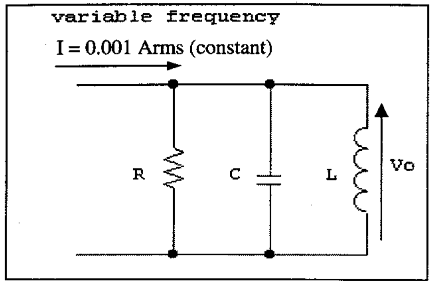
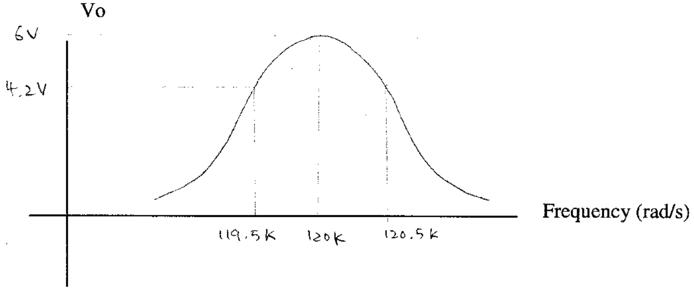
1. The parallel RLC circuit shown below has a resonant frequency (ωo) of 120k rad/s , a Q factor of 120 and a maximum Vo of 6 Vrms.



a) Find the bandwidth. (4 marks)
b) Sketch Vo versus frequency. Show the voltage at ωo and at the bandwidth in your sketch. (6 marks)
c) Find the values of R, L and C. (14 marks)



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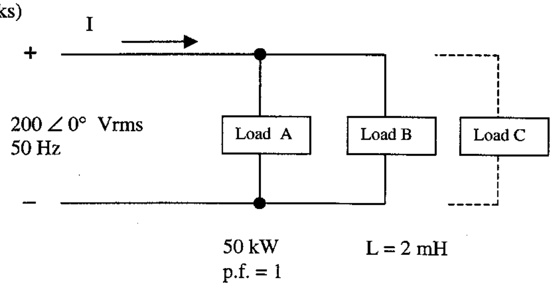
a) $BW = \frac{\omega_o}{Q} = \frac{120k}{120} = 1k$ rad/s 4

c) $R = \frac{6V}{1mA} = 6k\Omega$ 4

$L = \frac{R}{\omega_o Q} = \frac{6k}{120k(120)} = 0.42mH$ 5

$C = \frac{1}{\omega_o^2 L} = \frac{1}{(120k)^2\, 0.42m} = 167nF$ 5

5. Given the following circuit diagram. Each load contains only one element.
a) Determine the element and value of Load A. (5 marks)
b) Calculate the reactive power of Load B. (5 marks)
c) Calculate the total current I. (8 marks)
d) Calculate the power factor. Show lagging or leading. (5 marks)
e) If Load C is connected to improve the power factor to 1, calculate the reactive power of Load C. (5 marks)



a) A is R

$R = \frac{V^2}{P} = \frac{200^2}{50K} = 0.8\Omega$ 5

b) $Q_B = \frac{V^2}{2\pi f L} = \frac{200^2}{2\pi(50)2m} = 63.7$ kvar 5

c) $I = \frac{200}{0.8} + \frac{200}{j(2\pi)50(2m)}$

$= 250 - 318j$ Arms

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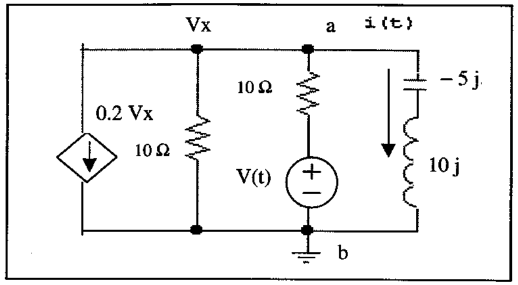
d) $PF = \cos\theta = \cos\tan^{-1}\frac{63.7K}{50K}$

$= 0.62$ lagging 5

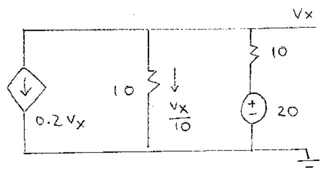
e) $Q_C = -63.7$ kvar 5

6. Given : $V(t) = 20\cos\omega t$ V. Use Norton's Theorem to find the current i(t).



a) Find the open circuit voltage Voc at terminals ab. (10 marks)
b) Find the short circuit current Isc at terminals ab. (7 marks)
c) Show that the equivalent impedence Zth = 2.5Ω. (Zth = Voc / Isc). (2 marks)
d) Draw the Norton equivalent circuit of the whole circuit. (3 marks)
e) Hence, find the current i (t). (9 marks)
f) Does i (t) lag V(t) ? (2 marks)

a)

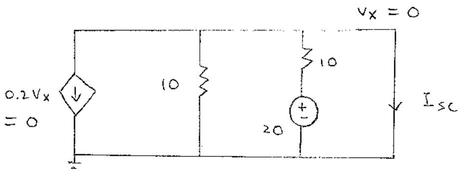


$$KCL : \frac{20 - V_x}{10} = \frac{V_x}{10} + 0.2V_x$$

$$20 - V_x = V_x + 2V_x$$

$$\therefore V_x = 5V = V_{oc}$$ 10

b)

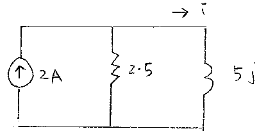


$$\therefore I_{sc} = \frac{20}{10} = 2A$$ 7

c) $$Z_{th} = \frac{V_{oc}}{I_{sc}} = \frac{5V}{2A}$$

$$= 2.5\ \Omega$$ 2

d)



3

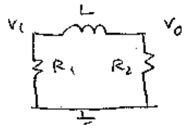
e) $$i = 2\,\frac{2.5}{2.5+5j}$$

$$= \frac{1}{0.5+j} = \frac{1}{\sqrt{1.25}\ \angle 63}$$ 6

$$\therefore i(t) = 0.89\cos(\omega t - 63^\circ)\ A$$ 3

f) i(t) lags v(t) 2

3. In the following circuit, (a) find the complex transfer function H (= Vo/Vi) if $R_1 = R_2 = 1\Omega$ and L = 1H. ~~(b) Find the pole and zero of H.~~ Find the frequency of Vi when (c) magnitude of Vo is one half the magnitude of Vi, and (d) phase of Vo is 30° lagging Vi. (e) What type of filter is the circuit? (f) Find the cut-off frequency if L is changed to 2mH. (29)



(a) $\frac{V_o}{V_i} = \frac{R_2}{R_2 + j\omega L} = \frac{1}{1+j\omega}$

$= \frac{1}{\sqrt{1+\omega^2}\ \angle \tan^{-1}\omega}$ 9

(c) $\frac{V_o}{V_i} = \frac{1}{2} = \frac{1}{\sqrt{1+\omega^2}}$ 6

$\therefore \omega = \sqrt{3}$ rad/s

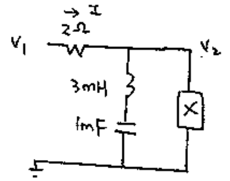
(d) $\theta = \tan^{-1}\omega = 30°$

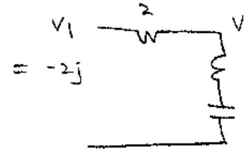
$\omega = \tan 30 = 0.577$ rad/s 6

(e) low pass filter 3

(f) $\omega_0 = \frac{R}{L} = \frac{1}{2m} = 500$ rad/s 5

5. In the following circuit, $V_1(t) = 2\cos(1000t - \pi/2)$ V. (a) If X is an open circuit, find $V_2(t)$. Find the element and value of X (b) if I = 0, (c) if V_1 and I are in phase, and (d) if I leads V_1 by 45°. (35)





$= -2j$

$j\omega L = j(1k)3m = 3j$

$\frac{1}{j\omega C} = \frac{1}{j(1k)1m} = -j$

(a) $\therefore V_2 = -2j\,\frac{2j}{2+2j} = \frac{2}{1+j}$

$= \sqrt{2}\angle -45$

$\therefore V_2(t) = \sqrt{2}\cos(1kt - \frac{\pi}{4})$, V 12

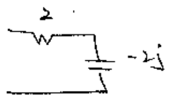
(b) $I = 0$ if $X \| 2j = \infty = \frac{X(2j)}{X+2j}$ 8

$\therefore X = -2j = \frac{-j}{\omega C}$

$\therefore C = \frac{1}{2\omega} = \frac{1}{2k} = 0.5mF$

(c) V_1, I in phase if $X = 0$ 4

(d)



$\frac{X(2j)}{X+2j} = -2j$ 11

$\therefore X = -j$

$\therefore C = 1mF$