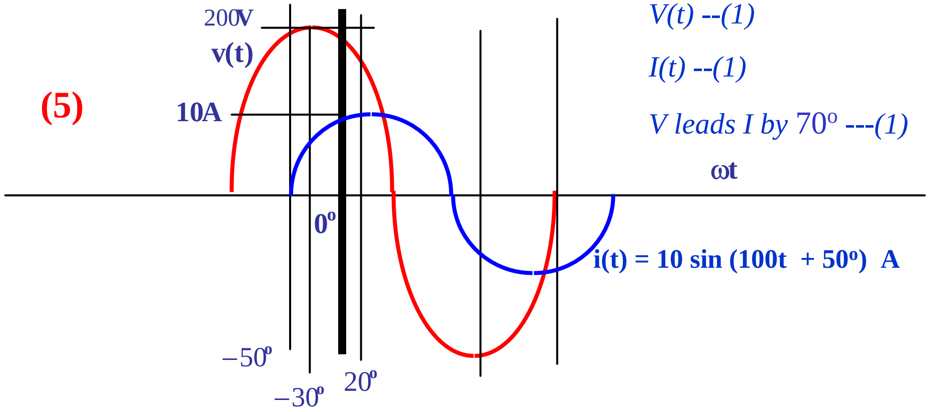
(23)

1



(5)



200V --(1)

10A --(1)

V(t) --(1)

I(t) --(1)

V leads I by 70° ---(1)

(3) **v(t) = 200 cos (100t + 30°) mV** *--(1)*

i(t) = 10 sin (100t + 50°) = 10 cos (100t - 40°) A *--(1)*

v(t) leads i(t) by 70° *--(1)*

inductive element (L in parallel with R)

(5)

$$\therefore Z = \frac{V}{I} = \frac{200\angle 30^{o}\,V}{10\angle -40^{o}\,A} \quad \text{--(3)}$$

$$= 20\angle 70^{o}\,\Omega \quad \text{--(2)}$$

(5)

$$\therefore Y = \frac{1}{20}\angle -70^{o}\,S = \frac{1}{R} + \frac{1}{j\omega L} \quad \text{--(2)}$$

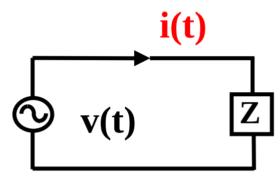
$\therefore$ **Y = 0.05 (cos -70° + j sin -70°) S**
= 0.0171 – j0.0470 S *--(3)*

(5)

$$\therefore R = \frac{1}{0.0171} = 58.476\Omega \quad \text{--(2)}$$

$$\therefore L = \frac{1}{0.047\omega} = \frac{1}{0.047(100)} = 0.213H \quad \text{--(3)}$$

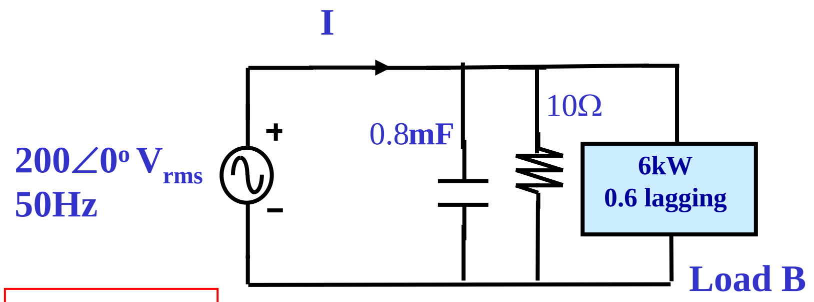
1. In the following circuit, v(t) = 200 cos (100t + 30°) V, i(t) = 10 sin (100t + 50°) A.
(a) Sketch v(t) and i(t) together. Show clearly the phase angles and amplitudes. Find the phase angles between v(t) and i(t). Does v(t) lead i(t) ?
(b) If Z is composed of two elements connected <u>in parallel</u>, determine their values. (23)



(33)

2

2. Loads A and B are connected in parallel to a 200 Vrms, 50Hz power source. Load A is 0.8mF in parallel with 10 Ω. Load B is 6kW at 0.6 lagging power factor. (a) Find the average power P reactive power Q, apparent power S and power factor PF supplied by the power source. (b) If a load D is connected in parallel to load A and B to make the total power factor = 0.99 leading, find the element and value of load D. (c) If total power factor of load A, B and D is 1, find the current in rms supplied by the power source. (33)



For load A

(3) $\therefore P = \frac{V^2}{R}$ --(2)

$= \frac{200^2}{10} = 4kW$ --(1)

(4) $\therefore Q = V^2 \omega C$ --(2)

$= 200^2 * 2\pi 50 * 0.8m = 10053 VAR(C)$ --(2)

(2) **For load B** $P = 6kW$ --(2)

(3) $Q = P\tan\theta$ --(2)

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

For load A and B

(2) **total P = 4k + 6k = 10kW**

(2) **total Q = 8k – 10.0531k = 2.0531 kVAR(C)**

(3) $\therefore \text{total } S = \sqrt{P^2 + Q^2}$ --(2)

$= \sqrt{10k^2 + 2.0531k^2} = 10.208kVA$ --(1)

(3) $\therefore PF = \cos\tan^{-1}\frac{Q}{P}$ --(1)

$= \cos\tan^{-1}\frac{2053}{10k} = 0.98 \text{ leading}$ --(2)

Add Load D to make PF = 0.99 leading (inductance L)

(3) $\therefore \textbf{new Q} = 10k\,\textbf{tan cos}^{-1} 0.99 = 1.425\textbf{kVAR(C)}$

(4) $\therefore L = \frac{V^2}{\omega Q_L}$ --(2)

$= \frac{200^2}{2\pi 50(2.0531k - 1.425k)} = 0.2mH$ --(2)

When PF = 1, Load A , B and D is now like a pure resistance R with P = 10kW

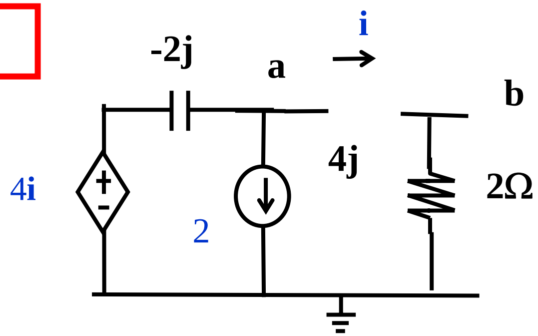
(4) **I in rms**

$I = \frac{S}{V}$ --(2)

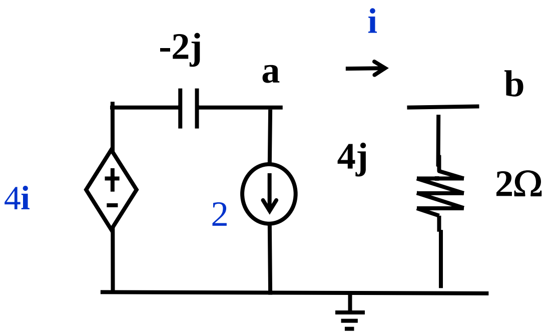
$= \frac{10kVA}{200V} = 50Arms$ --(2)

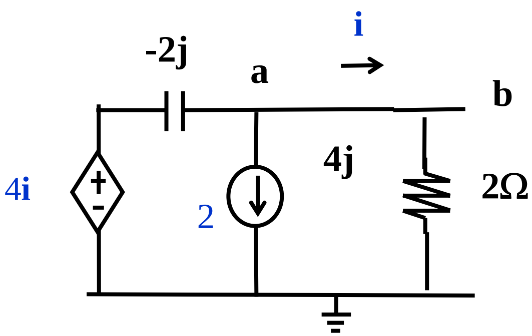
(24)

3



(5) $V_{OC} = -2(-2j) = 4j\,V$





(8)

$$4i = (i+2)(-2j) + 2i = -2ij - 4j + 2i \quad \text{--(3)}$$

$$2i + 2ij = -4j$$

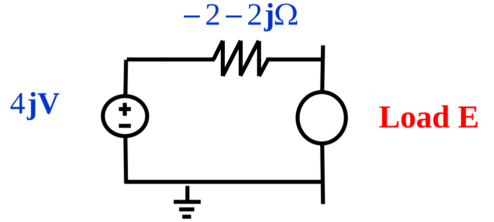
$$I_{SC} = i = \frac{-4j}{2+2j} = \frac{-2j}{1+j} = \frac{2\angle -90^{o}}{\sqrt{2}\angle 45^{o}} = \sqrt{2}\angle -135^{o}\,A \quad \text{--(5)}$$

(4)

$$\therefore Zth = \frac{Voc}{Isc} \quad \text{--(2)}$$

$$= \frac{4j}{\frac{-2j}{1+j}} = -2(1+j) = 2\sqrt{2}\angle -135^{o}\,\Omega \quad \text{--(2)}$$

(2)



(5)

$$I = \frac{Voc}{Z} \quad \text{--(2)}$$

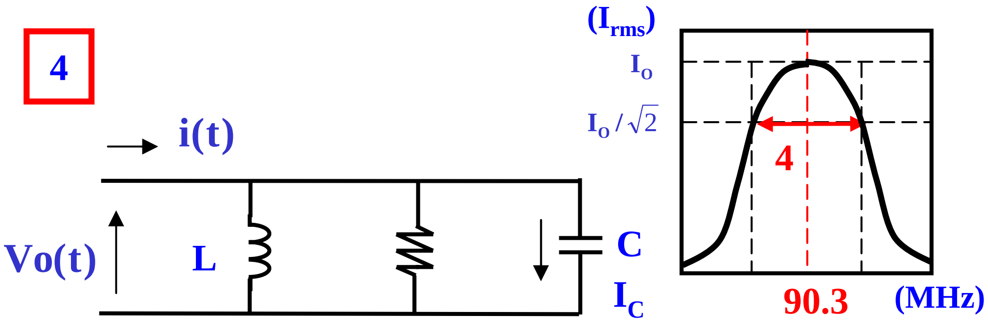
$$= \frac{4j}{-2-2j+E} = 2\angle 90^{o} = 2j$$

$$\therefore \text{load } E = 4+2j \quad \text{--(3)}$$

3. In the following circuit,
(a) find the complex open circuit voltage and short circuit current at <u>terminals ab</u>. Hence sketch the Thevenin equivalent at ab.
(b) A load E is now connected across ab. Find load E if current in load E is $2\angle 90^{o}$ A. (24)

(27)

4



$\mathbf{R} = 10\mathbf{k}\Omega$

(2) $f_o = 90.3\,\mathbf{MHz}$

$\therefore \omega_o = 2\pi f_o = 567.372\,\mathbf{Mrad/s}$

(2) $\therefore \mathbf{BW} = 4\,\mathbf{MHz}$ **or** $8\pi\,\mathbf{Mrad/s}$

(2) $\therefore f_2 = f_o + \dfrac{\mathbf{BW}}{2} = 90.3 + 2 = 92.3\,\mathbf{MHz}$

(2) $\therefore f_1 = f_o - \dfrac{\mathbf{BW}}{2} = 90.3 - 2 = 88.3\,\mathbf{MHz}$

(3) $\therefore Q = \dfrac{f_O}{BW}$ --(2)

$= \dfrac{90.3}{4} = 22.575$ --(1)

If i received is 0.089mArms

(4) $\therefore \max i_C = Qi$ --(2)

$= 22.575(0.089) = 2.0\,\mathrm{mA}_{rms}$ --(1)

(3) $\therefore \mathbf{R} = \dfrac{0.89\mathbf{V}}{0.089\mathbf{mA}} = 10\mathbf{k}\Omega$

(3) $\therefore L = \dfrac{R}{\omega_O Q}$ --(2)

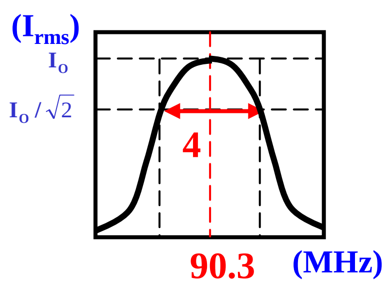
$= \dfrac{10k}{567.372M(22.575)} = 0.781\mu H$ --(1)

(3) $\therefore C = \dfrac{Q}{\omega_O R}$ --(2)

$= \dfrac{22.575}{567.372M(10k)} = 3.979\,pF$ --(1)

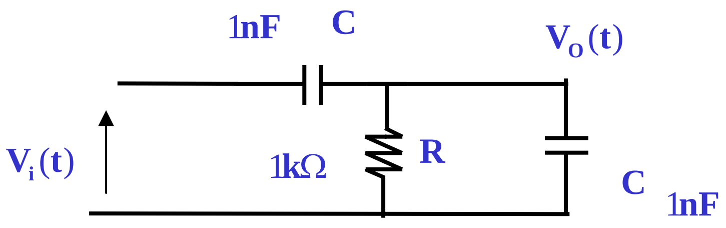
(3) $\therefore R = \dfrac{1}{BW * C}$ --(1) **Increase R to 20 k**Ω --(2)

4. A parallel LCR radio tuner circuit is used to receive radio stations as shown in the tuner curve. (a) Find the resonant frequency, bandwidth, upper and lower frequencies (in Hz). (b) If the current signal received by the tuner is 0.089 mA rms and maximum output voltage of tuner is 0.89V rms, find the maximum current (in rms) flowing in C. (c) Find also the values of L, C and R of the tuner circuit. (d) Suggest a method to improve the bandwidth to 2 MHz. (27)



5

In the filter circuit below,
(a) Find the complex transfer function G = Vo/Vi in terms of C, R and jω . (b) Show that at cut-off, the cutoff frequency = 500k rad/s. Find also the |G| in dB .
(c) Find |G| when ω = 50krad/s. What filter type is it?
(d) Sketch |G| versus angular frequency ω. Show clearly all intercepts in your sketch. (28)



(7) $$\therefore R // \frac{1}{j\omega C} = \frac{R\frac{1}{j\omega C}}{R+\frac{1}{j\omega C}} = \frac{R}{1+j\omega CR} \quad \text{--(2)}$$

$$\therefore G = \frac{V_o}{V_i} = \frac{\frac{R}{1+j\omega CR}}{\frac{1}{j\omega C}+\frac{R}{1+j\omega CR}} \quad \text{--(2)}$$

$$= \frac{1}{(\frac{1+j\omega CR}{j\omega CR})+1} = \frac{1}{(\frac{1}{j\omega CR})+1+1} \quad \text{--(3)}$$

At cut-off

(2) $$\therefore \frac{1}{\omega_O CR} = 2$$

(3) $$\therefore \omega_O = \frac{1}{2CR} = \frac{1}{2*1n(1k)} = 0.5\text{x}10^6 \text{rad/s}$$

(3) $$\therefore G = \frac{1}{2-2j} \quad \therefore |G| = \frac{1}{2\sqrt{2}}$$

(3) $$\therefore 20\log_{10}|G| = 20\log_{10}\frac{1}{2\sqrt{2}} = -9\text{dB}$$

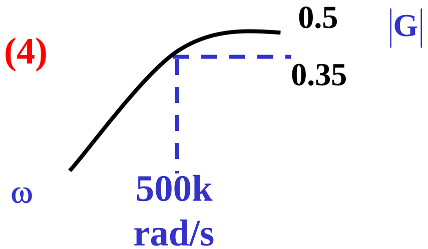
$$\text{at } \omega = \frac{\omega_o}{10} = 50\text{k rad/s}$$

(5) $$\therefore G = \frac{1}{2-20j} \quad \text{--(3)}$$

$$\therefore |G| = \frac{1}{2\sqrt{101}} = 0.05 \quad \text{--(2)}$$

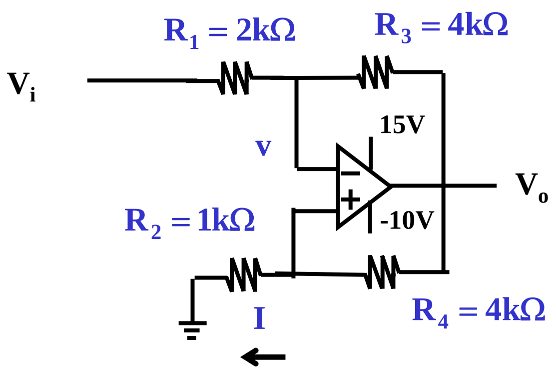
(2) **A high pass filter**

(4)

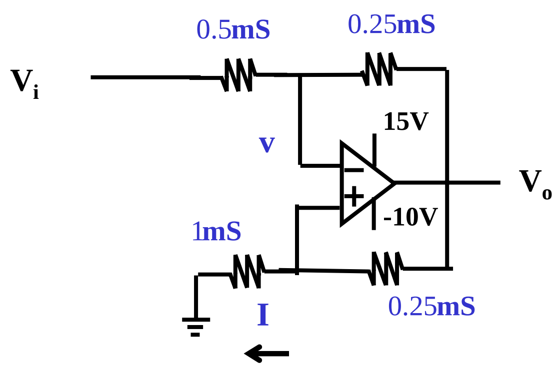


0.5--(1)
0.35--(1)
500k--(1)
shape--(1)

6



6. (a) In the following ideal op amp circuit, (i) find Vo when Vi = - 1V, (ii) find I when Vi = 4V. (17)
(b) Design an ideal op amp circuit (with very high input resistance) to generate an output current of 0.1Vi (mA) and output voltage of 5Vi (V) when input voltage is Vi (V). (10)



(11) $\because V_- = V_+ = V$ *--(3)*

$$\therefore V_+ = V_O \frac{1k}{1k+4k} = \frac{V_O}{5} = v = V_- \quad \text{--(3)}$$

$$\therefore \frac{Vi - v}{2k} = \frac{v - V_O}{4k} \quad \text{--(3)}$$

$$\therefore 2V_i - 2v = v - V_O \quad \therefore 2V_i = 3v - V_O = -\frac{2}{5}V_O$$

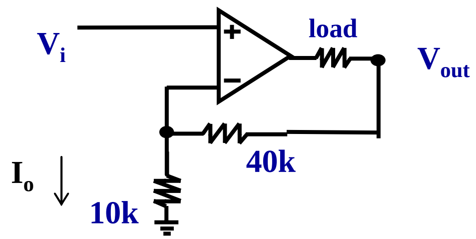
$$\therefore A_V = \frac{V_O}{V_i} = -5 \quad \text{--(2)}$$

(2) **If Vi = -1V, Vo = 5V**

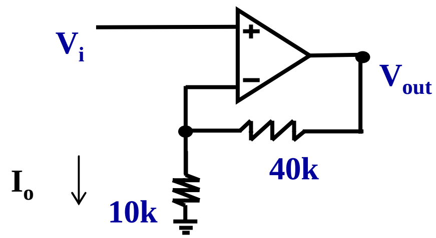
(4) **If Vi = 4V, Vo = -15V** *--(2)*

$$\therefore I = \frac{-15V}{5k} = -3mA \quad \text{--(2)}$$

(10)



or



Show Gain=5---(4)

Shpw I=0.1mVi ---(4)

all correct ---(2)