KOLEJ YAYASAN PELAJARAN JOHOR
FINAL EXAMINATION

COURSE NAME	**:**	**CIRCUIT ANALYSIS**
COURSE CODE	**:**	**DEE 2113**
SESSION	**:**	**JANUARY 2024**
DURATION	**:**	**2 HOURS 30 MINUTES**

INSTRUCTION TO CANDIDATES /
ARAHAN KEPADA CALON

1. This examination paper consists of **SIX (6)** questions. Answer **ALL** questions. /
   *Kertas soalan ini mengandungi **ENAM (6)** soalan. Jawab **SEMUA** soalan.*

2. Candidates are not allowed to bring any material/note to the examination hall/room except with the permission from the invigilator. /
   Calon tidak dibenarkan untuk membawa sebarang bahan/nota ke dewan/bilik peperiksaan tanpa kebenaran daripada pengawas.

3. Please check to make sure that this examination pack consist of: /
   Pastikan kertas soalan peperiksaan ini mengandungi:

   i. The Question Paper /
   Kertas Soalan
   ii. An Answering Booklet /
   Buku Jawapan
   iii. Attachment 1 /
   Lampiran 1
   iv. Semilog Paper/
   Kertas Semilog

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JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIBERITAHU

This examination paper consists of **14** printed pages including front page
*Kertas soalan ini mengandungi **14** halaman bercetak termasuk muka hadapan*

This examination paper consists of **SIX (6)** questions. Answer **ALL** the questions in the Answering Booklet.
*Kertas soalan ini mengandungi **ENAM (6)** soalan. Jawab **SEMUA** soalan dalam Buku Jawapan.*

QUESTION 1 / *SOALAN 1*

Figure 1 shows five (5) interconnected capacitor. The initial voltages for four (4) of the capacitors are also shown in **Figure 1**. Looking from terminal A - B.

a) Calculate the equivalent capacitance, C_{eq}.
b) Calculate the initial voltage in the capacitive network.
c) Find the energy stored in equivalent capacitance, C_{eq}.

(10 marks/ *markah*)

***Rajah 1** menunjukkan lima (5) pemuat yang saling berkaitan. Voltan awalan bagi empat (4) pemuat juga ditunjukkan dalam **Rajah 1.** Dilihat dari terminal A - B.*

a) *Kirakan kemuatan setara, C_{eq}.*
b) *Kirakan voltan awalan dalam rangkaian pemuat.*
c) *Dapatkan tenaga yang disimpan di dalam kemuatan setara, C_{eq}.*

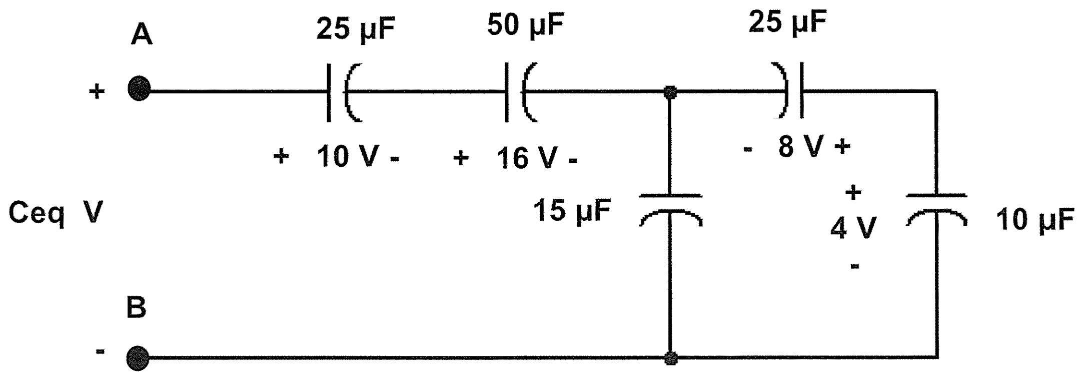

Figure 1/ *Rajah 1*

QUESTION 2 / *SOALAN 2*

Refer to **Figure 2**, S_1 at position B and S_2 closed at $t > 0$. Find i(t) for $t \geq 0$ using transient analysis method.

(15 marks/ *markah*)

Merujuk kepada **Rajah 2**, S_1 pada kedudukan B dan S_2 ditutup pada $t > 0$. Cari i(t) untuk $t \geq 0$ menggunakan kaedah analisis ubahtika.

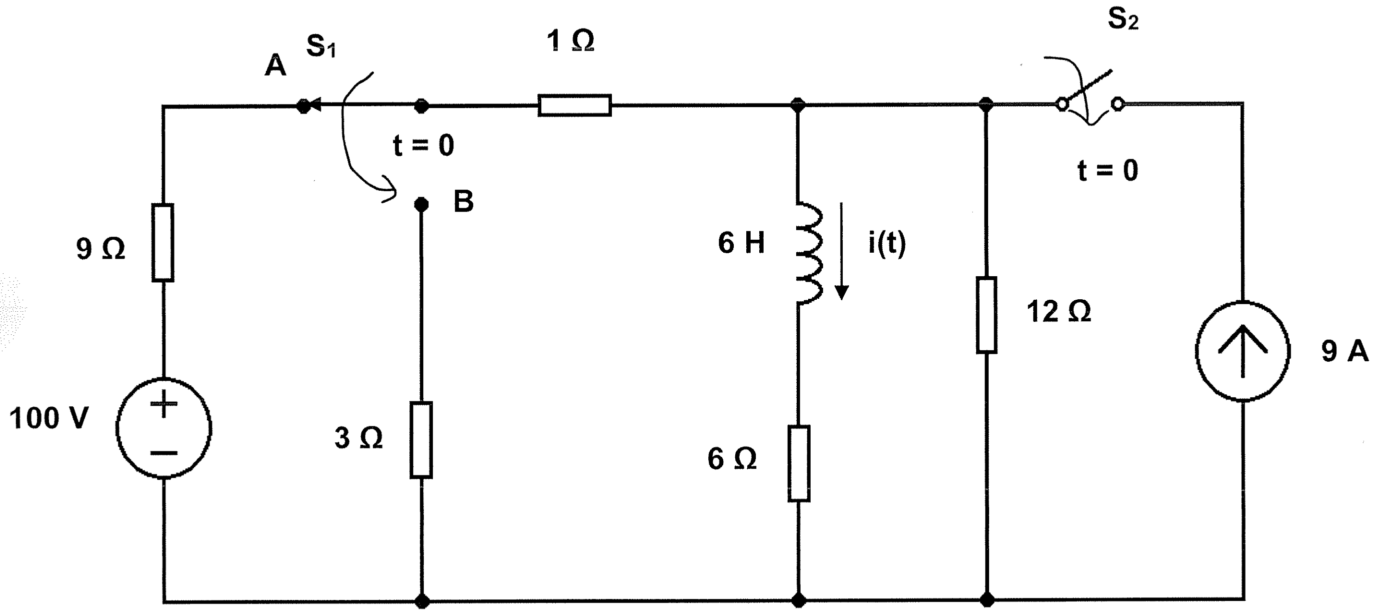

Figure 2 / ***Rajah 2***

QUESTION 3 / *SOALAN 3*

By referring to **Figure 3**. When switch is closed, $t < 0$ and when the switch is opened $t \geq 0$. Find:

a) the initial value at $t < 0$.

b) the possible behaviour for the natural response by refers to circuit.

c) the complete response of the current, $i(t)$. Assumed that the circuit has reached steady state at $t = 0^-$.

(25 marks/ *markah*)

Dengan merujuk kepada ***Rajah 3****. Apabila suis ditutup,* $t < 0$ *dan apabila suis dibuka,* $t \geq 0$*. Dapatkan:*

a) nilai awalan pada $t < 0$*.*

b) kemungkinan kelakuan bagi tindak balas semula jadi dengan merujuk kepada litar.

c) tindak balas lengkap bagi arus, $i(t)$*. Dianggap bahawa litar telah mencapai keadaan mantap pada* $t = 0^-$*.*

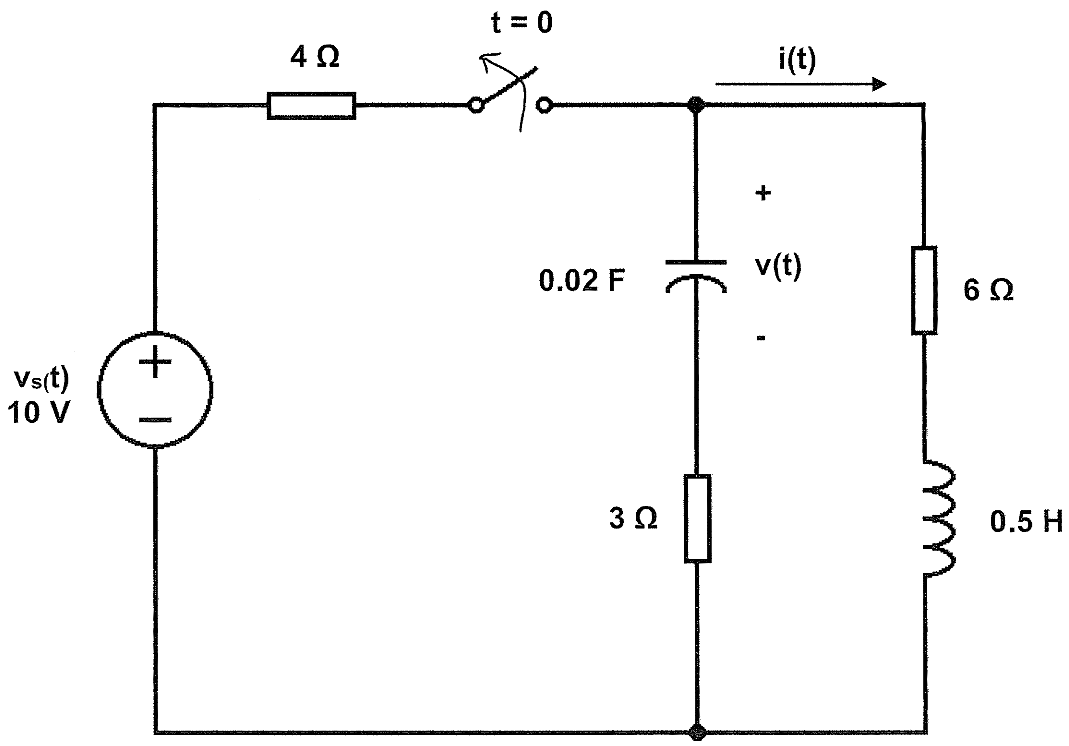

Figure 3 / ***Rajah 3***

QUESTION 4 / *SOALAN 4*

Referring to **Figure 4,** find the value of the voltage across the capacitor by using Laplace method. Assuming that the value of $v_s(t)$ = 10 V. Given initial value of current flow through inductor, $i(0^-)$ = - 1 A and initial value of voltage at voltage across capacitor, $v(0^-)$ = 5 V.

(15 marks/ *markah*)

*Merujuk kepada **Rajah 4**, cari nilai voltan merentasi pemuat dengan menggunakan kaedah Laplace. Dengan mengandaikan bahawa nilai $v_s(t)$ = 10 V. Diberi nilai awalan arus mengalir pearuh, $i(0^-)$ = - 1 A dan nilai awalan voltan merentasi pemuat, $v(0^-)$ = 5 V.*

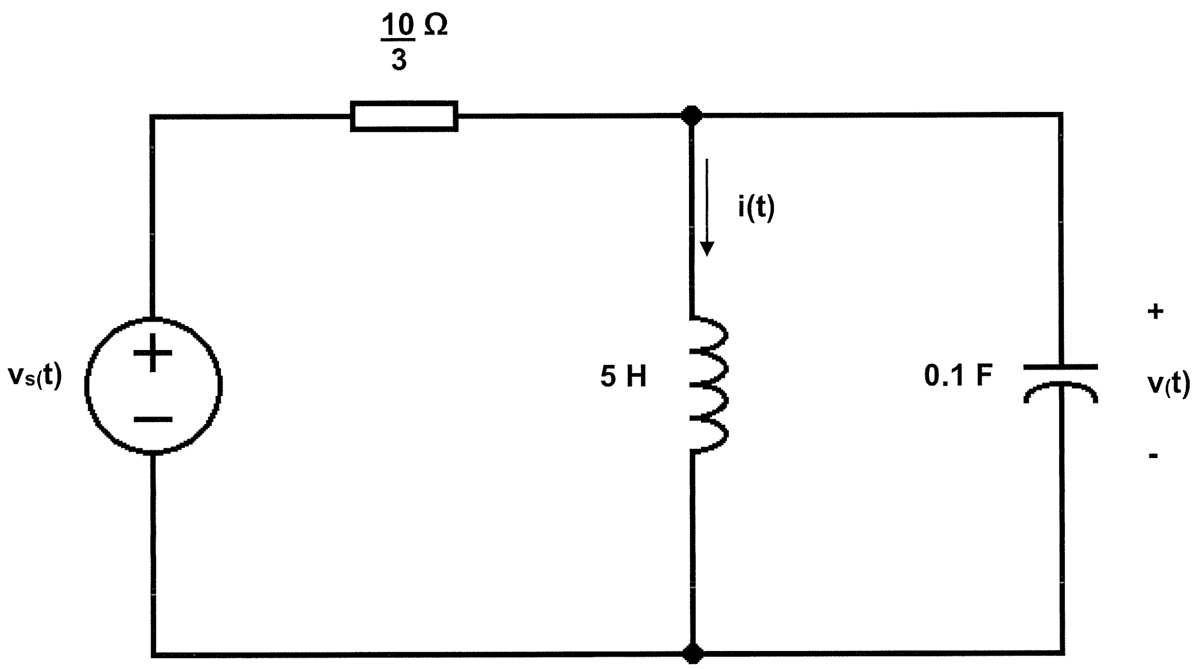

Figure 4/ *Rajah 4*

QUESTION 5 / *SOALAN 5*

Draw the magnitude Bode Plot for the following transfer function:

$$H(s) = \frac{50s}{(s+4)(s+10)^2}$$

Use minimum frequency, ω=0.1 radian/second and maximum frequency, ω=10,000 radian/second.

(15 marks/ *markah*)

Lukis Plot Bode magnitud untuk rangkap pindah berikut:

$$H(s) = \frac{50s}{(s+4)(s+10)^2}$$

Guna frekuensi minima, ω=0.1 radian/saat dan frekuensi maksima, ω=10,000 radian/saat.

QUESTION 6 / *SOALAN 6*

Referring to the **Figure 5,** obtain the y-parameters for the network as function of s.

(20 marks/ *markah*)

Merujuk kepada ***Rajah 5****, dapatkan parameter–y untuk rangkaian sebagai fungsi s.*

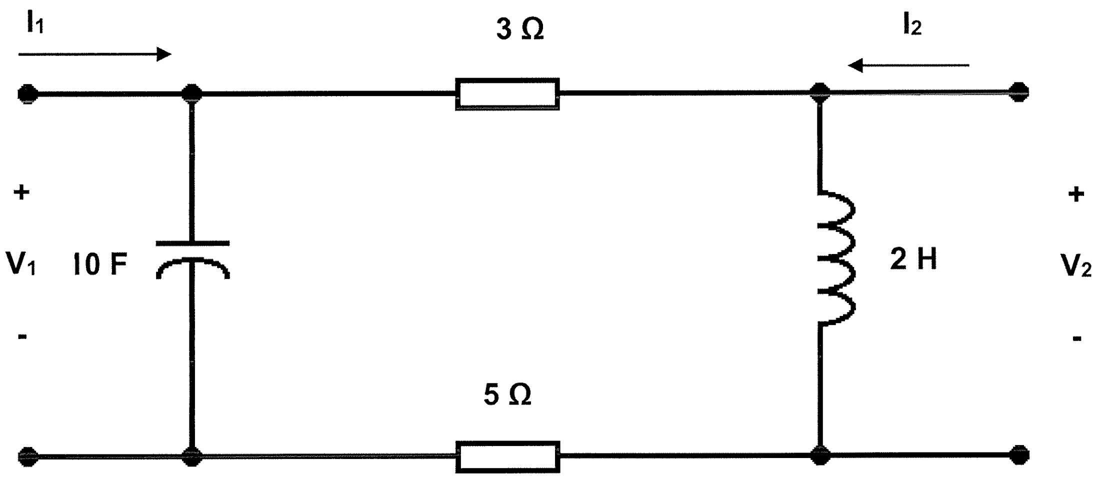

Figure 5 / *Rajah 5*

[100 MARKS/ *MARKAH*]

END OF QUESTION PAPER / KERTAS SOALAN TAMAT

Attachment 1 / *Lampiran 1*

Series, Parallel for Capacitor and Inductor
Siri, Selari untuk Pemuat dan Pearuh

Series / *Siri*	**Parallel / *Selari***
Capacitor / *Pemuat*	
$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots + \frac{1}{C_N}$	$C_{eq} = C_1 + C_2 + \ldots + C_N$
Inductor / *Pearuh*	
$L_{eq} = L_1 + L_2 + \ldots + L_N$	$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \ldots + \frac{1}{L_N}$

Current and Voltage Relationship for R, L, C
Hubungan Arus dan Voltan untuk R, L, C

Circuit element	Units	Voltage	Current	Power
Resistance	ohms (Ω)	$v = Ri$ (Ohm's law)	$i = \frac{v}{R}$	$p = vi = i^2 R$
Inductance	henries (H)	$v = L\frac{di}{dt}$	$i = \frac{1}{L}\int v\,dt + k_1$	$p = vi = Li\frac{di}{dt}$
Capacitance	farads (F)	$v = \frac{1}{C}\int i\,dt + k_2$	$i = C\frac{dv}{dt}$	$p = vi = Cv\frac{dv}{dt}$

RL Circuit and RC Circuit
Litar RL dan Litar RC

RL Circuit / *Litar RL*	**RC Circuit / *Litar RC***
Free Source / *Tiada Sumber*	
$i(t) = I_0\, e^{-t/\tau} \qquad \tau = \frac{L}{R}$	$v(t) = V_0\, e^{-t/\tau} \qquad \tau = RC$
Variety Source / *Pelbagai Sumber*	
$i(t) = i(\infty) + [i(0+) - i(\infty)]\,e^{-t/\tau}$	$v(t) = v(\infty) + [v(0+) - v(\infty)]\,e^{-t/\tau}$

Free Source RLC Circuit
Litar RLC Tiada Sumber

Series RLC Circuit   ***Litar RLC Siri***
1. If $\alpha > \omega_0$, over-damped case $i(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$ **where** $s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2}$ 2. If $\alpha = \omega_0$, critical damped case $i(t) = (A_2 + A_1 t)e^{-\alpha t}$ **where** $s_{1,2} = -\alpha$ 3. If $\alpha < \omega_0$, under-damped case $i(t) = e^{-\alpha t}(B_1 \cos \omega_d t + B_2 \sin \omega_d t)$ **where** $\omega_d = \sqrt{\omega_0^2 - \alpha^2}$ Where: $\alpha = \frac{R}{2L}$ *and* $\omega_0 = \sqrt{\frac{1}{LC}}$
Parallel RLC Circuit   ***Litar RLC Selari***
1. If $\alpha > \omega_0$, over-damped case $v(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$ **where** $s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2}$ 2. If $\alpha = \omega_0$, critical damped case $v(t) = (A_2 + A_1 t)e^{-\alpha t}$ **where** $s_{1,2} = -\alpha$ 3. If $\alpha < \omega_0$, under-damped case $v(t) = e^{-\alpha t}(A_1 \cos \omega_d t + A_2 \sin \omega_d t)$ **where** $\omega_d = \sqrt{\omega_0^2 - \alpha^2}$ Where: $\alpha = \frac{1}{2RC}$ and $\omega_0 = \sqrt{\frac{1}{LC}}$

Step Response RLC Circuit
Litar RLC Tindak Balas Langkah

Series RLC Circuit
Litar RLC Siri

$$v(t) = v_t(t) + v_{ss}(t)$$

$v_t(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$ If $\alpha > \omega_o$ (over-damped) $s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_o^2}$

$v_t(t) = (A_1 + A_2 t)e^{-\alpha t}$ If $\alpha = \omega_o$ (critically damped) $s_{1,2} = -\alpha$

$v_t(t) = e^{-\alpha t}(A_1 \cos \omega_d t + A_2 \sin \omega_d t)$ (under-damped) If $\alpha < \omega_o$

$\omega_d = \sqrt{\omega_0^2 - \alpha^2}$

And $v_{ss}(t) = v(\infty)$

Parallel RLC Circuit
Litar RLC Selari

$$i(t) = i_t(t) + i_{ss}(t)$$

$i_t(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$ If $\alpha > \omega_o$ (over-damped) $s_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_o^2}$

$i_t(t) = (A_1 + A_2 t)e^{-\alpha t}$ If $\alpha = \omega_o$ (critical damped) $s_{1,2} = -\alpha$

$i_t(t) = e^{-\alpha t}(A_1 \cos \omega_d t + A_2 \sin \omega_d t)$ (under-damped) If $\alpha < \omega_o$

$\omega_d = \sqrt{\omega_0^2 - \alpha^2}$

And $i_{ss}(t) = i(\infty)$

Forcing Functions and Their Assumed Solutions
Fungsi Berdaya dan Penyelesaian Anggapan

Forcing function / *Fungsi Berdaya*			Assumed Solution / *Penyelesaian Anggapan*
Constan / *Malar*		$f(t) = A$	$x_f(t) = K_2$
Exponential/ *Eksponen*		$f(t) = M\, e^{-st}$	$x_f(t) = K_2\, e^{-st}$
Variable/ *Pembolehubah*	Ramp/ *Tanjak*	$f(t) = mt$	$x_f(t) = K_2\, t + K_3$
	Parabolic/ *Parabola*	$f(t) = t^2$	$x_f(t) = K_2\, t^2 + K_3\, t + K_4$
Sinusoidal/ *Sinus*		$f(t) = M\ sin(\omega t + \theta)$ $f(t) = M\ cos(\omega t + \theta)$	$x_f(t) = K_2\ sin\, \omega t + K_3\ cos\, \omega t$
Exponential Sinusoidal/ *Sinus Eksponen*		$f(t) = M\, e^{-st}\ sin(\omega t + \theta)$	$x_f(t) = e^{-st}(K_2\ sin\, \omega t + K_3\ cos\, \omega t)$

Table of Laplace Transform Pairs
Jadual Penukaran Pasangan Jelmaan Laplace

Function/ *Rangkap*	f(t)	F(s)
Unit Impulse/ *Dedenyut*	$\delta(t)$	1
Unit Step/ *Unit langkah* Constant / *Malar*	u(t) 1	$\frac{1}{s}$
Unit Ramp/ *Unit Tanjak* t function / *Rangkap t*	t u(t)	$\frac{1}{s^2}$
Unit Parabolic / *Unit Parabola*	$\frac{1}{2}t^2\ u(t)$	$\frac{1}{s^3}$
n^{th} integral of impulse/ *Kamiran ke–n dedenyut*	$\delta^{-n}(t)$	$\frac{1}{s^n}$
n^{th} derivative of impulse/ *Kerbezaan ke–n dedenyut*	$\delta^{n}(t)$	s^n
Power of t/ *Kuasa t*	$\frac{t^{n-1}}{(n-1)!}$	$\frac{1}{s^n}$
Exponential / *Eksponen*	e^{-at}	$\frac{1}{s+a}$
t–multiplication exponential/ *Pendaraban t bagi eksponen*	te^{-at}	$\frac{1}{(s+a)^2}$
Repeated t–multiplication exponential/ *Pendaraban t berulang bagi eksponen*	$\frac{1}{(n-1)!}t^{n-1}e^{-at}$	$\frac{1}{(s+a)^n}$
Sine/ *Sinus*	$\sin \omega t$	$\frac{\omega}{s^2+\omega^2}$
Cosine/ *Kosinus*	$\cos \omega t$	$\frac{s}{s^2+\omega^2}$
Damped sine/ *Sinus teredam*	$e^{-at}\sin \omega t$	$\frac{\omega}{(s+a)^2+\omega^2}$

Damped cosine/ *Kosinus teredam*	$e^{-at}\cos\omega t$	$\frac{s+a}{(s+a)^2+\omega^2}$
t–multiplicated sine *Pendaraban t bagi sinus*	$t\sin\omega t$	$\frac{2\omega s}{(s^2+\omega^2)^2}$
t–multiplicated cosine *Pendaraban t bagi kosinus*	$t\cos\omega t$	$\frac{s^2-\omega^2}{(s^2+\omega^2)^2}$

Two–Port Network Parameters
Parameter Rangkaian Dua Liang

Impedance parameters

$$V_1 = z_{11}I_1 + z_{12}I_2$$
$$V_2 = z_{21}I_1 + z_{22}I_2$$

Admittance parameters

$$I_1 = y_{11}V_1 + y_{12}V_2$$
$$I_2 = y_{21}V_1 + y_{22}V_2$$

Hybrid parameters

$$V_1 = h_{11}I_1 + h_{12}V_2$$
$$I_2 = h_{21}I_1 + h_{22}V_2$$

Transmission parameters

$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$

Conversion Table for Two–Port Network Parameters

Jadual Penukaran Untuk Rangkaian Dua Liang

	Z		Y		h		ABCD	
Z	z_{11}	z_{12}	$\frac{y_{22}}{\Delta_y}$	$\frac{-y_{12}}{\Delta_y}$	$\frac{\Delta_h}{h_{22}}$	$\frac{h_{12}}{h_{22}}$	$\frac{A}{C}$	$\frac{\Delta_T}{C}$
	z_{21}	z_{22}	$\frac{-y_{21}}{\Delta_y}$	$\frac{y_{11}}{\Delta_y}$	$\frac{-h_{21}}{h_{22}}$	$\frac{1}{h_{22}}$	$\frac{1}{C}$	$\frac{D}{C}$
Y	$\frac{z_{22}}{\Delta_z}$	$\frac{-z_{12}}{\Delta_z}$	y_{11}	y_{12}	$\frac{1}{h_{11}}$	$\frac{-h_{12}}{h_{11}}$	$\frac{D}{B}$	$\frac{-\Delta_T}{B}$
	$\frac{-z_{21}}{\Delta_z}$	$\frac{z_{11}}{\Delta_z}$	y_{21}	y_{22}	$\frac{h_{21}}{h_{11}}$	$\frac{\Delta_h}{h_{11}}$	$\frac{-1}{B}$	$\frac{A}{B}$
h	$\frac{\Delta_z}{z_{22}}$	$\frac{z_{12}}{z_{22}}$	$\frac{1}{y_{11}}$	$\frac{-y_{12}}{y_{11}}$	h_{11}	h_{12}	$\frac{B}{D}$	$\frac{\Delta_T}{D}$
	$\frac{-z_{21}}{z_{22}}$	$\frac{1}{z_{22}}$	$\frac{y_{21}}{y_{11}}$	$\frac{\Delta_y}{y_{11}}$	h_{21}	h_{22}	$\frac{-1}{D}$	$\frac{C}{D}$
ABCD	$\frac{z_{11}}{z_{21}}$	$\frac{\Delta_z}{z_{21}}$	$\frac{-y_{22}}{y_{21}}$	$\frac{-1}{y_{21}}$	$\frac{-\Delta_h}{h_{21}}$	$\frac{-h_{11}}{h_{21}}$	A	B
	$\frac{1}{z_{21}}$	$\frac{z_{22}}{z_{21}}$	$\frac{-\Delta_y}{y_{21}}$	$\frac{-y_{11}}{y_{21}}$	$\frac{-h_{22}}{h_{21}}$	$\frac{-1}{h_{21}}$	C	D