UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang Akademik 2003/2004

September/Oktober 2003

EEE 208 – TEORI LITAR II

Masa : 3 jam

ARAHAN KEPADA CALON:

Sila pastikan bahawa kertas peperiksaan ini mengandungi **DUABELAS** **(12)** muka surat termasuk 3 Lampiran bercetak dan **ENAM** **(6)** soalan sebelum anda memulakan peperiksaan ini.

Jawab **LIMA** **(5)** soalan.

Agihan markah bagi soalan diberikan disut sebelah kanan soalan berkenaan.

Jawab semua soalan di dalam Bahasa Malaysia.

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1. Bagi litar dalam **Rajah 1**;

*For the circuit in **Figure 1**;*

$R_1 = 6\ \Omega$; $R_2 = 12\ \Omega$; $L_1 = 32$ mH; $L_2 = 48$ mH; $C = 636\ \mu$F

$k = 0.5$; $v(t) = 340\sin(100\pi t + 60°)$ V; $i(t) = 6\sin(100\pi t)$ A.

(a) Dapatkan ungkapan bagi arus $i_1(t)$ dan $i_2(t)$ dalam keadaan mantap;

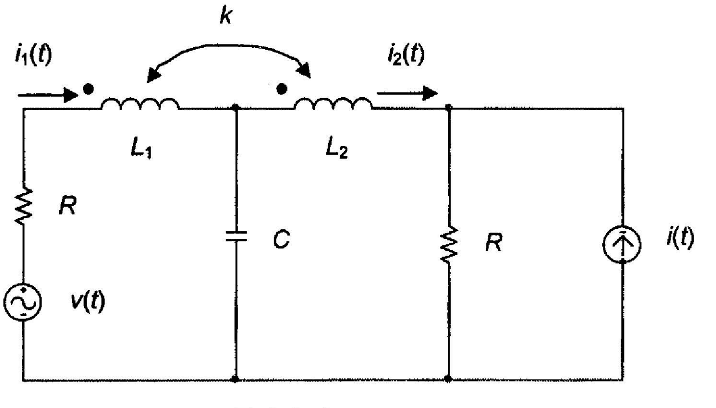
Derive the expressions for the currents $i_1(t)$ and $i_2(t)$ in the steady state condition;

(75%)

(b) Kira jumlah tenaga yang tersimpan dalam induktor terkembar L_1 dan L_2 ketika t = 0.5 ms.

Calculate the total energy stored in the magnetically coupled inductor L_1 dan L_2 when t = 0.5 ms.

(25%)



Rajah 1
Figure 1

2. Sumber arus $i(t)$ dalam **Rajah 2(a)** membekalkan arus seperti dalam **Rajah 2(b)**.
*The current source i(t) in **Figure 2(a)** supplies a current shown in **Figure 2(b)**.*

(a) Berikan ungkapan bagi arus $i(t)$.
Give an expression for the current i(t).

(10%)

(b) Jelmakan fungsi masa $i(t)$ kepada fungsi frekuensi kompleks $I(s)$.
Transform the time domain i(t) into the complex frequency domain I(s).

(10%)

(c) Terbitkan ungkapan bagi $V(s)$ di mana $V(s)$ adalah jelmaan bagi fungsi masa $v(t)$.
Derive an expression for V(s) where V(s) is the transform of the time function v(t).

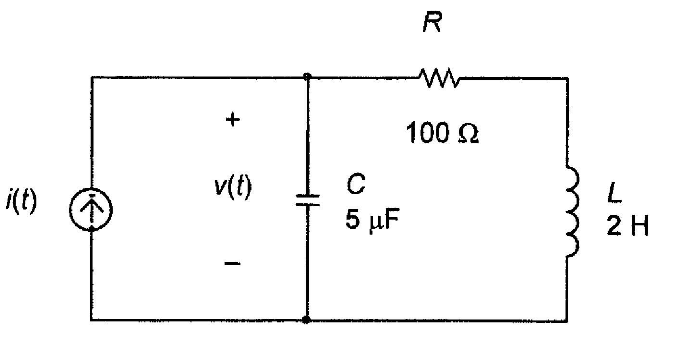
(20%)

(d) Dengan menggunakan Jelmaan songsang Laplace, dapatkan ungkapan bagi $v(t)$.
Use inverse Laplace Transform to obtain the expression for v(t).

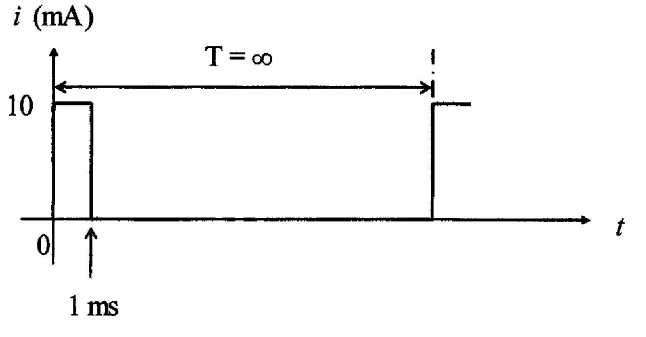
(40%)

(e) Lakarkan graf dan tandakan nilai-nilai penting bagi $v(t)$ yang diperolehi dalam (d) di atas.
Sketch the graph for v(t) obtained in (d) above and label all the critical values

(20%)



Rajah 2(a)
Figure 2(a)



Rajah 2(b)
Figure 2(b)

3. (a) Terbitkan ungkapan siri Fourier bagi arus berbentuk gerigi seperti dalam **Rajah 3(a)**.

*Derive the Fourier series expression for the current shown in **Figure 3(a)**.*

(50%)

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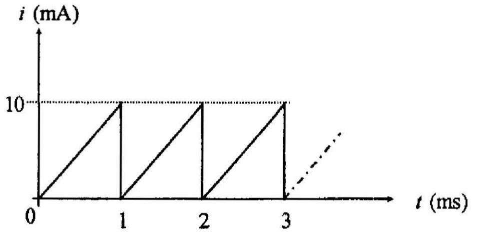
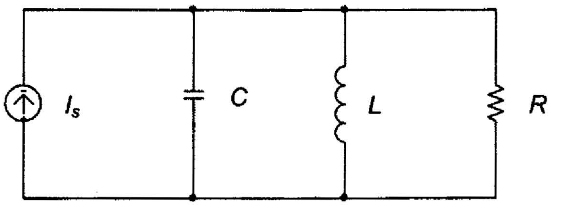
(b) Bagi litar dalam **Rajah 3(b)**; C = 0.5 μF, L = 100 mH dan R = 100 Ω; dan sumber arus I_s membekalkan arus berbentuk seperti yang ditunjukkan dalam **Rajah 3(a)**. Kira berapa jumlah kuasa yang dilesapkan oleh R pada harmonik kedua dan ketiga dalam peratus berbanding kuasa yang dilesapkan pada frekuensi fundamental.

*For the circuit in **Figure 3(b)**; C = 0.5 μF, L = 100 mH and R = 100 Ω; and the current source I_s supplies a current shown in **Figure 3(a)**. Calculate the second and third harmonic power dissipated by R in percentage of the power dissipated at the fundamental frequency.*

(50%)



Rajah 3(a)
Figure 3(a)



Rajah 3(b)
Figure 3(b)

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4. Bagi litar dalam **Rajah 4**;
*For the circuit in **Figure 4**;*

(a) Terbitkan ungkapan bagi fungsi pindah $H(s) = V_o(s)/V_i(s)$;

Derive an expression for the transfer function $H(s) = V_o(s)/V_i(s)$;

(30%)

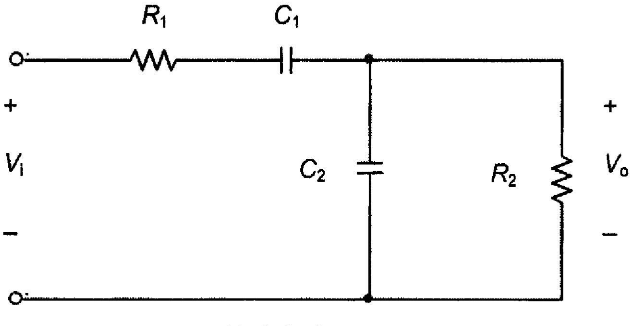
(b) Sekiranya R_1 = 500 Ω, R_2 = 2 kΩ, C_1 = 50 nF dan C_2 = 4.7 nF, lakarkan hampiran garis lurus plot Bode bagi magnitud dan fasa melawan frekuensi dalam Hz dan tandakan nilai-nilai penting;

If R_1 = 500 Ω, R_2 = 2 kΩ, C_1 = 50 nF and C_2 = 4.7 nF, sketch the approximate straight line Bode plot for the magnitude and phase against frequency in Hz and label your plot with critical values;

(60%)

(c) Daripada plot Bode, anggarkan lebar jalur bagi litar dalam Hz.
From the Bode plot, estimate the bandwidth for the circuit in Hz.

(10%)



Rajah 4
Figure 4

5. (a) Cari parameter-parameter z bagi rangkaian dua pengkalan dalam **Rajah 5(a)**.

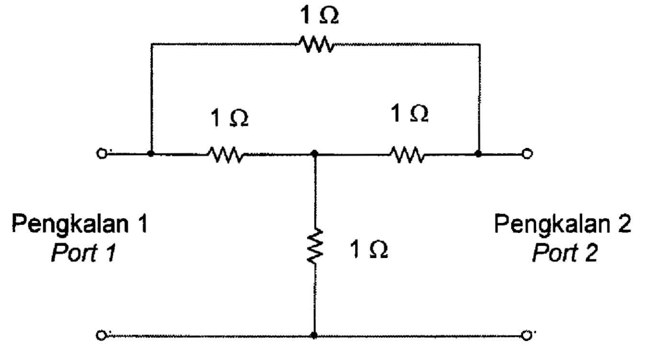
Determine the z parameters for the two-port network in ***Figure 5(a)***.

(50%)

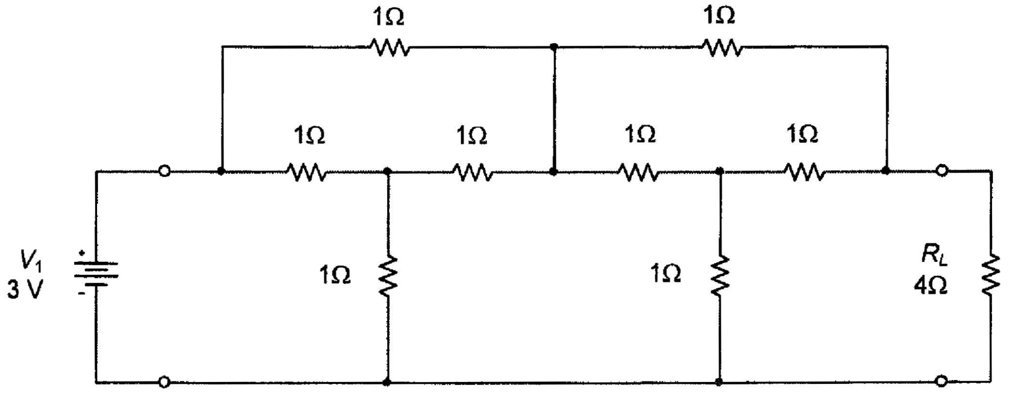
(b) Dengan menggunakan kaedah rangkaian dua pengkalan yang sesuai, cari nisbah kuasa yang terlesap dalam R_L dalam peratus berbanding dengan kuasa yang dibekalkan oleh sumber voltan V_1 dalam **Rajah 5(b)**.

Use a suitable two-port network method to find the ratio in percent, of power dissipated in R_L to total power delivered by the voltage source V_1 in ***Figure 5(b)***.

(50%)



Rajah 5(a)
Figure 5(a)



Rajah 5(b)
Figure 5(b)

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6. Litar sekunder bagi gegelung terkembar dalam **Rajah 6** adalah berlitar buka. Suis S adalah dalam keadaan tertutup sehingga litar mencapai keadaan mantap dan kemudian suis dibuka ketika $t = 0$.

*The secondary circuit of the magnetically-coupled coil in **Figure 6** is open. The circuit is in a steady state condition before the switch S opens at t = 0.*

(a) Jelmakan litar ke dalam domain frekuensi kompleks s, bagi $t \geq 0$.
Transform the circuit into complex frequency domain s for $t \geq 0$.

(10%)

(b) Terbitkan ungkapan bagi $I_1(s)$.
Derive an expression for $I_1(s)$.

(30%)

(c) Terbitkan ungkapan bagi $v_2(t)$.
Derive an expression for $v_2(t)$.

(50%)

(d) Kira nilai $v_2(t)$ apabila t = 157 μs selepas suis dibuka.
Determine the value of $v_2(t)$ *at t = 157 μs after the switch S opens.*

(10%)

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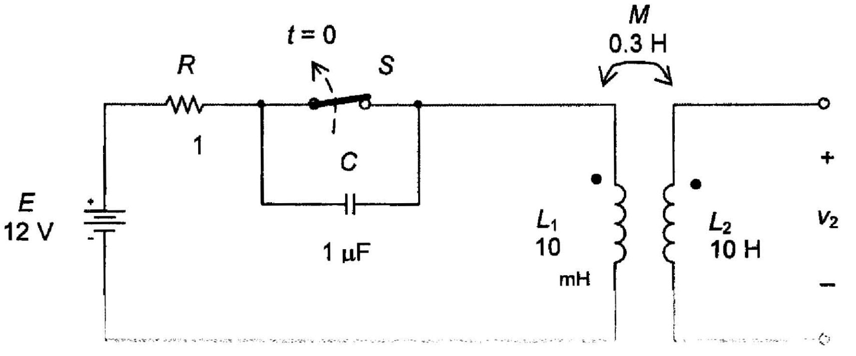

Rajah 6
Figure 6

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TABLE 1: PROPERTIES OF THE LAPLACE TRANSFORM

Property	$f(t)$	$F(s)$
Linearity	$a_1 f_1(t) + a_2 f_2(t)$	$a_1 F_1(s) + a_2 F_2(s)$
Scaling	$f(at)$	$\frac{1}{a} F\left(\frac{s}{a}\right)$
Time shift	$f(t-a)u(t-a)$	$e^{-as} F(s)$
Frequency shift	$e^{-at} f(t)$	$F(s+a)$
Time differentiation	$\frac{df}{dt}$	$sF(s) - f(0^-)$
	$\frac{d^2 f}{dt^2}$	$s^2 F(s) - sf(0^-) - f'(0^-)$
	$\frac{d^3 f}{dt^3}$	$s^3 F(s) - s^2 f(0^-) - sf'(0^-) - f''(0^-)$
	$\frac{d^n f}{dt^n}$	$s^n F(s) - s^{n-1} f(0^-) - s^{n-2} f'(0^-) - \cdots - f^{(n-1)}(0^-)$
Time integration	$\int_0^t f(t)\, dt$	$\frac{1}{s} F(s)$
Frequency differentiation	$tf(t)$	$-\frac{d}{ds} F(s)$
Frequency integration	$\frac{f(t)}{t}$	$\int_s^{\infty} F(s)\, ds$
Time periodicity	$f(t) = f(t+nT)$	$\frac{F_1(s)}{1 - e^{-sT}}$
Initial value	$f(0^+)$	$\lim_{s \to \infty} sF(s)$
Final value	$f(\infty)$	$\lim_{s \to 0} sF(s)$
Convolution	$f_1(t) * f_1(t)$	$F_1(s) F_2(s)$

TABLE 2: LAPLACE TRANSFORM PAIRS

$f(t)$	$F(s)$
$\delta(t)$	1
$u(t)$	$\frac{1}{s}$
e^{-at}	$\frac{1}{s+a}$
t	$\frac{1}{s^2}$
t^n	$\frac{n!}{s^{n+1}}$
te^{-at}	$\frac{1}{(s+a)^2}$
$t^n e^{-at}$	$\frac{n!}{(s+a)^{n+1}}$
$\sin \omega t$	$\frac{\omega}{s^2+\omega^2}$
$\cos \omega t$	$\frac{s}{s^2+\omega^2}$
$\sin(\omega t+\theta)$	$\frac{s\sin\theta+\omega\cos\theta}{s^2+\omega^2}$
$\cos(\omega t+\theta)$	$\frac{s\cos\theta-\omega\sin\theta}{s^2+\omega^2}$
$e^{-at}\sin \omega t$	$\frac{\omega}{(s+a)^2+\omega^2}$
$e^{-at}\cos \omega t$	$\frac{s+a}{(s+a)^2+\omega^2}$

*Defined for $t \geq 0$, $f(t) = 0$ for $t < 0$.

JADUAL PENGUBAHAN PARAMETER-PARAMETER RANGKAIAN DUA PENGKALAN

Two port parameters conversion table

	z		y		h		g		T		t	
z	z_{11}	z_{12}	$\frac{y_{22}}{\Delta_y}$	$-\frac{y_{12}}{\Delta_y}$	$\frac{\Delta_h}{h_{22}}$	$\frac{h_{12}}{h_{22}}$	$\frac{1}{g_{11}}$	$-\frac{g_{12}}{g_{11}}$	$\frac{A}{C}$	$\frac{\Delta_T}{C}$	$\frac{d}{c}$	$\frac{1}{c}$
	z_{21}	z_{22}	$-\frac{y_{21}}{\Delta_y}$	$\frac{y_{11}}{\Delta_y}$	$-\frac{h_{21}}{h_{22}}$	$\frac{1}{h_{22}}$	$\frac{g_{21}}{g_{11}}$	$\frac{\Delta_g}{g_{11}}$	$\frac{1}{C}$	$\frac{D}{C}$	$\frac{\Delta_t}{c}$	$\frac{a}{c}$
y	$\frac{z_{22}}{\Delta_z}$	$-\frac{z_{12}}{\Delta_z}$	y_{11}	y_{12}	$\frac{1}{h_{11}}$	$-\frac{h_{12}}{h_{11}}$	$\frac{\Delta_g}{g_{22}}$	$\frac{g_{12}}{g_{22}}$	$\frac{D}{B}$	$-\frac{\Delta_T}{B}$	$\frac{a}{b}$	$-\frac{1}{b}$
	$-\frac{z_{21}}{\Delta_z}$	$\frac{z_{11}}{\Delta_z}$	y_{21}	y_{22}	$\frac{h_{21}}{h_{11}}$	$\frac{\Delta_h}{h_{11}}$	$-\frac{g_{21}}{g_{22}}$	$\frac{1}{g_{22}}$	$-\frac{1}{B}$	$\frac{A}{B}$	$-\frac{\Delta_t}{b}$	$\frac{d}{b}$
h	$\frac{\Delta_z}{z_{22}}$	$\frac{z_{12}}{z_{22}}$	$\frac{1}{y_{11}}$	$-\frac{y_{12}}{y_{11}}$	h_{11}	h_{12}	$\frac{g_{22}}{\Delta_g}$	$-\frac{g_{12}}{\Delta_g}$	$\frac{B}{D}$	$\frac{\Delta_T}{D}$	$\frac{b}{a}$	$\frac{1}{a}$
	$-\frac{z_{21}}{z_{22}}$	$\frac{1}{z_{22}}$	$\frac{y_{21}}{y_{11}}$	$\frac{\Delta_y}{y_{11}}$	h_{21}	h_{22}	$-\frac{g_{21}}{\Delta_g}$	$\frac{g_{11}}{\Delta_g}$	$-\frac{1}{D}$	$\frac{C}{D}$	$\frac{\Delta_t}{a}$	$\frac{c}{a}$
g	$\frac{1}{z_{11}}$	$-\frac{z_{12}}{z_{11}}$	$\frac{\Delta_y}{y_{22}}$	$\frac{y_{12}}{y_{22}}$	$\frac{h_{22}}{\Delta_h}$	$-\frac{h_{12}}{\Delta_h}$	g_{11}	g_{12}	$\frac{C}{A}$	$-\frac{\Delta_T}{A}$	$\frac{c}{d}$	$-\frac{1}{d}$
	$\frac{z_{21}}{z_{11}}$	$\frac{\Delta_z}{z_{11}}$	$-\frac{y_{21}}{y_{22}}$	$\frac{1}{y_{22}}$	$-\frac{h_{21}}{\Delta_h}$	$\frac{h_{11}}{\Delta_h}$	g_{21}	g_{22}	$\frac{1}{A}$	$\frac{B}{A}$	$\frac{\Delta_t}{d}$	$-\frac{b}{d}$
T	$\frac{z_{11}}{z_{21}}$	$\frac{\Delta_z}{z_{21}}$	$-\frac{y_{22}}{y_{21}}$	$-\frac{1}{y_{21}}$	$-\frac{\Delta_h}{h_{21}}$	$-\frac{h_{11}}{h_{21}}$	$\frac{1}{g_{21}}$	$\frac{g_{22}}{g_{21}}$	A	B	$\frac{d}{\Delta_t}$	$\frac{b}{\Delta_t}$
	$\frac{1}{z_{21}}$	$\frac{z_{22}}{z_{21}}$	$-\frac{\Delta_y}{y_{21}}$	$-\frac{y_{11}}{y_{21}}$	$-\frac{h_{22}}{h_{21}}$	$-\frac{1}{h_{21}}$	$\frac{g_{11}}{g_{21}}$	$\frac{\Delta_g}{g_{21}}$	C	D	$\frac{c}{\Delta_t}$	$\frac{a}{\Delta_t}$
t	$\frac{z_{22}}{z_{12}}$	$\frac{\Delta_z}{z_{12}}$	$-\frac{y_{11}}{y_{12}}$	$-\frac{1}{y_{12}}$	$\frac{1}{h_{12}}$	$\frac{h_{11}}{h_{12}}$	$-\frac{\Delta_g}{g_{12}}$	$-\frac{g_{22}}{g_{12}}$	$\frac{D}{\Delta_T}$	$\frac{B}{\Delta_T}$	a	b
	$\frac{1}{z_{12}}$	$\frac{z_{11}}{z_{12}}$	$-\frac{\Delta_y}{y_{12}}$	$-\frac{y_{22}}{y_{12}}$	$\frac{h_{22}}{h_{12}}$	$\frac{\Delta_h}{h_{12}}$	$-\frac{g_{11}}{g_{12}}$	$-\frac{1}{g_{12}}$	$\frac{C}{\Delta_T}$	$\frac{A}{\Delta_T}$	c	d

$\Delta_z = z_{11}z_{22} - z_{12}z_{21}$, $\Delta_h = h_{11}h_{22} - h_{12}h_{21}$, $\Delta_T = AD - BC$

$\Delta_y = y_{11}y_{22} - y_{12}y_{21}$, $\Delta_g = g_{11}g_{22} - g_{12}g_{21}$, $\Delta_t = ad - bc$