Second Semester Examination
2017/2018 Academic Session

May/June 2018

EEU104 – Electrical Technology
(Teknologi Elektrik)

Duration : 3 hours
(Masa : 3 jam)

Please ensure that this examination paper consists of **SIXTEEN (16)** pages and **SEVEN (7)** pages of printed appendix material before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **ENAM BELAS (16)** muka surat dan **TUJUH (7)** muka surat lampiran yang bercetak sebelum anda memulakan peperiksaan ini.]*

Instructions: This question paper consists of **SIX (6)** questions. Answer **FIVE (5)** questions : **TWO (2)** from Section A and **THREE (3)** from Section B. All questions carry the same marks.

[***Arahan:*** *Kertas soalan ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan : **DUA (2)** daripada Bahagian A dan **TIGA (3)** daripada Bahagian B. Semua soalan membawa jumlah markah yang sama.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

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SECTION A

BAHAGIAN A

1. (a) *State and explain briefly what are:*

(i) Ohm's Law

(ii) Kirchhoff's Current Law

(iii) Kirchhoff's Voltage Law

Nyatakan dan terangkan secara ringkas apakah:

(i) Hukum Ohm's Law

(ii) Hukum Arus Kirchhoff

(iii) Hukum Voltan Kirchhoff

(30 marks/*markah*)

(b) Design a network in Figure 1(b) such that $I_2=2I_1$ and $I_3= 2I_2$.
Rekabentuk rangkaian dalam Rajah 1(b) dengan $I_2=2I_1$ and $I_3= 2I_2$.

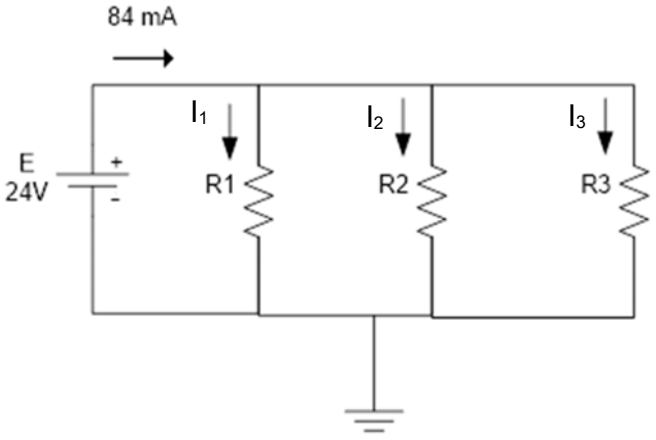

Figure 1(b)

Rajah 1(b)

(30 marks/*markah*)

(c) Considering the network in Figure 1(c).

Pertimbangkan rangkaian dalam Rajah 1(c)

(i) Redraw the network after combining the series/parallel elements.
Lukis kembali rangkaian setelah menggabungkan elemen sesiri dan selari.

(15 marks/markah)

(ii) Calculate the indicated currents and voltages, I_5, V_7 and I_s

Kira arus dan voltan seperti yang ditunjukkan, I_5, V_7 and I_s

(25 marks/markah)

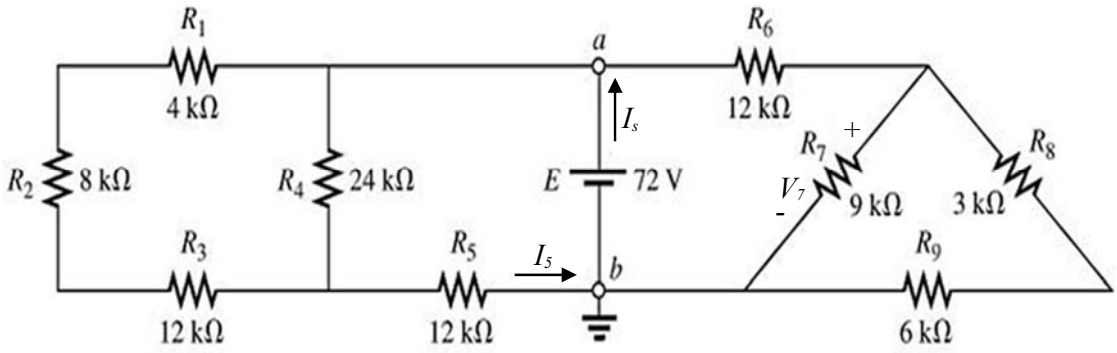

Figure 1(c)
Rajah 1(c)

2. (a) Find the root-mean-square (rms) value of the voltage, V_{rms} in Figure 2(a)i and current, I_{rms} in Figure 2(a)ii. Calculate the average power dissipated in an 8Ω resistor **for both figures**.

Cari nilai punca min kuasa dua (pmkd) untuk voltan, V_{pmkd} dalam Rajah 2(a)i dan arus, I_{pmkd} dalam Rajah 2(a)ii. Kirakan kuasa purata yang hilang di dalam suatu perintang 8Ω ***bagi kedua-dua rajah tersebut****.*

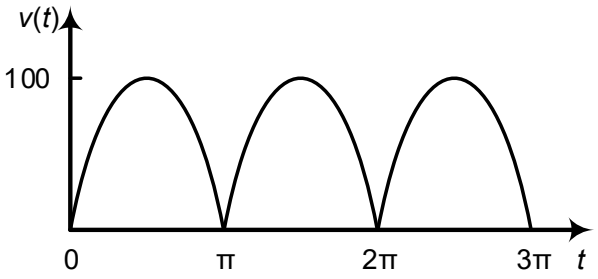

Figure 2(a)i

Rajah 2(a)i

(15 marks/*markah*)

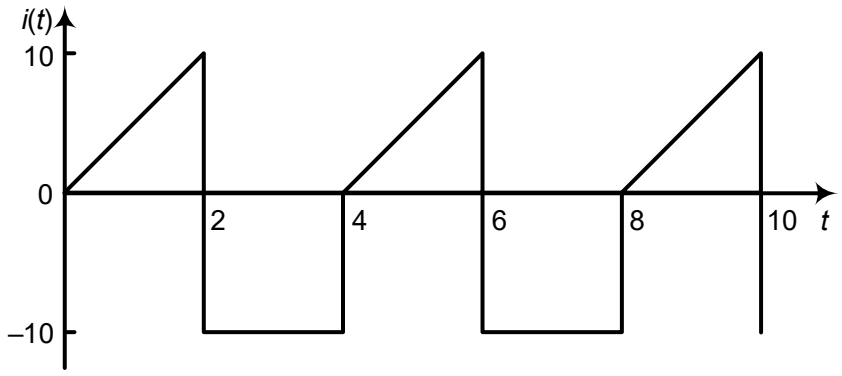

Figure 2(a)ii

Rajah 2(a)ii

(15 marks/*markah*)

(b) Calculate the average power absorbed by each of the five elements in the circuit in Figure 2(b) below.
Kirakan kuasa purata yang diserap oleh setiap lima elemen di dalam Rajah 2(b) di bawah.

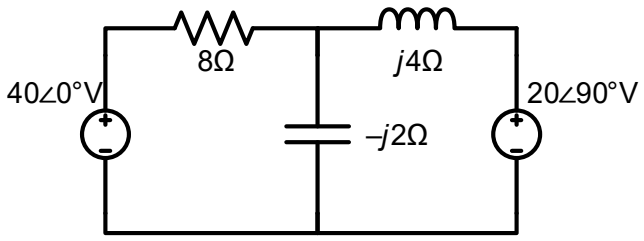

Figure 2(b)
Rajah 2(b)

(30 marks/*markah*)

(c) Obtain the Thevenin equivalent circuit at terminals *a-b* of the circuit in Figure 2(c).
Dapatkan litar setara Thevenin pada terminal a-b pada litar di dalam Rajah 2(c).

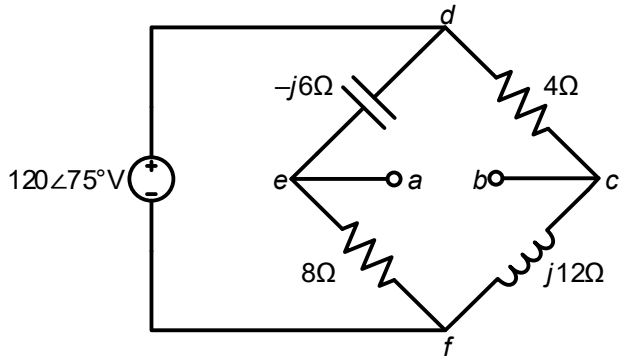

Figure 2(c)
Rajah 2(c)

(40 marks/*markah*)

SECTION B

BAHAGIAN B

3. (a) Calculate $\mathbf{V_0}$ in the circuit of Figure 3(a) using mesh analysis.

Kirakan V_0 dalam litar Rajah 3(a) dengan menggunakan analisa Mesh.

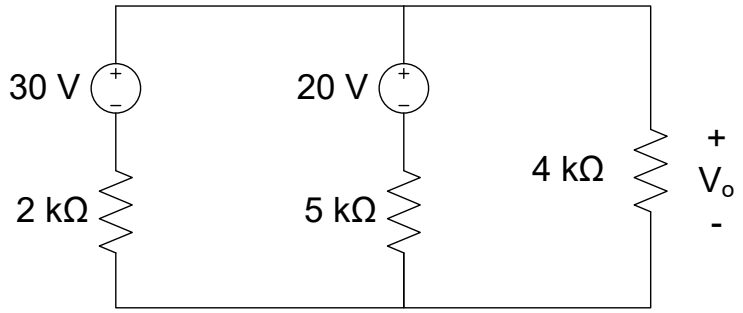

Figure 3(a)

Rajah 3(a)

(30 marks/*markah*)

(b) Refer to Figure 3(b). Using the Thevenin's Theorem, find the current I_3 if R_3=10Ω.

Rujuk Rajah 3(b). Dengan menggunakan Teorem Thevenin, cari arus I_3 jika R_3 = 10 Ω.

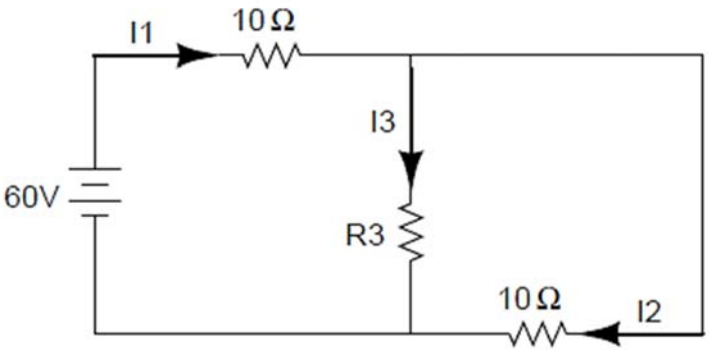

Figure 3(b)

Rajah 3(b)

(35 marks/*markah)*

(c) For the circuit in Figure 3(c), use source transformation to find *i*.

Bagi litar dalam Rajah 3(c), gunakan transformasi punca untuk mencari i.

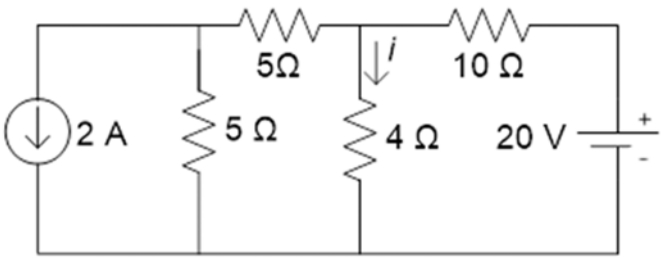

Figure 3(c)

Rajah 3(c)

(35 marks/*markah)*

4. (a)

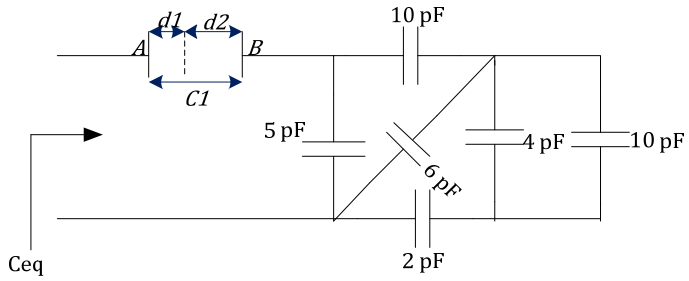

Figure 4(a)

Rajah 4(a)

(i) Calculate the capacitance (*C1*) between A and B plates as shown in Figure 4(a).

A capacitor consists of two metal plates, $400\ \mu m^2$ area with 5 mm thickness. The space between metal plates (*A* and *B*) is filled with Mica plate 2 mm thick (*d1*) and a layer of Glass 3 mm (*d2*) thick. The relative permittivities of Glass is 6 and Mica is 2. Given $\varepsilon_0 = 8.854 \times 10^{-12}\ F/m$ permittivity of free space.

(Hint $C = \frac{\varepsilon A}{d}$)

Hitungkan kemuatan (C1) antara plat A dan plat B seperti ditunjukkan dalam Rajah 4(a). Kapasitor mengandungi dua logam plat, keluasan $400\ \mu m^2$ *dengan 5 mm ketebalan. Ruang antara logam plat (A dan B) diisikan dengan 2 mm tebal(d1) untuk lapisan Mika dan 3mm tebal(d2) untuk lapisan Gelas. Ketelusan relatif gelas adalah 6 dan 2 untuk Mika. Diberikan* $\varepsilon_0 = 8.854 \times 10^{-12}\ F/m$ *ketelusan untuk ruang bebas.*

(Petunjuk $C = \frac{\varepsilon A}{d}$ *)*

(20 marks/*markah*)

(ii) Calculate the total equivalent capacitance, Ceq.

Hitung nilai kemuatan setara, Ceq

(20 marks/*markah*)

(iii) Calculate the current through Ceq capacitor if the voltage across is shown in Figure 4(b). Draw the current waveform. (Ceq value is based on Q4(a)(ii answer).

Hitung arus elektrik yang melalui Ceq kapasitor jika voltan yang merentasi ditunjukkan dalam Rajah 4(b). Lukiskan bentuk gelombang arus. (Nilai Ceq adalah berdasarkan pada jawapan Q4(a)(ii)).

(20 marks/*markah*)

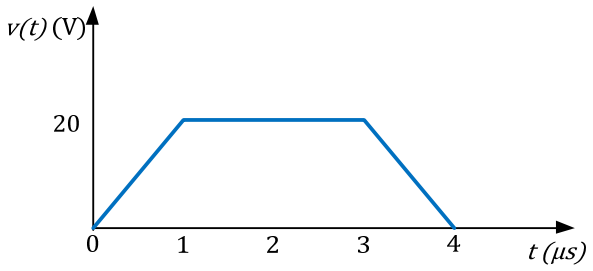

Figure 4(b)

Rajah 4(b)

(b) In the circuit of Figure 4(c), given

Bagi litar dalam Rajah 4(c), diberikan

$v(t) = 60e^{-30t}$ V $t > 0$

$i(t) = 25e^{-30t}$ mA $t > 0$

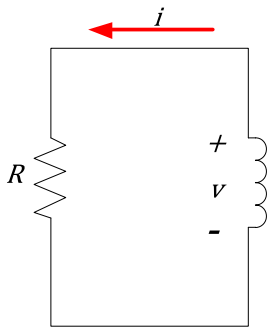

Figure 4(c)
Rajah 4(c)

(i) Find R, L and time constant.

Hitung R, L dan pemalar masa.

(15 marks/*markah*)

(ii) Calculate the initial energy in the inductor.

Hitung tenaga awal di dalam induktor.

(10 marks/*markah*)

(iii) Define the natural response of the circuit. Show one example of natural response circuit.

Definisikan litar respons/tindak balas asli. Tunjukkan satu contoh litar respons/tindak balas asli.

(15 marks/*markah*)

5. (a) For the circuit in Figure 5(a), determine

Bagi litar dalam Rajah 5(a), hitung

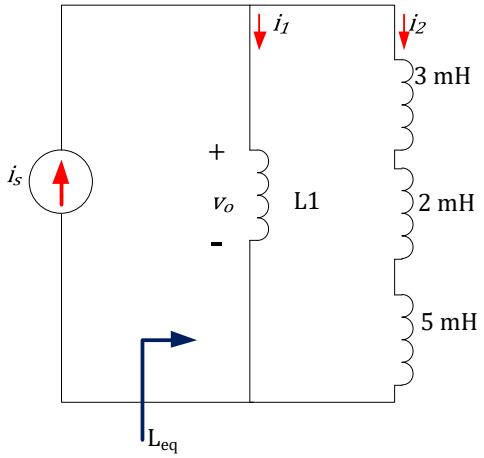

Figure 5(a)

Rajah 5(a)

(i) L1, inductor

L1, induktor

It is built from a coil of 200 turns. The core is iron that having a relative permeability of 700, 30 mm core length and $20\ \mathrm{m}^2$ cross-section area. Given $\mu_0 = 4\pi \times 10^{-7}\ H/m$ permeability of free space. (Hint $L = \frac{\mu N^2 A}{l}$)

Ia dibina dari gelung dengan 200 lilitan. Teras tersebut adalah besi di mana mengandungi kebolehtelapan relatif 700, panjang teras adalah 30 mm dan keluasan keratan rentas $20\ m^2$.
Diberikan $\mu_0 = 4\pi \times 10^{-7}\ H/m$ *kebolehtelapan ruang bebas.*
(Petunjuk $L = \frac{\mu N^2 A}{l}$*)*

(5 marks/*markah*)

(ii) L_{eq}
L_{eq}

(10 marks/*markah)*

(iii) $i_1(t), i_2(t)$ if $i_s = 5e^{-t}$ mA
$i_1(t), i_2(t)$ jika $i_s = 5e^{-t}$ mA

(20 marks/*markah*)

(iv) $v_0(t)$
$v_0(t)$

(10 marks*/markah*)

(v) Energy stored in the L1 inductor
Tenaga tersimpan di dalam Induktor, L1

(10 marks/*markah*)

(b) In the circuit of Figure 5(b),

Bagi litar dalam Rajah 5(b),

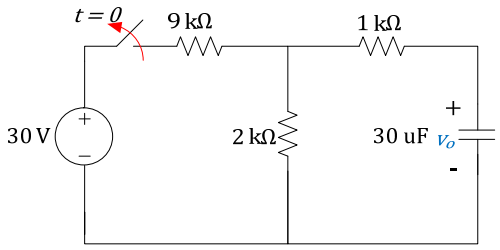

Figure 5(b)

Rajah 5(b)

(i) Find $v_o(t)$ for $t > 0$.

Hitung $v_o(t)$ *untuk* $t > 0$.

(20 marks/ *markah*)

(ii) Calculate the initial energy in the capacitor.

Hitung tenaga awal dalam kapasitor.

(10 marks/*markah*)

(iii) Define time constant of RC circuit and RL circuit. Sketch the RC voltage response and RL current response.

Definisikan pemalar masa untuk litar RC dan RL circuit. Lakarkan voltan respons/tindak balas RC dan arus respons/tindak balas RL.

(15 marks/*markah*)

6. (a) In a DC circuit in Figure 6(a), find i_{total} **by using the Y-Δ transformation method**. Resistance of each of the resistors is 3Ω.

*Dalam litar arus terus dalam Rajah 6(a), cari i_{total} **dengan menggunakan transformasi Y – Δ**. Rintangan untuk setiap perintang adalah 3Ω.*

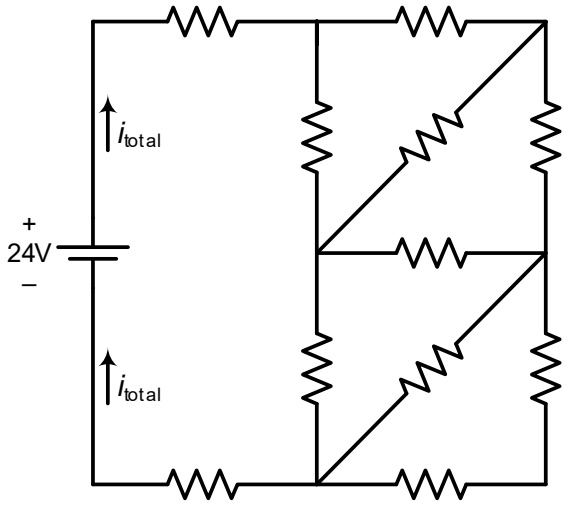

Figure 6 (a)

Rajah 6 (a)

(20 marks/*markah*)

(b) Calculate the phasor currents I_1 and I_2 in the circuit shown in Figure 6(b) below
Kirakan arus pemfasa I_1 dan I_2 dalam litar yang ditunjukkan di dalam Rajah 6 (b) di bawah.

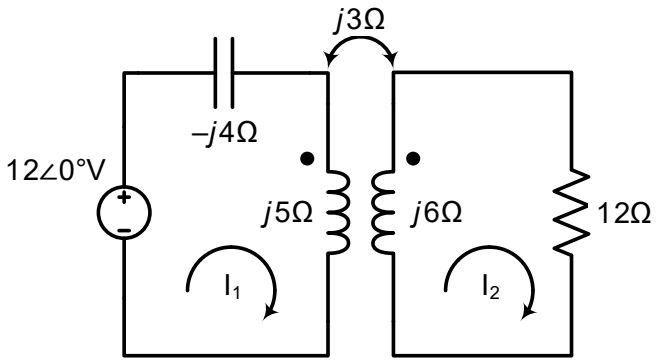

Figure 6(b)
Rajah 6(b)

(30 marks/*markah*)

(c) Calculate:
Kirakan:

(i) line currents in the three-wire Y-Y system in Figure 6(c)i, and
arus talian di dalam sistem tiga-wayar Y-Y dalam Rajah 6(c)i, dan

(20 marks/*markah*)

(ii) line currents and phase currents in the Y-Δ transformation system in Figure 6(c)ii.
arus talian dan arus fasa dalam sistem transformasi Y-Δ dalam Rajah 6(c)ii.

(30 marks/*markah*)

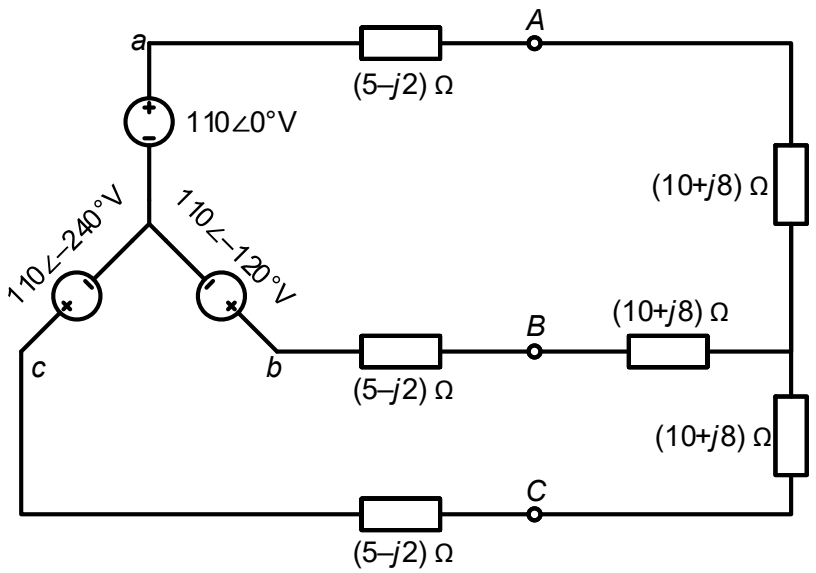

Figure 6(c)i

Rajah 6(c)i

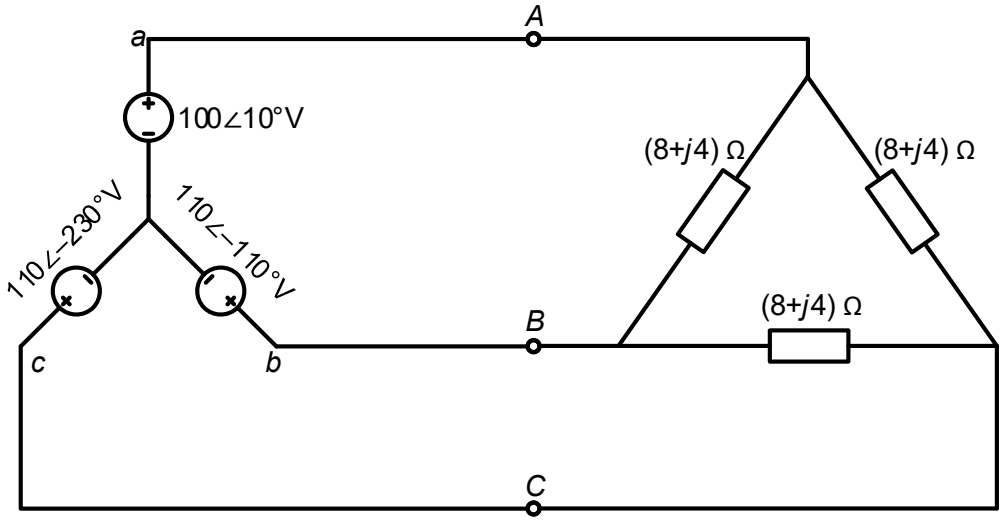

Figure 6(c)ii

Rajah 6(c)ii

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APPENDIX A

LAMPIRAN A

Course Outcomes (CO) – Programme Outcomes (PO) Mapping

Pemetaan Hasil Pembelajaran Kursus – Hasil Program

Questions ***Soalan***	**CO**	**PO**
1	1	1
2	2	2
3	1	2
4	1	1
5	1	2
6	2	1

APPENDIX

LAMPIRAN

Mathematical Formulas

This appendix – by no means exhaustive – serves as a handy reference. It does contain all the formulas needed to solve circuit problems in this examination book.

Quadratic Formula

The roots of the quadratic equation $ax^2 + bx + c = 0$ are

$$x_1, x_2 = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Trigonometric Identities

$$\sin(-x) = -\sin x$$

$$\cos(-x) = \cos x$$

$$\sec x = \frac{1}{\cos x}, \csc x = \frac{1}{\sin x}$$

$$\tan x = \frac{\sin x}{\cos x}, \cot x = \frac{1}{\tan x}$$

$$\sin(x \pm 90°) = \pm \cos x$$

$$\cos(x \pm 90°) = \mp \sin x$$

$$\sin(x \pm 180°) = -\sin x$$

$$\cos(x \pm 180°) = -\cos x$$

$$\cos^2 x + \sin^2 x = 1$$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} \quad \text{(law of sines)}$$

$$a^2 = b^2 + c^2 - 2bc \cos A \quad \text{(law of cosines)}$$

$$\frac{\tan \frac{1}{2}(A - B)}{\tan \frac{1}{2}(A + B)} = \frac{a - b}{a + b} \quad \text{(law of tangents)}$$

$$\sin(x \pm y) = \sin x \cos y \pm \cos x \sin y$$

$$\cos(x \pm y) = \cos x \cos y \mp \sin x \sin y$$

$$\tan(x \pm y) = \frac{\tan x \pm \tan y}{1 \mp \tan x \tan y}$$

$$2 \sin x \sin y = \cos(x - y) - \cos(x + y)$$

$$2 \sin x \cos y = \sin(x + y) + \sin(x - y)$$

$$2 \cos x \cos y = \cos(x + y) + \cos(x - y)$$

$$\sin 2x = 2 \sin x \cos x$$

$$\cos 2x = \cos^2 x - \sin^2 x = 2\cos^2 x - 1 = 1 - 2\sin^2 x$$

$$\tan 2x = \frac{2\tan x}{1-\tan^2 x}$$

$$\sin^2 x = \frac{1}{2}(1 - \cos 2x)$$

$$\cos^2 x = \frac{1}{2}(1 + \cos 2x)$$

$$K_1 \cos x + K_2 \sin x = \sqrt{K_1^2 + K_2^2}\cos\left(x + \tan^{-1} - \frac{K_2}{K_1}\right)$$

$$e^{\pm jx} = \cos x \pm j \sin x \quad \text{(Euler's identity)}$$

$$\cos x = \frac{e^{jx} + e^{-jx}}{2}$$

$$\sin x = \frac{e^{jx} - e^{-jx}}{2j}$$

$$1 \text{ rad} = 57.296°$$

Hyperbolic Functions

$$\sinh x = \frac{1}{2}(e^x - e^{-x})$$

$$\cosh x = \frac{1}{2}(e^x + e^{-x})$$

$$\tanh x = \frac{\sinh x}{\cosh x}$$

$$\coth x = \frac{1}{\tanh x}$$

$$\operatorname{csch} x = \frac{1}{\sinh x}$$

$$\operatorname{sech} x = \frac{1}{\cosh x}$$

$$\sinh(x \pm y) = \sinh x \cosh y \pm \cosh x \sinh y$$

$$\cosh(x \pm y) = \cosh x \cosh y \pm \sinh x \sinh y$$

Derivatives

If $U = U(x)$, $V = V(x)$, and $a =$ constant,

$$\frac{d}{dx}(aU) = a\frac{dU}{dx}$$

$$\frac{d}{dx}(UV) = U\frac{dV}{dx} + V\frac{dU}{dx}$$

$$\frac{d}{dx}\left(\frac{U}{V}\right) = \frac{\left(V\frac{dU}{dx} - U\frac{dV}{dx}\right)}{V^2}$$

$$\frac{d}{dx}(aU^n) = naU^{n-1}$$

$$\frac{d}{dx}(a^U) = a^U \ln a\frac{dU}{dx}$$

$$\frac{d}{dx}(e^U) = e^U\frac{dU}{dx}$$

$$\frac{d}{dx}(\sin U) = \cos U\frac{dU}{dx}$$

$$\frac{d}{dx}(\cos U) = -\sin U\frac{dU}{dx}$$

Indefinite Integrals

If $U = U(x)$, $V = V(x)$, and $a =$ constant,

$$\int a\,dx = ax + C$$

$$\int U\,dV = UV - \int V\,dU \quad \text{(integration by parts)}$$

$$\int U^n\,dU = \frac{U^{n+1}}{n+1} + C, \quad n \neq 1$$

$$\int \frac{dU}{U} = \ln U + C$$

$$\int a^U\,dU = \frac{a^U}{\ln a} + C, \quad a > 0, a \neq 1$$

$$\int e^{ax}\,dx = \frac{1}{a}e^{ax} + C$$

$$\int xe^{ax}\,dx = \frac{e^{ax}}{a^2}(ax - 1) + C$$

$$\int x^2e^{ax}\,dx = \frac{e^{ax}}{a^3}(a^2x^2 - 2ax + 2) + C$$

$$\int \ln x\,dx = x\ln x - x + C$$

$$\int \sin ax\,dx = -\frac{1}{a}\cos ax + C$$

$$\int \cos ax\, dx = \frac{1}{a}\sin ax + C$$

$$\int \sin^2 ax\, dx = \frac{x}{2} - \frac{\sin 2ax}{4a} + C$$

$$\int \cos^2 ax\, dx = \frac{x}{2} + \frac{\sin 2ax}{4a} + C$$

$$\int x \sin ax\, dx = \frac{1}{a^2}(\sin ax - ax\cos ax) + C$$

$$\int x \cos ax\, dx = \frac{1}{a^2}(\cos ax + ax\sin ax) + C$$

$$\int x^2 \sin ax\, dx = \frac{1}{a^3}(2ax\sin ax + 2\cos ax - a^2x^2\cos ax) + C$$

$$\int x^2 \cos ax\, dx = \frac{1}{a^3}(2ax\cos ax - 2\sin ax + a^2x^2\sin ax) + C$$

$$\int e^{ax} \sin bx\, dx = \frac{e^{ax}}{a^2+b^2}(a\sin bx - b\cos bx) + C$$

$$\int e^{ax} \cos bx\, dx = \frac{e^{ax}}{a^2+b^2}(a\cos bx + b\sin bx) + C$$

$$\int \sin ax \sin bx\, dx = \frac{\sin(a-b)x}{2(a-b)} - \frac{\sin(a+b)x}{2(a+b)} + C, \quad a^2 \neq b^2$$

$$\int \sin ax \cos bx\, dx = -\frac{\cos(a-b)x}{2(a-b)} - \frac{\cos(a+b)x}{2(a+b)} + C, \quad a^2 \neq b^2$$

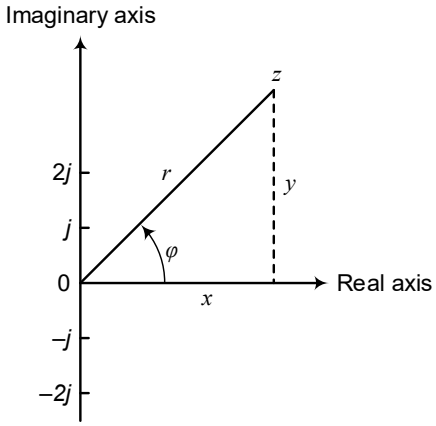
$$\int \cos ax \cos bx\, dx = \frac{\sin(a-b)x}{2(a-b)} + \frac{\sin(a+b)x}{2(a+b)} + C, \quad a^2 \neq b^2$$

$$\int \frac{dx}{a^2+x^2} = \frac{1}{a}\tan^{-1}\frac{x}{a} + C$$

$$\int \frac{x^2 dx}{a^2+x^2} = x - a\tan^{-1}\frac{x}{a} + C$$

$$\int \frac{dx}{(a^2+x^2)^2} = \frac{1}{2a^2}\left(\frac{x}{x^2+a^2} + \frac{1}{a}\tan^{-1}\frac{x}{a}\right) + C$$

Phasor & Complex Number



Complex number in rectangular form:

$$z = x + jy$$

$$r = \sqrt{x^2 + y^2}$$

$$\varphi = \tan^{-1}\frac{y}{x}$$

$$z = r(\cos\varphi + j\sin\varphi)$$

$$\frac{1}{j} = -j \text{ and } j = 1\angle 90°$$

Complex number in polar form:

$$z = r\angle\varphi$$

Complex number in exponential form:

$$z = re^{j\varphi}$$

Sinusoid ↔ phasor transformation:

$$V_m\cos(\omega t + \varphi) \leftrightarrow V_m\angle\varphi$$

$$V_m\sin(\omega t + \varphi) \leftrightarrow V_m\angle(\varphi - 90°)$$

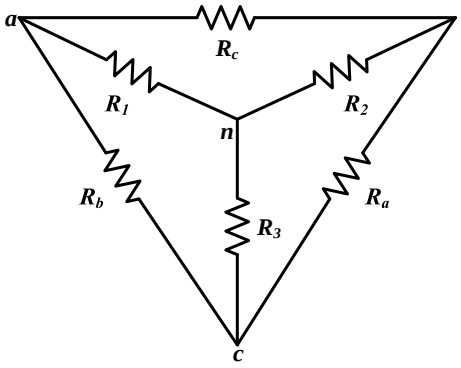
$$I_m\cos(\omega t + \theta) \leftrightarrow I_m\angle\theta$$

$$I_m\sin(\omega t + \theta) \leftrightarrow I_m\angle(\theta - 90°)$$

Mathematic operation of complex number:

Addition	$z_1 + z_2 = (x_1 + x_2) + j(y_1 + y_2)$
Subtraction	$z_1 - z_2 = (x_1 - x_2) + j(y_1 - y_2)$
Multiplication	$z_1 z_2 = r_1 r_2\angle(\varphi_1 + \varphi_2)$

Division	$\frac{z_1}{z_2} = \frac{r_1}{r_2}\angle(\varphi_1 - \varphi_2)$
Reciprocal	$\frac{1}{z} = \frac{1}{r}\angle -\varphi$
Square-root	$\sqrt{z} = \sqrt{r}\angle(\varphi/2)$
Complex conjugate	$z^* = x - jy = r\angle -\varphi = re^{-j\varphi}$



$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_c R_a}{R_a + R_b + R_c}$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c}$$

$$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$$

$$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$$

$$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$$

Delta-Wye Transformation

Transformasi Delta-Wye