ANGKA GILIRAN:

UNIVERSITI SAINS MALAYSIA

First Semester Examination
2016/2017 Academic Session

December 2016 / January 2017

# EEE 208 – CIRCUIT THEORY II
# [TEORI LITAR II]

Duration 3 hours
*[Masa : 3 jam]*

Please check that this examination paper consists of **NINETEEN (19)** pages and Appendices **EIGHT (8)** pages of printed material before you begin the examination. This examination paper consist of two versions, The English version and Malay version. The English version from page **TWO (2)** to page **TEN (10)** and Malay version from page **ELEVEN (11)** to page **NINETEEN (19).**

*Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEMBILAN BELAS (19)** muka surat dan Lampiran **LAPAN (8)** muka surat bercetak sebelum anda memulakan peperiksaan ini. Kertas peperiksaan ini mengandungi dua versi, versi Bahasa Inggeris dan Bahasa Melayu. Versi Bahasa Inggeris daripada muka surat **DUA (2)** sehingga muka surat **SEPULUH (10)** dan versi Bahasa Melayu daripada muka surat **SEBELAS (11)** sehingga muka surat **SEMBILAN BELAS (19)**.*

**Instructions:** This question paper consists **FIVE (5)** questions. Answer **ALL** questions. All questions carry the same marks.
*[**Arahan:** Kertas soalan ini mengandungi **LIMA (5)** soalan. Jawab **SEMUA** soalan. Semua soalan membawa jumlah markah yang sama]*

Use separate answer booklets for **PART A** and **PART B**
*[Gunakan dua buku jawapan yang berasingan bagi **BAHAGIAN A** dan **BAHAGIAN B**]*

**"In the event of any discrepancies, the English version shall be used".**
***[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai]***

**You are not allowed to bring this question paper out of the examination hall.**
***[Anda tidak dibenarkan untuk membawa kertas soalan ini keluar dari dewan peperiksaan]***

**ENGLISH VERSION**
**PART A**

1. (a) For the circuit given in Figure 1.1, find $v_{out}(t)$. Note that $k$ is the coefficient of coupling.

(40 marks)

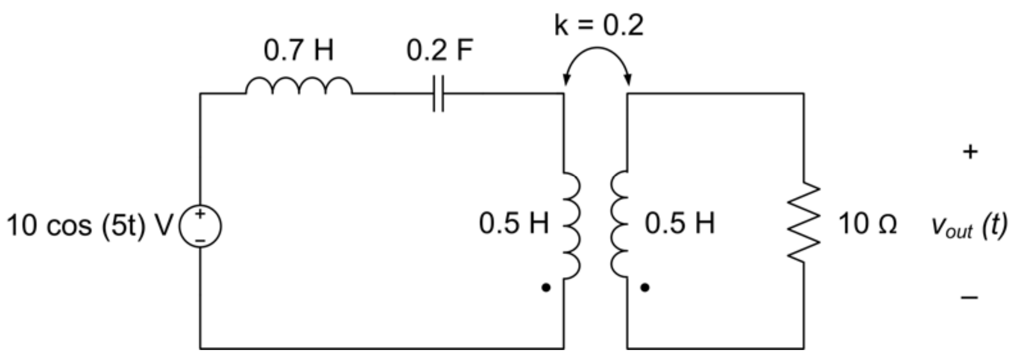


Figure 1.1

(b) For the circuit given in Figure 1.2, find $I_{out}$. All the values given are in the phasor domain.

(40 marks)

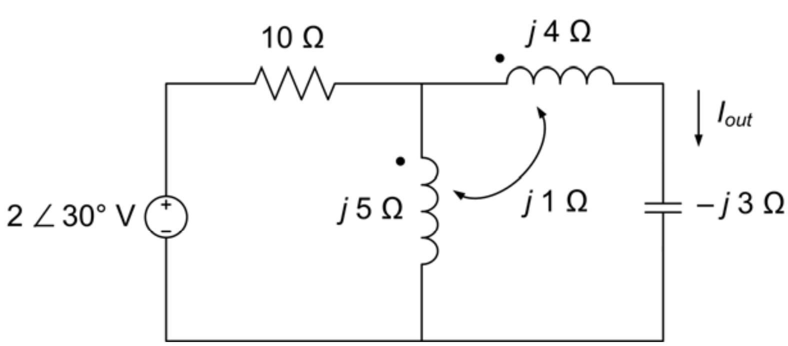


Figure 1.2

(c) For the circuit given in Figure 1.3, find the value of the turns ratio, *n*, that will result in maximum power delivered to the 112.5 Ω resistor.

(20 marks)

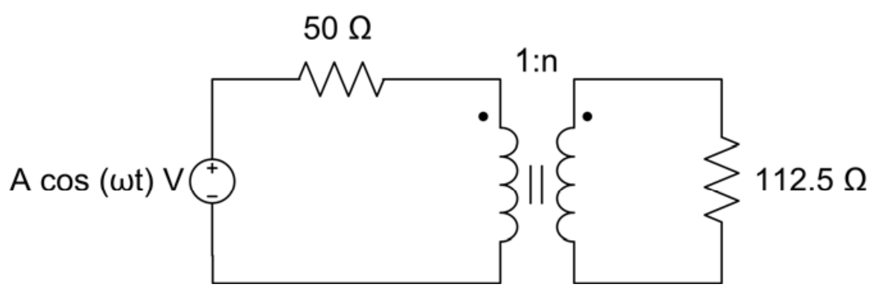


Figure 1.3

2. (a) For the circuit given in Figure 2.1, find $v_{out}(t)$. (70 marks)

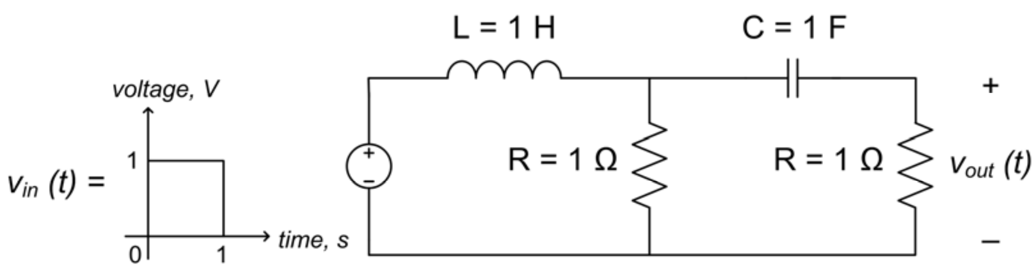


Figure 2.1

(b) Determine the output of the convolution between the two functions shown in Figure 2.2. Sketch the output.

(30 marks)

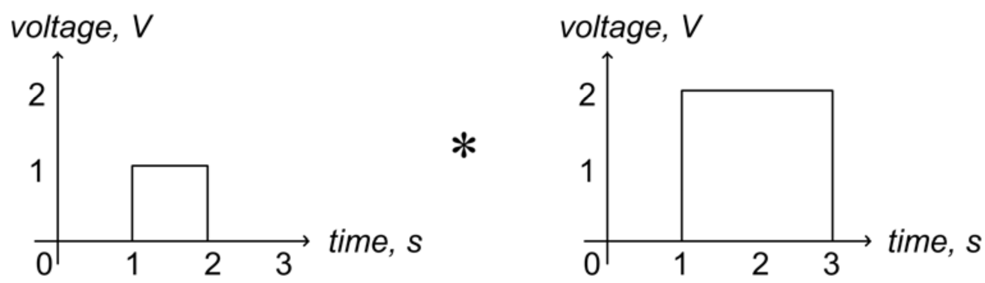


Figure 2.2

3. (a) Design a parallel RLC circuit with a resonant frequency of 50 rad/s and a bandwidth of 10 rad/s. Use R = 10 ohm. Draw the circuit.

(25 marks)

(b) For the circuit given in Figure 3.1, determine if it implements a lowpass, highpass, bandpass or bandstop filter. Show your work.

(25 marks)

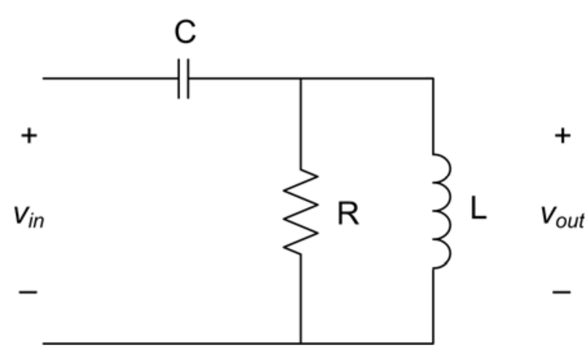


Figure 3.1

**PART B**

(c) A passive T-pad Attenuator system comprises of several subsystems as shown in Figure 3.0. Use the data given for each subsystem to answer the following questions. Present your methods and answers **CLEARLY** and **NEATLY**.

Parameters for all subsystems:

(*Refer to Figure 3.1)*

Using the reference given in Appendix section;

(i) ***Convert*** each subsystem in Figure 3.0 into suitable Network Parameter representation suitable for the following cascade topology.

(ii) ***Determine*** the overall Network Parameters using suitable cascade topology parameter.

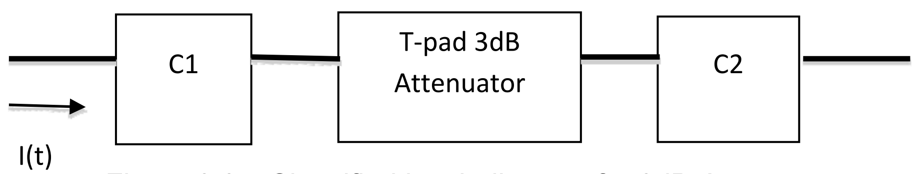


Figure 3.0 – Simplified block diagram for 3dB-Attenuator system

(50 marks)

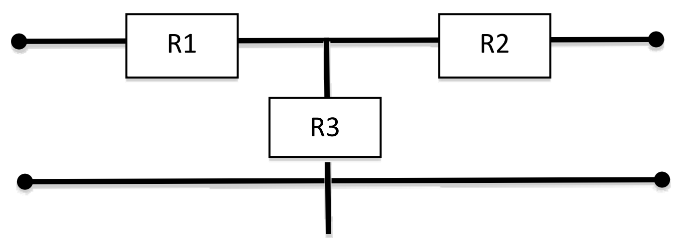


Figure 3.1 – Two-port Passive T-pad Attenuator ($A_{T\_3dB}$)

4. Read the following instruction carefully. Present **NEATLY** and **CLEARLY** your methods and solutions. Maximum frequency range is ±15π. At all time, t is in seconds, and voltage, $V_i$ in volts.

(a) You are provided with several input signal in Table 4.0.

(i) What name is given to set of conditions that MUST be met by all signals before applying Fourier analysis

(ii) In Table 4.0, ***choose and state*** an input signal that *correctly* describes the condition.

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(iii) ***Verify*** your answer by providing short reasonable explanations on decisions to *reject* other signals.

(30 marks)

(b) ***Present*** a complete worked solution with a FINAL Fourier expression containing the dc, sine and cosine components, for the input signal $V_i(t)$ using trigonometric Fourier series .

(40 marks)

(c) ***Convert*** the following trigonometric Fourier representation in Question 4(b) to complex exponential Fourier series representation. ***Draw*** the amplitude spectrum for n=-5 to 5

(30 marks)

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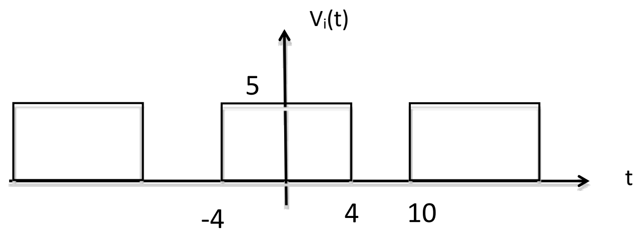
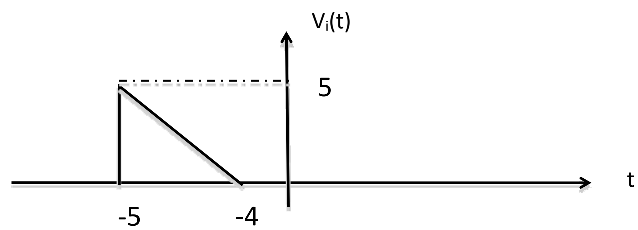
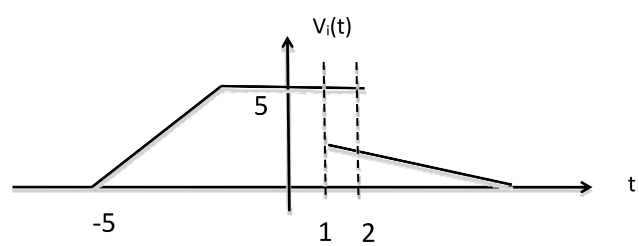
Table 4.0

| **Input Signal, $V_i(t)$** | **Illustration for $V_i(t)$** |
|---|---|
| Signal A |   |
| Signal B |   |
| Signal C |   |

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5. An aperiodic-continuous signal source is passed into a system that behaves as a low pass filter. The system is represented in a system flow chart shown in Figure 5.0. In this question, you are required to investigate the effect on a signal source as it passes through a low pass filter. The filter is shown in Figure 5.2. Answer all questions and present your methods and answers **CLEARLY** and **NEATLY** on the answer booklet. Maximum limit for the spectrum range is ±1000 rad/s.

(a) The aperiodic-continuous input source, $V_s(t)$, has the following description given below: $V_s(t) = 0$ for $t < -1$ s and $t > 1$ s; and $V_s(t) = 10$ V for $-1 \le t \le 1$ s. ***Sketch*** the ideal input signal.

(10 marks)

(b) The Low Pass Filter is required to filter out specific frequency ranges. The circuit in Figure 5.2 is used to perform the low pass filtering process. Assuming the transfer function $|H(j\omega)|$ is ideal and all elements are not influenced by frequency change, ***propose*** a value if $|\omega_c|$=400 rad/s.

(i) Capacitor C, and;

(ii) Transfer function $|H(j\omega)|$ at $|\omega_c|$.

(30 marks)

(c) Using answers in Question 5(a) and 5(b), the output of the system $Y(j\omega)$ can be determined.

(i) ***Present*** the overall equation, and;

(ii) ***Sketch*** of the output continues spectrum $Y(j\omega)$.

(60 marks)

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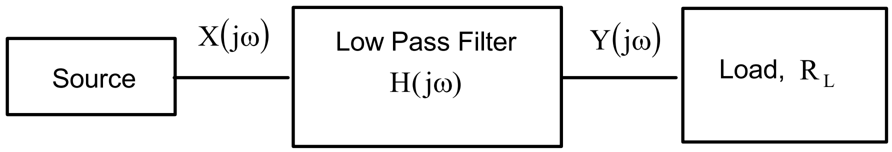


Figure 5.0 : System flow chart

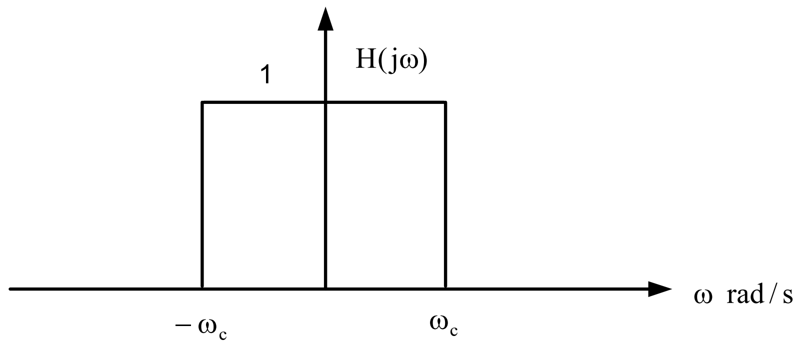


Figure 5.1 – H(jω) Transfer function

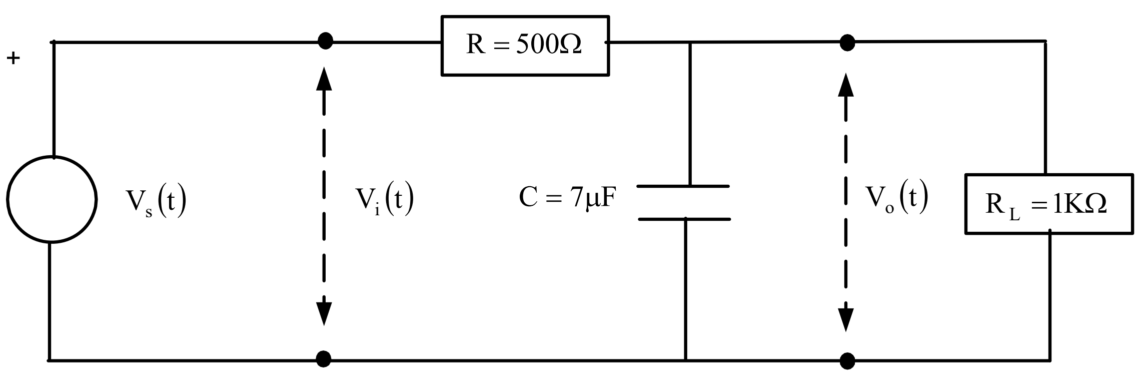


Figure 5.23 : First order low pass filter circuit

Note:

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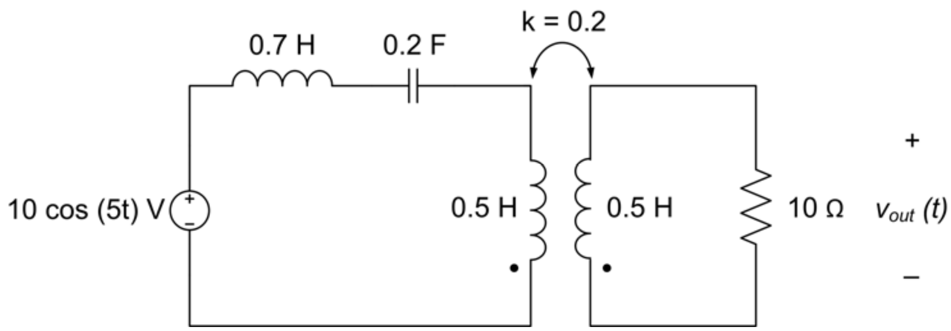
**VERSI BAHASA MALAYSIA**
**BAHAGIAN A**

1. (a) Bagi litar yang diberi dalam Rajah 1.1, cari nilai $v_{out}(t)$. Nota: $k$ ialah pekali gandingan.

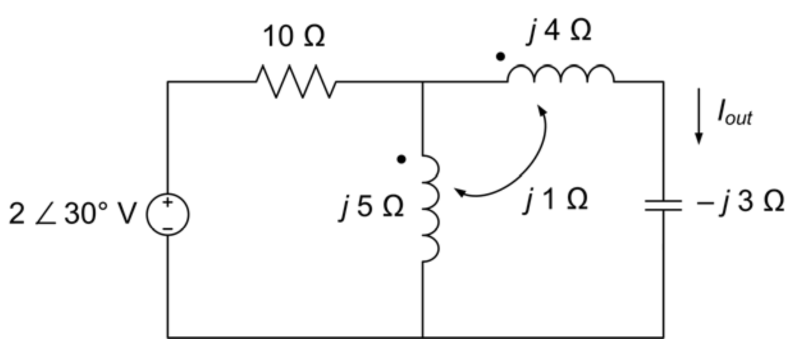
(40 markah)




Rajah 1.1

(b) Bagi litar yang diberi dalam Rajah 1.2, cari nilai $I_{out}$. Semua nilai yang diberi adalah dalam domain pemfasa.

(40 markah)




Rajah 1.2

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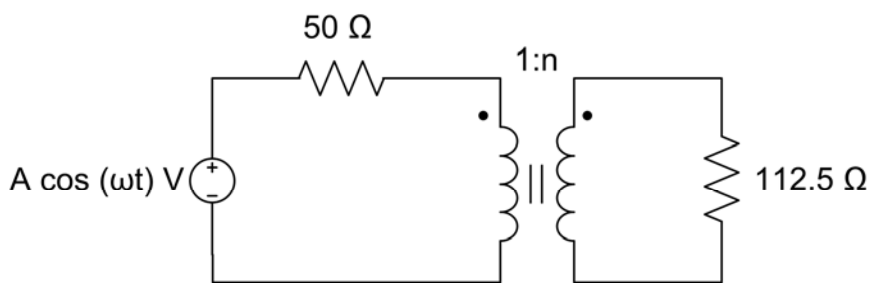
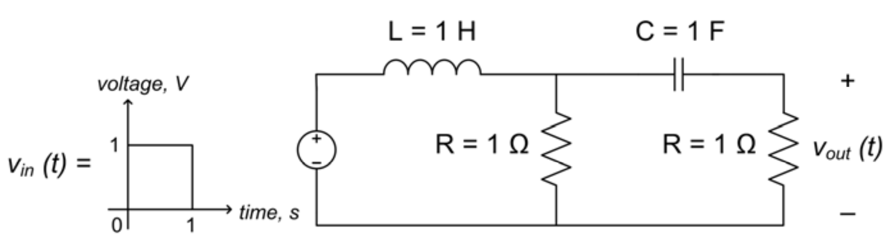
(c) Bagi litar yang diberi dalam Rajah 1.3, cari nilai nisbah lilitan, n, yang akan menghasilkan jumlah kuasa hantaran yang maksimum kepada perintang 112.5 Ω.

(20 markah)




Rajah 1.3

2. (a) Bagi litar yang diberi dalam Rajah 2.1, cari nilai $v_{out}(t)$. (70 markah)




Rajah 2.1

(b) Tentukan keluaran antara dua fungsi yang ditunjukkan dalam Rajah 2.2. Lakarkan keluaran tersebut.

(30 markah)

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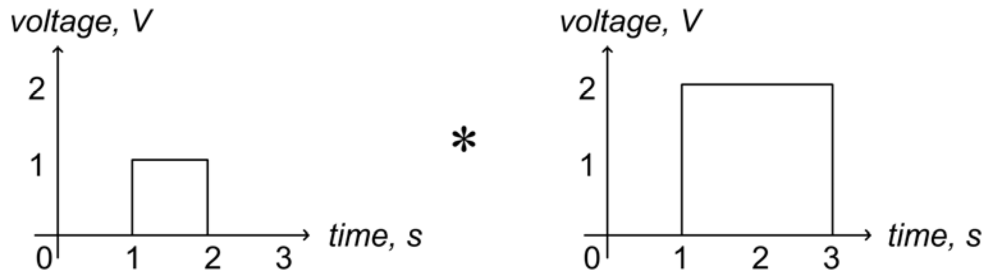


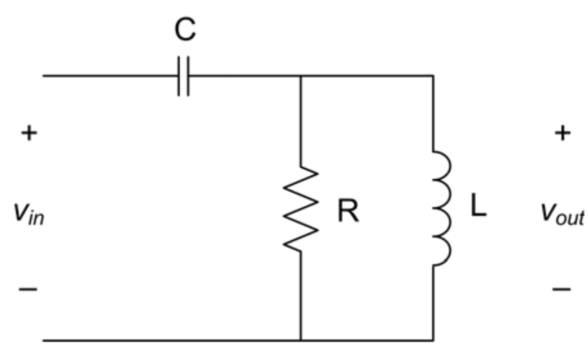

Rajah 2.2

3. (a) Reka sebuah litar selari RLC dengan frekuensi resonan sebanyak 50 rad/s dan lebar jalur sebanyak 10 rad/s. Gunakan R = 10 ohm. Lukis litar tersebut.

(25 markah)

(b) Bagi litar yang diberi dalam Rajah 3.1, tentukan sama ada litar itu mengimplimentasikan penuras laluan rendah, laluan tinggi, lintasan jalur atau batasan jalur. Tunjukkan jalan kerja anda.

(25 markah)




Rajah 3.1

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## BAHAGIAN B

(c) Sebuah sistem T-pad Pelemah pasif terdiri dari beberapa subsistem seperti di Rajah 3.0. Gunakan data-data untuk setiap subsistem untuk menjawab soalan berikut. Bentangkan kaedah-kaedah berserta jawapan-jawapan dengan JELAS dan KEMAS.

Parameter untuk semua subsistem:

*(Rujuk Rajah 3.1)*

Dengan menggunakan rujukan di seksyen Appendik:

(i) **Tukar** informasi di Rajah 3.0 dengan Rangkaian Parameter bersesuaian dengan topologi lata yang dipaparkan.

(ii) **Dapatkan** keseluruhan Rangkaian Parameter berdasarkan jawapan yang sepadan dengan rangkaian topologi.

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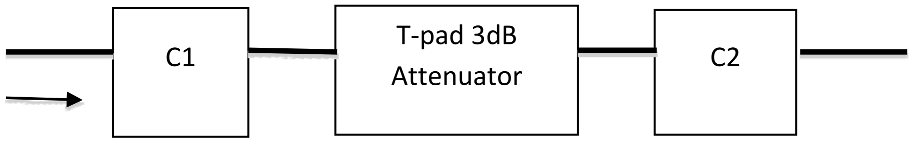
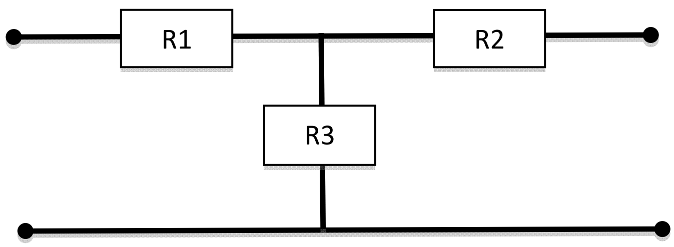



Rajah 3.0 – Gambarajah blok ringkas untuk sistem 3dB Attenuator

(50 markah)




Rajah 3.1 – Attenuator T-pad Dua-port Pasif ($A_{T\_3dB}$)

4. Baca arahan dengan teliti. Tunjukkan dengan **KEMAS** dan **JELAS** kaedah-kaedah dan jalan penyelesaian. Had maksima julat frekuasi adalah ±15π. Semua nilai masa, t adalah saat, dan voltan , $V_i$ sebagai volts.

(a) Anda diberikan beberapa isyarat masukan beserta penerangan di Jadual 4.0.

(i) Apakah nama yang diberikan untuk kondisi yang MESTI dipatuhi setiap isyarat sebelum menggunakan analisis Fourier

(ii) Pada Jadual 4.0, **pilih dan nyatakan** isyarat masukan yang menggambarkan kondisi tersebut dengan betul.

(iii) **Dapatkan** pengesahan jawapan dengan penerangan ringkas yang sesuai dalam mencapai keputusan untuk *menolak* pemilihan isyarat yang lain.

(30 markah)

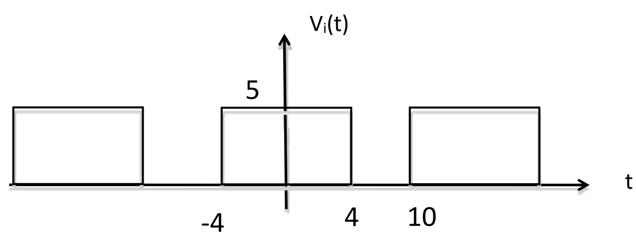
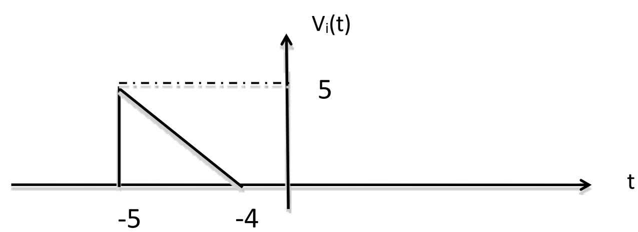
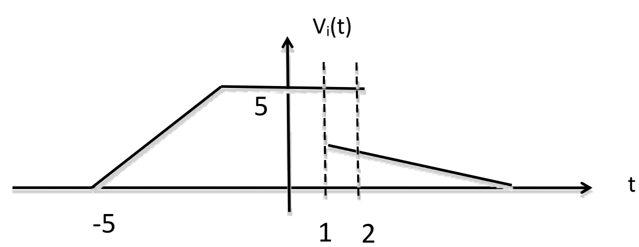
(b) **Tunjukkan** hasil penyelesaian kerja yang lengkap beserta ungkapan TERAKHIR Fourier bersama dc, sine dan kosine, untuk isyarat masukan $V_i(t)$ dengan jujukan Fourier trigonometri.

(40 markah)

(c) **Alihkan** ungkapan trigonometri Fourier di Soalan 4(b) kepada ungkapan exponent Fourier kompleks. **Lakarkan** spektrum amplitud untuk n=-5 ke 5

(30 markah)

Jadual 4.0

| **Isyarat Masukan, $V_i(t)$** | **Ilustrasi Untuk $V_i(t)$** |
|---|---|
| Isyarat A |   |
| Isyarat B |   |
| Isyarat C |   |

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5. Sumber isyarat tak berkala-berterusan dimasukkan ke dalam sistem yang berfungsi seperti penapis laluan rendah. Sistem ini ditunjukan dalam carta aliran proses dalam Rajah 5.0. Di dalam soalan ini, anda dikehendaki menyiasat kesan ke atas sumber jika sumber isyarat melalui penapis laluan rendah. Penapis tersebut diandaikan bersifat ideal dan frekuensi sempadan di $\pm\omega_{c.}$ seperti di Rajah 5.2. Jawab kesemua soalan dan tunjukkan kaedah-kaedah dan jawapan dengan **JELAS** dan **KEMAS** dalam buku japawan. Had maksima untuk julat spektrum adalah ±1000 rad/s.

(a) Masukan sumber $V_i(t)$ aperiodic-bersambung dinyatakan sebagai: $V_s(t) = 0$ for t <-1 s dan t>1 s; dan $V_s(t) = 10$ V untuk $-1 \leq t \leq 1$ s. **Lakarkan** isyarat masukan ideal tersebut.

(10 markah)

(b) Penapis laluan redah diperlukan untuk melupuskan julat frekuensi tertentu. LItar yang ditonjolkan dalam Rajah 5.3 telah digunapakai dalam proses penapisan ini. Anggapkan fungsi peralihan $|H(\omega)|$ sebagai ideal dan semua elemen tidak terpengaruh dengan perubahan frekuensi, kira dan nyatakan nilai untuk sempadan frekuensi $\pm\omega_c$, **cadangkan** nilai jika $|\omega_c|$=400 rad/s.

(i) Capacitor, C dan;

(ii) Fungsi peralihan $|H(j\omega)|$ di $|\omega_c|$.

(30 markah)

(c) Dengan jawapan-jawapan untuk Soalan 5(a) dan 5(b) hasil keluaran sistem $|Y(\omega)|$ dapat diberikan:

(i) **Dapatkan** persamaannya, dan;

(ii) **Lakarkan** keluaran spektrum tanpa had $Y|j\omega|$.

(60 markah)

Nota:

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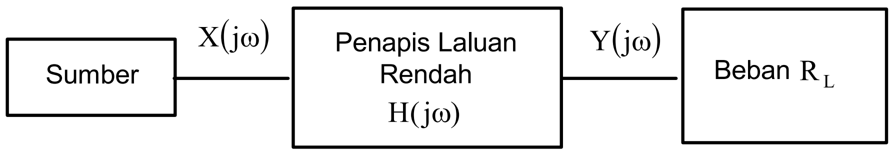
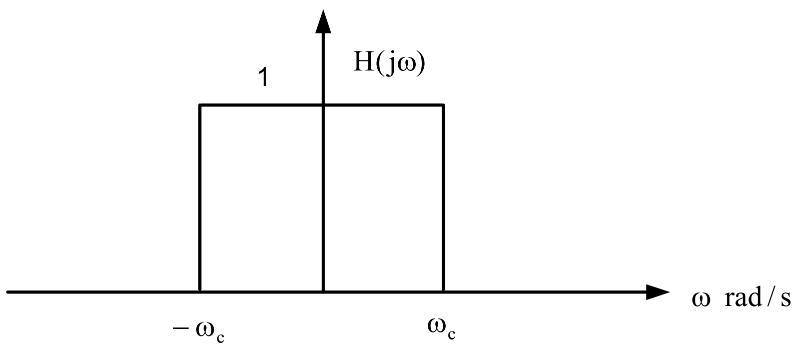
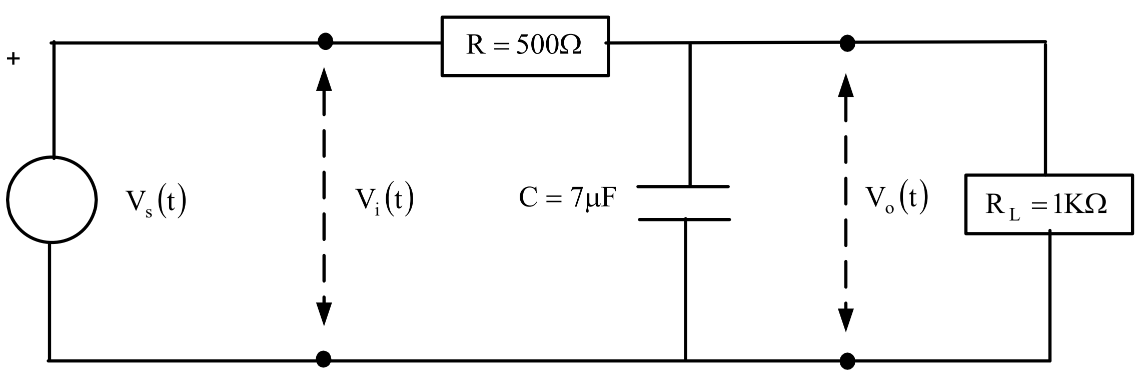



Rajah 5.0 : Carta Alir Proses




Rajah 5.1 – Fungsi Pindah H(jω)




Rajah 5.2 : Litar Penapis Laluan Randah Peringkat Pertama

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**Formula sheet:**

| Mutual inductance | Ideal transformer |
|---|---|
| $v_2 = M_{21}\frac{di_1}{dt}$ <br> $v_1 = M_{12}\frac{di_2}{dt}$ | $\frac{V_2}{V_1} = \frac{I_1}{I_2} = \frac{N_2}{N_1} = n$ |
| $M = k\sqrt{L_1L_2}$ | $S_1 = V_1I_1^* = \frac{V_2}{n}(nI_2) = V_2I_2^* = S_2$ |
| $w = \frac{1}{2}L_1i_1^2 + \frac{1}{2}L_2i_2^2 \pm Mi_1i_2$ | $Z_{in} = \frac{Z_L}{n^2}$ |

**TABLE 14.4**

Summary of the characteristics of resonant *RLC* circuits.

| Characteristic | Series circuit | Parallel circuit |
|---|---|---|
| Resonant frequency, $\omega_0$ | $\frac{1}{\sqrt{LC}}$ | $\frac{1}{\sqrt{LC}}$ |
| Quality factor, $Q$ | $\frac{\omega_0 L}{R}$ or $\frac{1}{\omega_0 RC}$ | $\frac{R}{\omega_0 L}$ or $\omega_0 RC$ |
| Bandwidth, $B$ | $\frac{\omega_0}{Q}$ | $\frac{\omega_0}{Q}$ |
| Half-power frequencies, $\omega_1, \omega_2$ | $\omega_0\sqrt{1+\left(\frac{1}{2Q}\right)^2} \pm \frac{\omega_0}{2Q}$ | $\omega_0\sqrt{1+\left(\frac{1}{2Q}\right)^2} \pm \frac{\omega_0}{2Q}$ |
| For $Q \geq 10$, $\omega_1, \omega_2$ | $\omega_0 \pm \frac{B}{2}$ | $\omega_0 \pm \frac{B}{2}$ |

**TABLE 15.2**

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 $t < 0$.

**TABLE 15.1**

Properties of the Laplace transform.

| Property | $f(t)$ | $F(s)$ |
|---|---|---|
| Linearity | $a_1f_1(t) + a_2f_2(t)$ | $a_1F_1(s) + a_2F_2(s)$ |
| 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 | $\frac{df}{dt}$ | $sF(s) - f(0^-)$ |
| | $\frac{d^2f}{dt^2}$ | $s^2F(s) - sf(0^-) - f'(0^-)$ |
| | $\frac{d^3f}{dt^3}$ | $s^3F(s) - s^2f(0^-) - sf'(0^-) - f''(0^-)$ |
| | $\frac{d^nf}{dt^n}$ | $s^nF(s) - s^{n-1}f(0^-) - s^{n-2}f'(0^-) - \cdots - f^{(n-1)}(0^-)$ |
| Time integration | $\int_0^t f(x)dx$ | $\frac{1}{s}F(s)$ |
| 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 | $f_1(t) * f_2(t)$ | $F_1(s)F_2(s)$ |