UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 1996/97

April 1997

EEE 126 - Teori Litar

Masa : [3 jam]

ARAHAN KEPADA CALON :

Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEMBILAN** (9) muka surat berserta **DUA** (2) Lampiran bercetak dan **ENAM** (6) soalan sebelum anda memulakan peperiksaan ini.

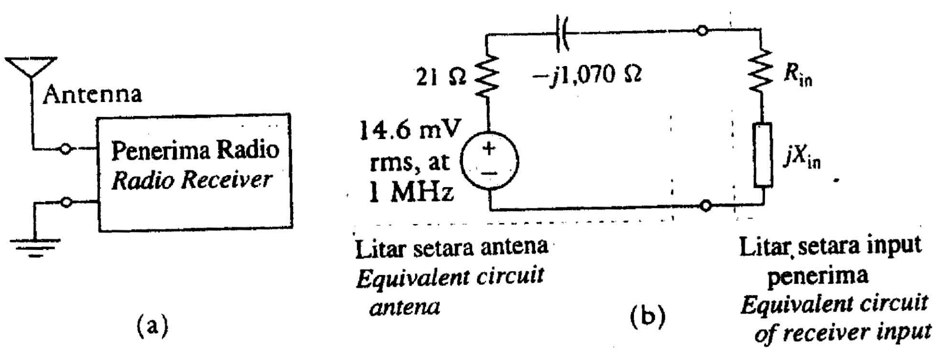
Jawab **LIMA** (5) soalan.

Agihan markah bagi soalan diberikan di sut sebelah kanan soalan berkenaan.

Jawab semua soalan di dalam Bahasa Malaysia.

1. (a) Penerima radio yang ditunjukkan dalam Rajah 1(a) disambung kepada suatu antena. Antena menggalang gelombang elektromagnet daripada stesen penyiaran yang beroperasi pada 1 MHz. Untuk tujuan analisis litar, antena diwakilkan dengan suatu litar setara Thevenin, yang ditunjukkan dalam Rajah 1(a).

The radio receiver shown in Figure 1(a) is connected to an antenna. The antenna intercepts the electromagnetic waves from a broadcast station operating at 1 Mhz. For circuit analysis purposes, the antenna is represented by a Thevenin equivalent circuit, shown in Figure 1(b).



Rajah 1 *(Figure 1)*

(i) Cari impedans input $R_{in} + jX_{in}$ penerima jika kuasa maksimum akan dipindahkan dari antena ke penerima.

Find the input impedance $R_{in} + jX_{in}$ of the receiver if maximum power is to be transferred from the antenna to the receiver.

(25%)

(ii) Di bawah keadaan (i), cari magnitud voltan melintangi terminal-terminal penerima dan kuasa purata yang dipersembahkan ke penerima.

Under the condition of (i), find the magnitude of the voltage across the receiver terminals and the average power delivered to the receiver.

(25%)

...3/-

(b) Suatu kerintangan beban R_L = 100 kΩ, mewakili kerintangan input suatu amplifier disambung ke sumber bagi soalan 1(a) melalui rangkaian pengganding tanpa rugi, iaitu, rangkaian yang tidak mengguna atau menjana kuasa purata.

A fixed load resistance R_L = 100 kΩ, representing the input resistance of an amplifier, is connected to the source of question 1(a) through a lossless coupling network, i.e., a network that does not consume or generate average power.

(i) Tunjukkan bahawa voltan maksimum dibolehkan wujud melintangi R_L dalam Rajah 2 ialah 0.504V.

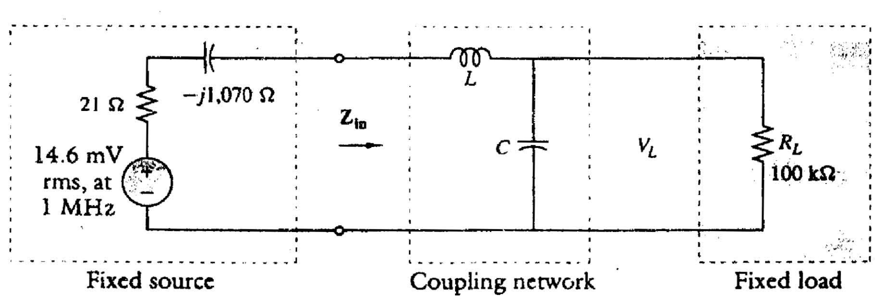
Show that the maximum possible voltage that can be developed across R_L in Figure 2 is 0.504 V.

(25%)

(ii) Tunjukkan bahawa dengan L = 400.9 µH dan C = 109.8 pF, rangkaian pengganding Rajah 2 mencapai voltan maksimum ini melintangi R_L.

Show that with L = 400.9 µH and C = 109.8 pF, the coupling network of Figure 2 achieves this maximum voltage across R_L.

(25%)

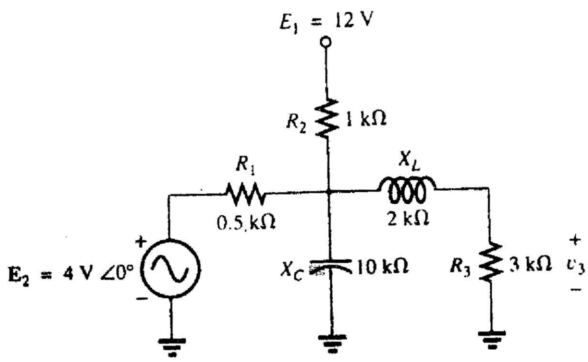


Rajah 2 *(Figure 2)*

2. (a) Untuk rangkaian dalam Rajah 3, tentukan ungkapan sinus untuk voltan v_3, dengan menggunakan tindihan.

For the network of Figure 3, determine the sinusoidal expression for the voltage v_3 using superposition.

(50%)

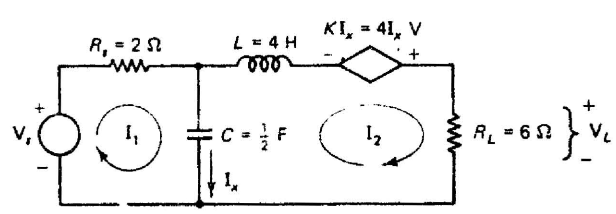


Rajah 3 *(Figure 3)*

(b) Tentukan fungsi pindah V_L/V_s bagi rangkaian yang tertera dalam Rajah 4. Nilaikan voltan output untuk kes-kes berikut: V_s ialah sumber voltan sinus dengan amplitud 100V dan frekuensi sudut: (i) 0.2 r/s (ii) 2 r/s (iii) 20 r/s.

Determine the transfer function V_L/V_s of the network shown in Figure 4. Evaluate the output voltage for the following cases: V_s is a sinusoidal voltage source of 100 V amplitude and angular frequency: (i) 0.2 r/s (ii) 2 r/s (iii) 20 r/s.

(50%)



Rajah 4 *(Figure 4)*

...5/-

3. Misalkan $i_s(t)$ diberi oleh

Let $i_s(t)$ be given by

$$i_s(t) = 0.225 + 0.409 \cos(2\pi \times 10^3 t) + 0.300 \cos(4\pi \times 10^3 t) + 0.159 \cos(6\pi \times 10^3 t) \text{mA}$$

Arus i_s ialah input ke litar tertala yang tertera dalam Rajah 5.

The current i_s is the input to a tuned circuit, as shown in Figure 5.

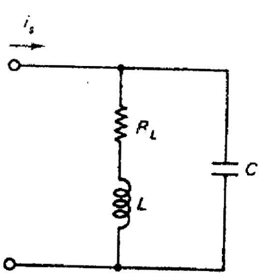
(a) Jika L = 400 mH dan R_L = 250Ω, tentukan nilai C supaya litar beresonansi 1 kHz.

If L = 400 mH and R_L = 250Ω, determine the value of C so that the circuit resonates at 1 kHz.

(40%)

(b) Dapatkan ungkapan untuk voltan output $v_o(t)$ bagi litar. Bandingkan amplitud komponen-komponen pada dc, 2 kHz dan 3 kHz dengan komponen pada 1 kHz bagi output.

Obtain the expression for the output voltage $v_o(t)$ of the circuit. Compare the amplitudes of the components at dc, 2 kHz and 3 kHz with respect to that at 1 kHz in the output.



Rajah 5 *(Figure 5)*

(60%)

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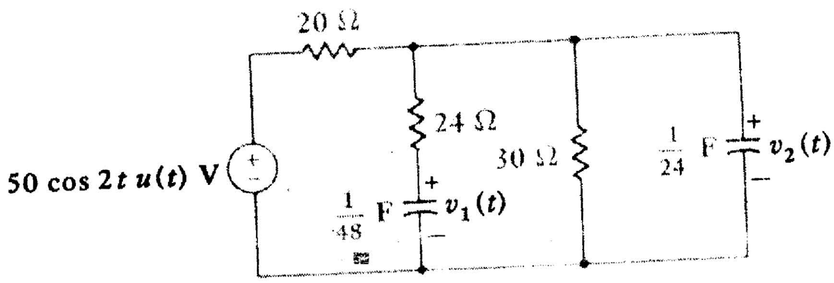
4. (a) Litar ditunjukkan dalam Rajah 6. Biarkan $v_1(0^-) = 10V$ dan $v_2(0^-) = 25V$, dan tentukan $v_2(t)$ dengan menggunakan teknik-teknik jelmaan Laplace.

The circuit is shown in Figure 6. Let $v_1(0^-) = 10V$ and $v_2(0^-) = 25V$, and determine $v_2(t)$ by using Laplace transform techniques.

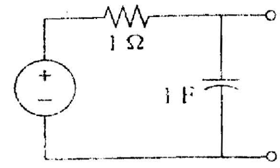


Rajah 6 *(Figure 6)*

(50%)

(b) Pertimbangkan litar RC bersiri dalam Rajah 7, yang sambutan dedenyutnya ialah $h(t) = e^{-t}u(t)$. Andaikan di sini bahawa pengujaan input ialah $v_{in}(t) = e^{-a|t|}$, di mana $a \neq 1$ dan $a > 0$. Tentukan sambutan $v_{out}(t)$ untuk semua t.

Consider the series RC circuit of Figure 7, whose impulse response is $h(t) = e^{-t}u(t)$. Suppose here that the input excitation is $v_{in}(t) = e^{-a|t|}$, where $a \neq 1$ and $a > 0$. Determine the response $v_{out}(t)$ for all t.



Rajah 7 *(Figure 7)*

(50%)

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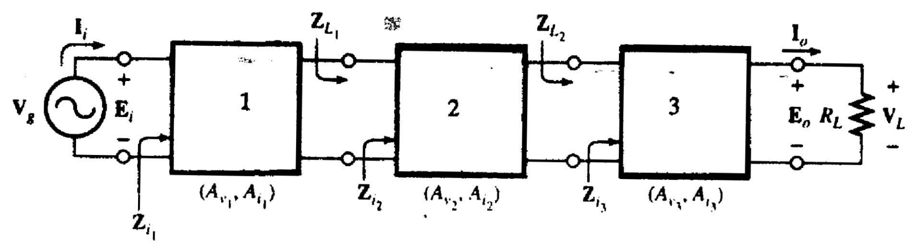
5. (a) Untuk sistem dua-port dalam kaskad, seperti dalam Rajah 8, parameter terminal terpenting (A_v, A_i, Z_i and Z_o) dipengaruhi oleh pembebanan satu tahap ke tahap lain. Jika kita takrifkan (A_v, A_i, Z_i and Z_o) untuk aras-aras untung dan impedans di bawah keadaan berbeban maka

For two-port systems in cascade, as shown in Figure 8, the important terminal parameters (A_v, A_i, Z_i and Z_o) are affected by the loading of one stage on another. For the input impedance to the third stage is the load impedance for the second stage, and so on. If we define A_v, A_i, Z_i and Z_o to the levels of gain and impedance under loaded condition



Rajah 8 *(Figure 8)*

(i) Cari untung voltan total

Find the total voltage gain

(ii) Tentukan untung arus total

Determine the total current gain

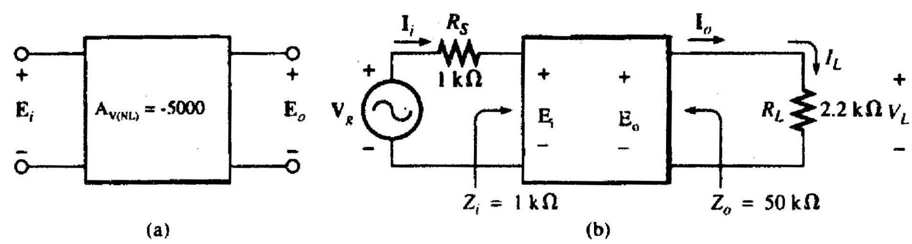
(iii) Tentukan magnitud voltan beban

Determine the magnitude of the load voltage

(50%)

(b) Jika sistem dua-port Rajah 9(a) digunakan dengan impedans sumber dan bebannya seperti dalam Rajah 9(b), tentukan

If the two-port system of Figure 9(a) is employed with the source and load impedance of Figure 9(b) , determine:



Rajah 9 *(Figure 9)*

(i) Untung voltan $A_v = E_o / E_i$

The voltage gain $A_v = E_o / E_i$

(ii) Untung voltan total $A_{v_T} = V_L / V_g$

The total voltage gain $A_{v_T} = V_L / V_g$

(iii) Untung arus total $A_{i_T} = I_o / I_i$

The total current gain $A_{i_T} = I_o / I_i$

(50%)

6. (a) Anda dikehendaki membinakan suatu rangkaian bagi merealisasikan impedans pindah keseluruhan $Z_{21} = V_2 / I_1$ bagi rangkaian dua-port seperti di dalam Rajah 10.

You are required to build a network for realization of overall transfer impedance $Z_{21} = V_2 / I_1$ *of a two-port network shown in Figure 10.*

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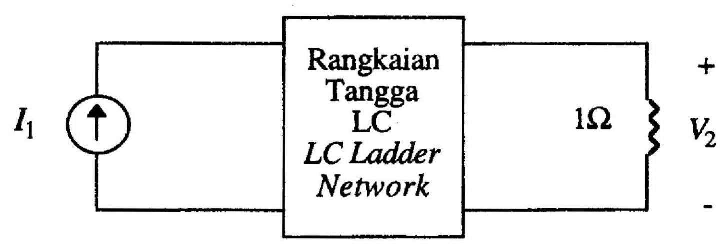

Rajah 10 *(Figure 10)*

Terangkan bagaimanakah realisasi ini dapat dicapai?

Explain how this realization can be accomplished?

(30%)

(b) Berdasarkan kaedah yang anda cadangkan di dalam Rajah 10 di atas sintesiskan rangkaian penuras yang berbentuk seperti di dalam Rajah 10 supaya

Based on the method that you have proposed in Figure 10 above, synthesize a filter network of the form shown in Figure 10 such that

$$Z_{21}(s) = \frac{1}{s^3 + 2s^2 + 2s + 1}$$

(40%)

(c) Daripada sintesis di atas anda mendapat suatu prototaip penuras laluan-rendah tertib ketiga. Jelmakannya kepada suatu penuras laluan-tinggi agar mempunyai frekuensi setengah kuasa sama dengan 1 MHz.

From the above synthesis you have obtained a prototype of a third order low-pass filter. Transform it into a high-pass filter with half-power frequency equal to 1 MHz.

(30%)

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APPENDIX (LAMPIRAN)

Jadual Jelmaan Laplace

Laplace Transform Techniques

$f(t) = \mathcal{L}^{-1}\{\mathbf{F(s)}\}$	$\mathbf{F(s)} = \mathcal{L}\{f(t)\}$
$\delta(t)$	1
$u(t)$	$\dfrac{1}{\mathbf{s}}$
$tu(t)$	$\dfrac{1}{\mathbf{s}^2}$
$\dfrac{t^{n-1}}{(n-1)!}u(t),\ n = 1, 2, \ldots$	$\dfrac{1}{\mathbf{s}^n}$
$e^{-\alpha t}u(t)$	$\dfrac{1}{\mathbf{s}+\alpha}$
$te^{-\alpha t}u(t)$	$\dfrac{1}{(\mathbf{s}+\alpha)^2}$
$\dfrac{t^{n-1}}{(n-1)!}e^{-\alpha t}u(t),\ n = 1, 2,$	$\dfrac{1}{(\mathbf{s}+\alpha)^n}$
$\dfrac{1}{\beta-\alpha}(e^{-\alpha t} - e^{-\beta t})u(t)$	$\dfrac{1}{(\mathbf{s}+\alpha)(\mathbf{s}+\beta)}$
$\sin \omega t\ u(t)$	$\dfrac{\omega}{\mathbf{s}^2+\omega^2}$
$\cos \omega t\ u(t)$	$\dfrac{\mathbf{s}}{\mathbf{s}^2+\omega^2}$
$\sin(\omega t + \theta)u(t)$	$\dfrac{\mathbf{s}\sin\theta + \omega\cos\theta}{\mathbf{s}^2+\omega^2}$
$\cos(\omega t + \theta)u(t)$	$\dfrac{\mathbf{s}\cos\theta - \omega\sin\theta}{\mathbf{s}^2+\omega^2}$
$e^{-\alpha t}\sin \omega t\ u(t)$	$\dfrac{\omega}{(\mathbf{s}+\alpha)^2+\omega^2}$
$e^{-\alpha t}\cos \omega t\ u(t)$	$\dfrac{\mathbf{s}+\alpha}{(\mathbf{s}+\alpha)^2+\omega^2}$

Operation	$f(t)$	$\mathbf{F}(\mathbf{s})$
Addition	$f_1(t) \pm f_2(t)$	$\mathbf{F}_1(\mathbf{s}) \pm \mathbf{F}_2(\mathbf{s})$
Scalar multiplication	$kf(t)$	$k\mathbf{F}(\mathbf{s})$
Time differentiation	$\frac{df}{dt}$	$\mathbf{sF}(\mathbf{s}) - f(0^-)$
	$\frac{d^2f}{dt^2}$	$\mathbf{s}^2\mathbf{F}(\mathbf{s}) - \mathbf{s}f(0^-) - f'(0^-)$
	$\frac{d^3f}{dt^3}$	$\mathbf{s}^3\mathbf{F}(\mathbf{s}) - \mathbf{s}^2f(0^-) - \mathbf{s}f'(0^-) - f''(0^-)$
Time integration	$\int_0^t f(t)\,dt$	$\frac{1}{\mathbf{s}}\mathbf{F}(\mathbf{s})$
	$\int_{-\infty}^t f(t)\,dt$	$\frac{1}{\mathbf{s}}\mathbf{F}(\mathbf{s}) + \frac{1}{\mathbf{s}}\int_{-\infty}^0 f(t)\,dt$
Convolution	$f_1(t) * f_2(t)$	$\mathbf{F}_1(\mathbf{s})\mathbf{F}_2(\mathbf{s})$
Time shift	$f(t-a)u(t-a)$, $a \geq 0$	$e^{-a\mathbf{s}}\mathbf{F}(\mathbf{s})$
Frequency shift	$f(t)e^{-at}$	$\mathbf{F}(\mathbf{s}+a)$
Frequency differentiation	$-tf(t)$	$\frac{d\mathbf{F}(\mathbf{s})}{d\mathbf{s}}$
Frequency integration	$\frac{f(t)}{t}$	$\int_{\mathbf{s}}^{\infty}\mathbf{F}(\mathbf{s})\,d\mathbf{s}$
Scaling	$f(at)$, $a \geq 0$	$\frac{1}{a}\mathbf{F}\left(\frac{\mathbf{s}}{a}\right)$
Initial value	$f(0^+)$	$\lim_{\mathbf{s}\to\infty}\mathbf{sF}(\mathbf{s})$
Final value	$f(\infty)$	$\lim_{\mathbf{s}\to 0}\mathbf{sF}(\mathbf{s})$, all poles of $\mathbf{sF}(\mathbf{s})$ in LHP
Time periodicity	$f(t) = f(t+nT)$, $n = 1, 2, \ldots$	$\frac{1}{1-e^{-T\mathbf{s}}}\mathbf{F}_1(\mathbf{s})$, where $\mathbf{F}_1(\mathbf{s}) = \int_0^T f(t)e^{-\mathbf{s}t}\,dt$