DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
HONG KONG UNIVERSITY OF SCIENCE OF TECHNOLOGY

ELEC 101 BASIC ELECTRONICS

TEST 2 TIME: 1835 - 1955 08 November 1999 ANSWER ALL QUESTIONS

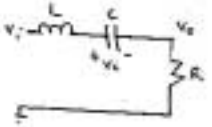
NOTE: Try your best to answer all questions. Write down clearly all work, steps, and formulae to get marks (marking will be based mainly on steps.) Total mark is 160 marks, i.e. 2 marks – 1 min work. So make best use of your time!

Name: **Department:**

Student ID: **Email address:**

Question	Q1	Q2	Q3	Q4	Q5	Total
Mark	(23)	(40)	(29)	(33)	(35)	(160)
		45				165

1. In the series LCR circuit, L = 25mH, C = 10 μF and R = 1 Ω. (a) Find the frequency (in rad/s) of Vi such that (i) Vo = 0, (ii) Vo = Vi. (b) If the circuit is at resonance, find the Q factor. Find Vc if Vi = 1V rms. (c) If L is changed to 50 mF and R to 2 Ω, find the bandwidth. (23)



(a) (i) $V_o = 0$ $\omega = 0$ 3

(ii) $V_o = V_i$ $\omega = \omega_0 = \frac{1}{\sqrt{LC}}$

$= \frac{1}{\sqrt{25m \cdot 10\mu}} = 2k$ rad/s 5

(b) $Q = \frac{\omega_0 L}{R} = \frac{2k(25m)}{1} = 50$ 5

$V_c = 50\ V_{rms}$ 5

(c) $BW = \frac{\omega_0}{Q} = \frac{R}{L} = \frac{2}{50m} = 40$ rad/s 5

Power P = 24.2kW.

2. Three loads A, B and C are connected in parallel to a 220 ∠0° Vrms 50Hz supply. Load A consumes 50 kVAR lagging with power factor (PF) of 0, load B consumes 50 kW at a PF of 0.5 leading, and load C is a 1 Ω resistor in series with a 1/100π H inductor. (a) Find the apparent power, reactive power, average power and PF of the combined load. (b) Find the element and value of load A. (c) Find the source current Is(t) supplied to the combined load. (40)

45

load C : $1 + j\omega L = 1 + j(2\pi 50)\frac{1}{100\pi} = 1 + j$

$\therefore Z = 1 + j = \sqrt{2}\angle 45 \quad \therefore I = \frac{220\angle 0}{\sqrt{2}\angle 45} = \frac{220}{\sqrt{2}}\angle -45\ A_{rms}$

$\therefore P = I^2 R = \left(\frac{220}{\sqrt{2}}\right)^2 = 24.2kW$ 12

$\therefore Q = I^2 X = \left(\frac{220}{\sqrt{2}}\right)^2 = 24.2kVAR$

$\therefore P = 0 + 50kW + 24.2kW = 74.2kW$ 5

$Q = 50k - 50k\tan(\cos^{-1}0.5) + 24.2k$ 7

$= 12.4\ kVar$

$\therefore S = \sqrt{74.2^2 + 12.4^2} = 75.2kVA$ 4

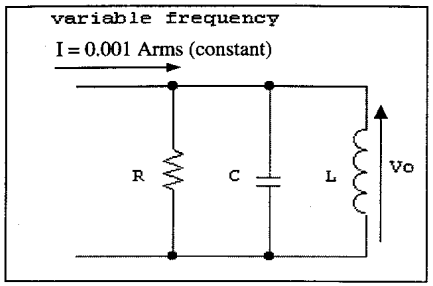
$PF = \frac{P}{S} = \frac{74.2}{75.2} = 0.987$ lagging 5

load A : $50k = \frac{V^2}{\omega L} = \frac{220^2}{2\pi 50 L}$ 6

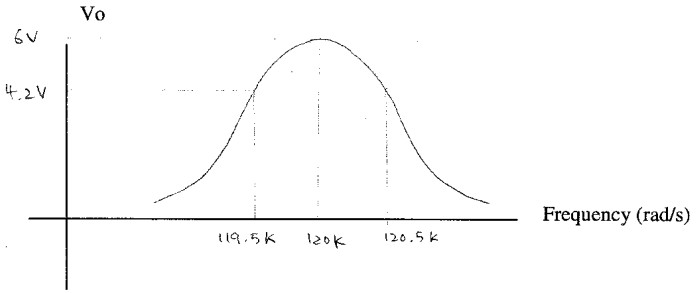
$\therefore L = 3mH$

$I_s(t) = \frac{75.2k}{220}\sqrt{2}\cos(2\pi 50t - \cos^{-1}0.987)\ A$ 6

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)



6

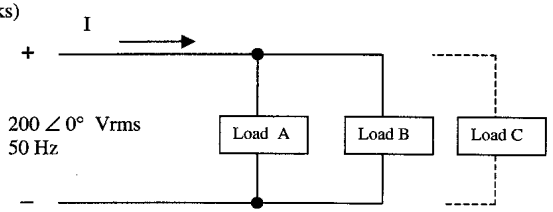
a) $BW = \frac{\omega_o}{Q} = \frac{120K}{120} = 1k \text{ rad/s}$ 4

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)



50 kW
p.f. = 1
L = 2 mH

a) A is R

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

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

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

$= 250 - 318j \text{ Arms}$

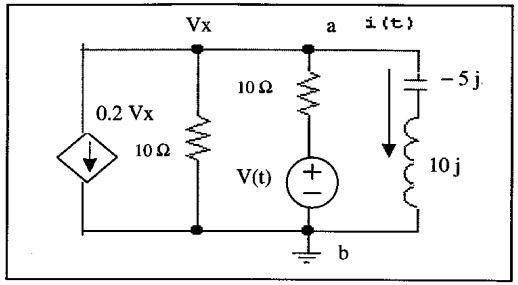
8

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

$= 0.62$ lagging 5

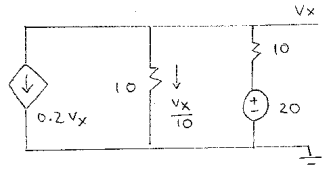
e) $Q_C = -63.7 \text{ kvar}$ 5

6. Given : V(t) = 20 cos ωt 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)

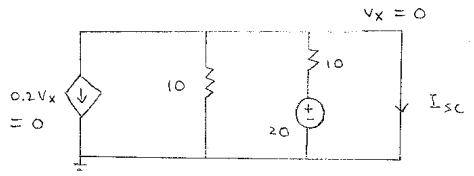


KCL : $\frac{20 - V_x}{10} = \frac{V_x}{10} + 0.2V_x$

$20 - V_x = V_x + 2V_x$

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

b)

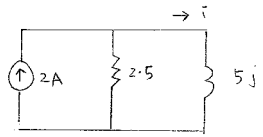


$\therefore I_{sc} = \frac{20}{10} = 2A$ 7

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

$= 2.5\ \Omega$ 2

d)



3

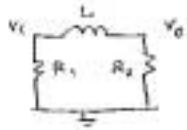
e) $i = 2\ \frac{2.5}{2.5 + 5j}$

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

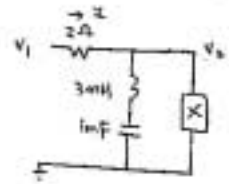
(d) $\theta = \tan^{-1}\omega = 30°$

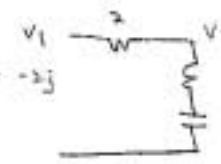
$\omega = \tan 30 = 0.577$ rad/s 6

(e) low pass filter 3

(f) $\omega_c = \frac{R}{L} = \frac{1}{2m} = 500$ 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)





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

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

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

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

$\therefore v_2(t) = \sqrt{2}\cos(1kt - \frac{\pi}{4})$, 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) 

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

$\therefore X = -j$

$\therefore C = 1mF$

End of paper. Good luck. Try the best and very good study!