UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2015/2016 Academic Session

June 2016

EEU 104 – ELECTRICAL TECHNOLOGY
[TEKNOLOGI ELEKTRIK]

Duration 3 hours

[Masa : 3 jam]

Please check that this examination paper consists of **TWENTY ONE (21)** 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 **ELEVEN (11**) and Malay version from page **TWELVE (12)** to page **TWENTY ONE (21).**

*Sila pastikan bahawa kertas peperiksaan ini mengandungi **DUA PULUH SATU (21)** 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 **SEBELAS (11**) dan versi Bahasa Melayu daripada muka surat **DUA BELAS (12)** sehingga muka surat **DUA PULUH SATU (21)**.*

Instructions: This question paper consists **SIX (6)** questions. Answer **FIVE (5)** questions. All questions carry the same marks.

*[**Arahan:** Kertas soalan ini mengandungi **SIX (6)** soalan. Jawab **LIMA (5)** soalan. Semua soalan membawa jumlah markah yang sama]*

Begin your answer to each question on a new page.
[Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru]

"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]

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ENGLISH VERSION

1. (a) Figure 1(a) shows a potentially dangerous situation. A voltage difference exists between one arm and one leg of a human body. A body will act as a conductor of current. Table 1(a) shows a range of reactions to various current levels.

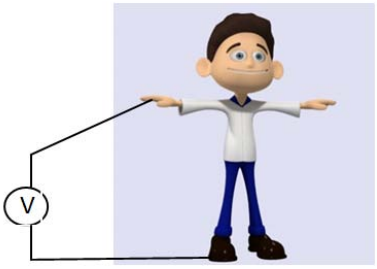

Figure 1(a)

Table 1(a): Reactions to Current Levels in Human

Reactions	Current
Barely preceptible	3-5 mA
Extreme pain	35-50 mA
Muscle paralysis	50-70 mA
Heart stoppage	500 mA

(i) Based on Figure 1(a), develop a simplified electrical model of the whole human body.

(15 marks)

(ii) Based on the model in Figure 1(a) and the circuit in (i). Assuming that the source is 250 V, the resistance of the arm is 400 Ω, the resistance of the trunk (chest and abdomen) is 50 Ω, and the resistance of the leg is 200 Ω. Calculate the current produced and discuss the effect to human body [Refer to Table 1(a)].

(15 marks)

(b) Using Mesh analysis,

(i) Write the mesh equations for the network in Figure 1(b)

(15 marks)

(iii) Solve the loop currents in the network.

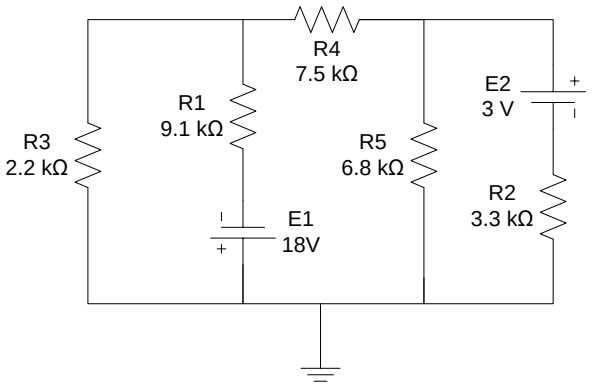

Figure 1(b)

(15 marks)

(c) Use a Y to Δ transformation to find i_0, i_1 and i_2 for the circuit in Figure 1(c).

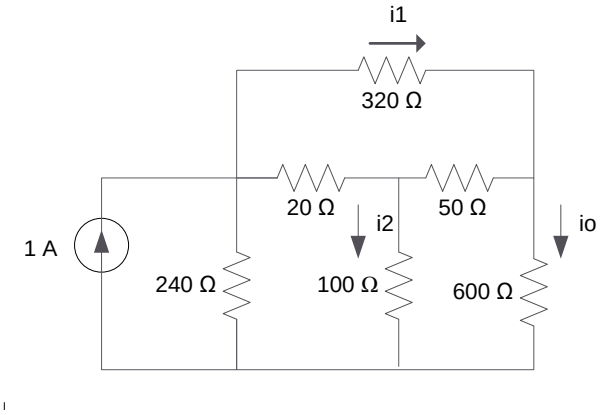

Figure 1(c)

(40 marks)

2. (a) For the network in Figure 2(a):

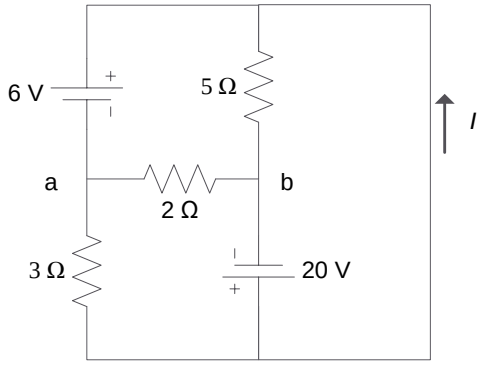

Figure 2(a)

(i) By using Kirchoff Voltage Law, determine the voltage, V_{ab} .

(15 marks)

(ii) Calculate the current, *I*. (15 marks)

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(b) Using superposition, find the current through *R1* for the network in Figure 2(b).

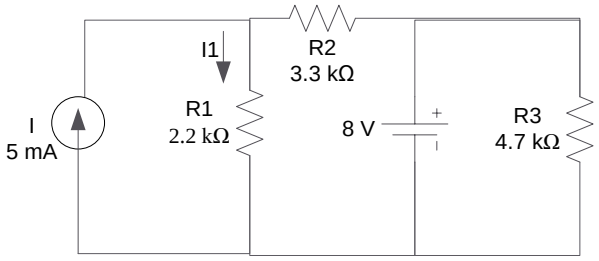

Figure 2(b)

(35 marks)

(c) Find the Thevenin equivalent circuit for the portions of the network in Figure 2(c) external to the point a and b.

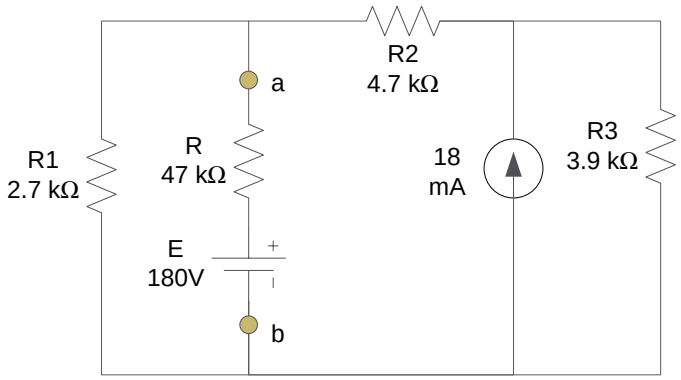

Figure 2(c)

(35 marks)

3. Switch in the following circuit [Figure 3(a)] is closed at $t = 0$.
Given that:

$u(-t) = 1$ for $t < 0$

$u(-t) = 0$ for $t > 0$

$u(-t) = 1 - u(t)$

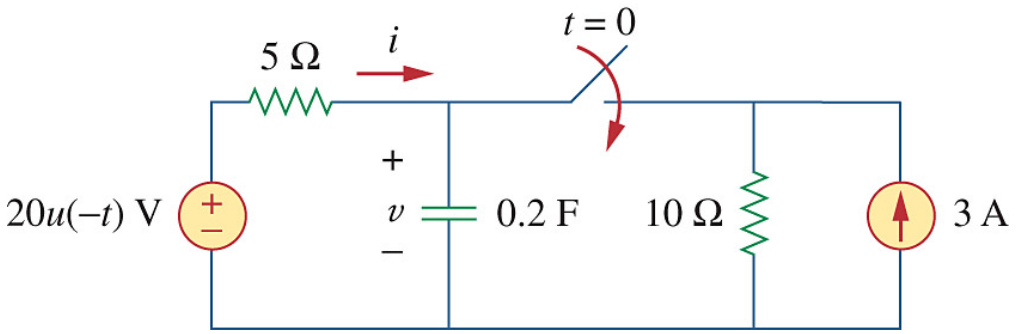

Figure 3(a)

For $t < 0$

(a) sketch the equivalent circuit (10 marks)

(b) find $i(t)$ (10 marks)

For $t > 0$, determine

(c) sketch the equivalent circuit by transforming current source into voltage source. (10 marks)

(d) $v(\infty)$ (10 marks)

(e) R_{th}, (10 marks)

(f) time constant , (10 marks)

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(g) current $i(t)$ (20 marks)

(h) $v(t)$ (20 marks)

4. (a) Determine v_c, i_L and the energy stored in the capacitor and inductor in the circuit below [Figure 4(a)].

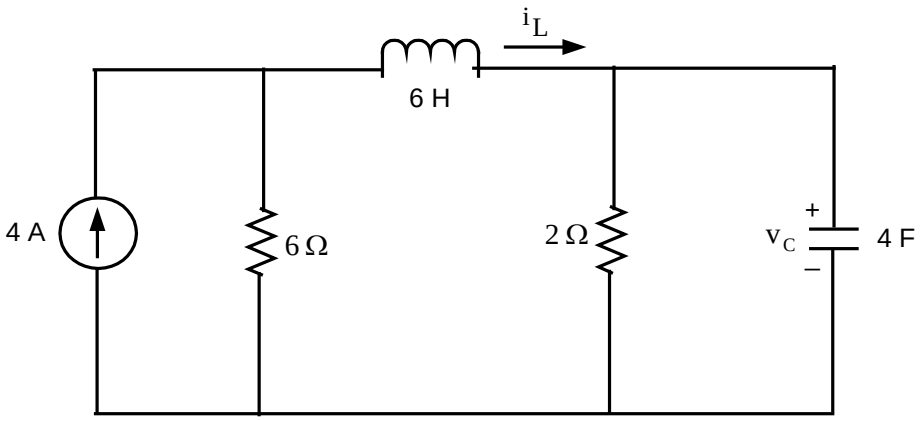

Figure 4(a) (30 marks)

(b) Obtain the equivalent capacitance of the network shown in the Figure 4(b).

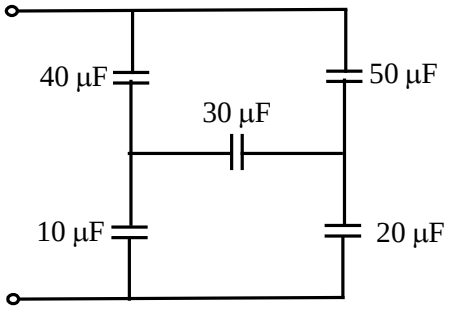

Figure 4(b)

(30 marks)

(c) The switch in the following circuit [Figure 4(c)] has been in position *a* for a long time. At $t = 0$, it moves to position *b*. For $t > 0$, sketch the equivalent circuit, determine C_{eq}, time constant τ and calculate $i(t)$ for all $t > 0$.

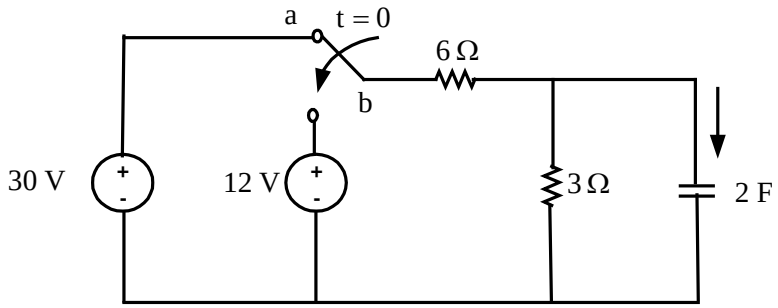

Figure 4(c) (40 marks)

5. Based on the 1-phase AC circuit shown in Figure 5:

(a) Calculate impedance . (5 marks)

(b) Calculate impedance . (5 marks)

(c) Calculate impedance . (5 marks)

(d) Determine the total impedance . as seen by the voltage source (10 marks)

(e) Draw the impedance triangle for the circuit. (5 marks)

(f) Determine . The final answer should be in the time domain. (10 marks)

(g) By applying current division rule, get The final answer should be in the time domain. (15 marks)

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(h) By using Kirchhoff current low, get The final answer should be in the time domain.

(15 marks)

(i) Analyse the circuit and determine the value of at time

(15 marks)

(j) Calculate the active power P used by the circuit. (15 marks)

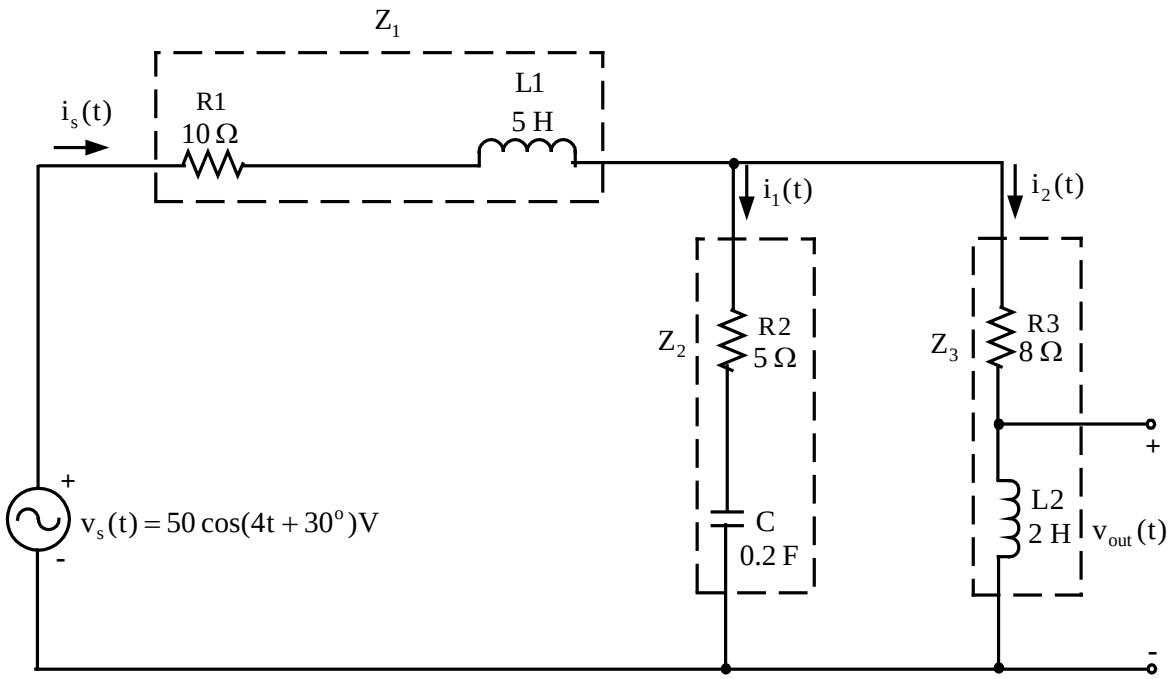


Figure 5

6. (a) Figure 6(a) shows a three-phase system with a balanced source, arranged as Y-connected. This systems is operated by frequency, f 60 Hz and has the line-to-neutral RMS voltage This voltage sourse is connected to a balanced load, also arranged as Y-connected. Each phase of load consists of a 0.1F capacitor in series with a resistor. Calculate:

(j) Line currents (15 marks)

(ii) Line-to-line voltages (15 marks)

(iii) Total active power, P, that is used by the load (5 marks)

(iv) Total reactive power, Q, that is delivered to the load (5 marks)

(v) The current that flow through the neutral line . (5 marks)

(vi) The value of current that flow through CN at time t=3 s. Given that

(10 marks)

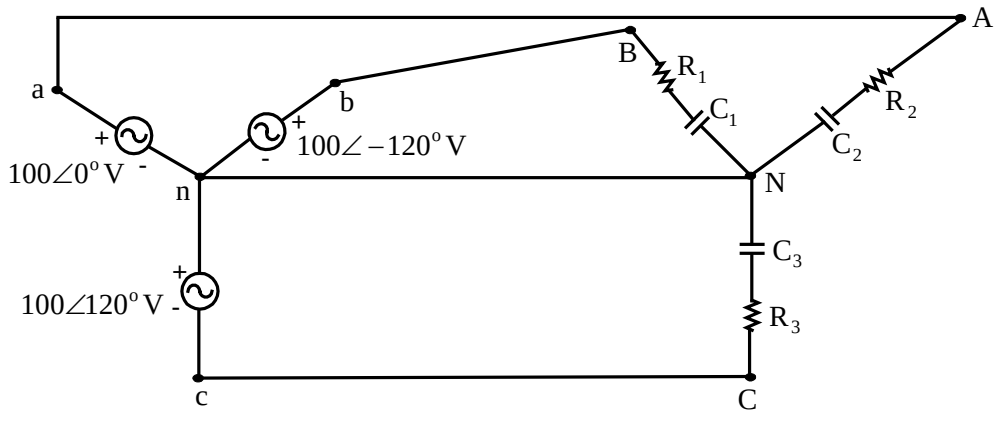


Figure 6(a)

(b) Figure 6(b) shows a circuit with an ideal transformer: Based on this circuit, calculate:

(i) Phasor currents and (15 marks)

(ii) Phasor voltages (15 marks)

(iii) Power delivered to load (15 marks)

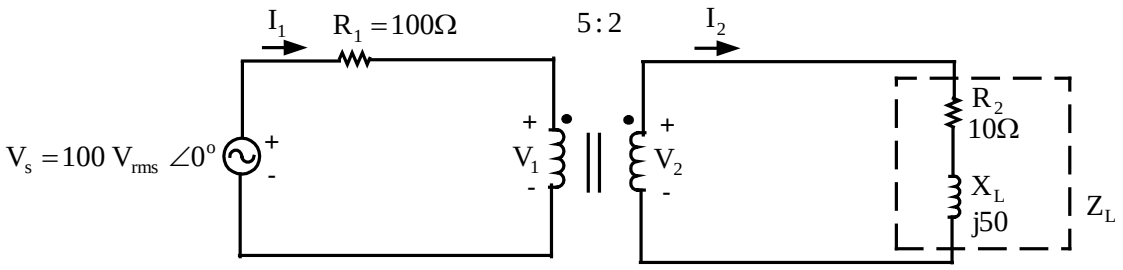
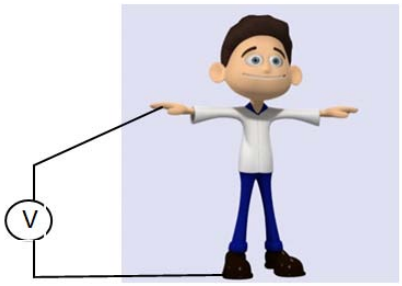


Figure 6(b)

VERSI BAHASA MALAYSIA

1. (a) Rajah 1(a) menunjukkan situasi yg berbahaya. Terdapat perbezaan voltan di antara salah satu tangan dan kaki badan manusia tersebut. Badan manusia akan bertindak sebagai konduktor arus. Jadual 1(a) menunjukkan reaksi pada kadar arus yang berbeza.



Rajah 1(a)

Jadual 1(a): Reaksi pada Kadar Arus Terhadap Manusia

Reaksi	Arus
Hampir ketara	3-5 mA
Sakit melampau	35-50 mA
Kelumpuhan otot	50-70 mA
Denyutan nadi terhenti	500 mA

(i) Berdasarkan Rajah 1(a), bangunkan model elektrikal termudah pada keseluruhan badan manusia.

(15 markah)

(ii) Berdasarkan model dalam Rajah 1(a) dan model dalam (i). Dengan anggapan bahawa punca ialah 250 V, rintangan pada tangan ialah 400 Ω, rintangan pada dada dan abdomen ialah 50 Ω, dan rintangan kaki ialah 200 Ω. Kira arus yang terhasil dan bincangkan kesan terhadap badan manusia. [Rujuk Jadual 1(a)].

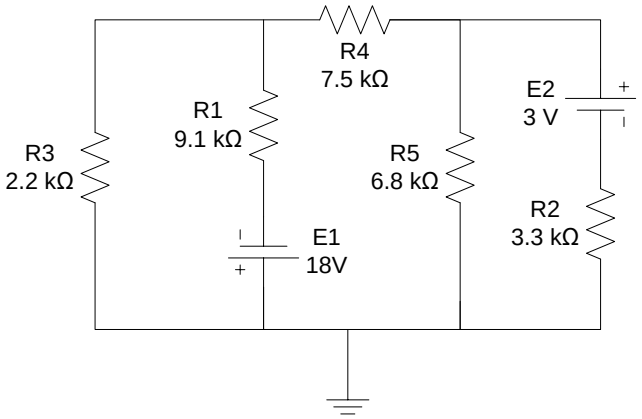
(15 markah)

(b) Dengan menggunakan analisis gegelung,

(i) Tuliskan persamaan gegelung bagi rangkaian dalam Rajah 1(b).

(15 markah)

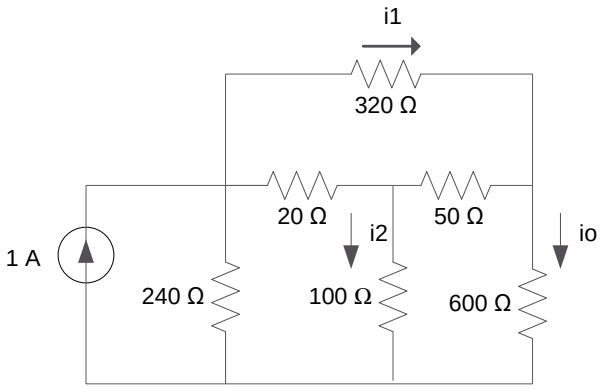
(ii) Selesaikan arus gegelung dalam rangkaian.



Rajah 1(b)

(15 markah)

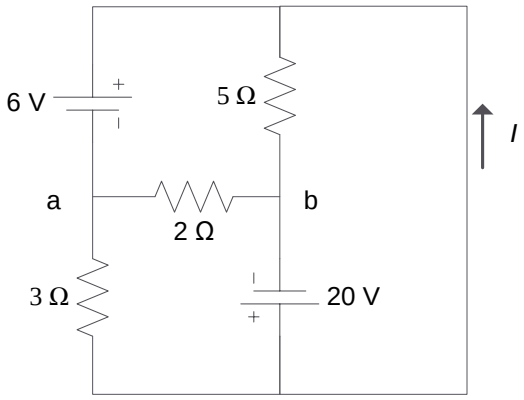
(c) Gunakan transformasi Y keΔ untuk mendapatkan i_0, i_1 dan i_2 bagi litar dalam Rajah 1(c).



Rajah 1(c)

(40 markah)

2. (a) Bagi rangkaian dalam Rajah 2(a):

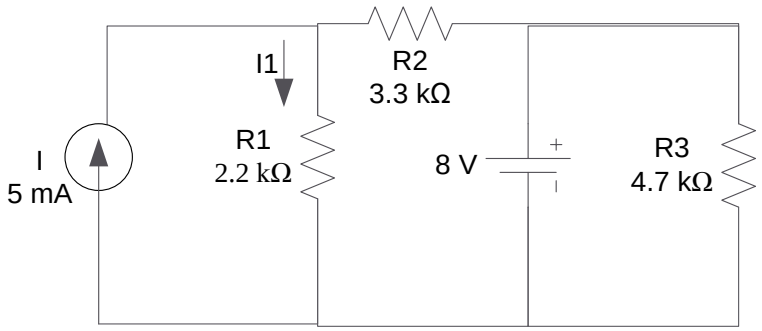


Rajah 2(a)

(i) Dengan menggunakan Hukum Voltan Kirchoff, tentukan nilai voltan, V_{ab} .
(15 markah)

(ii) Kirakan arus, *I*. (15 markah)

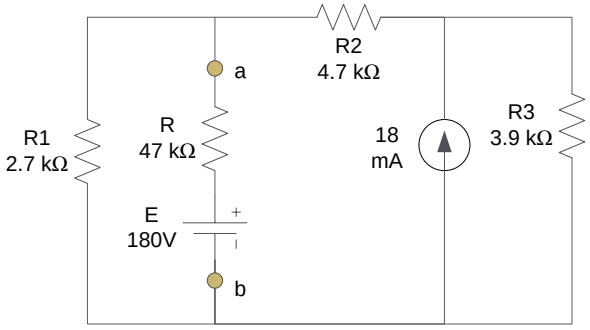
(b) Dengan menggunakan teknik Superposisi, kirakan arus yang melalui *R1* bagi rangkaian dalam Rajah 2(b).



Rajah 2(b)

(35 markah)

(c) Tentukan litar setara Thevenin bagi bahagian rangkaian dalam Rajah 2(c), luaran kepada titik *a* and *b*.



Rajah 2(c)

(35 markah)

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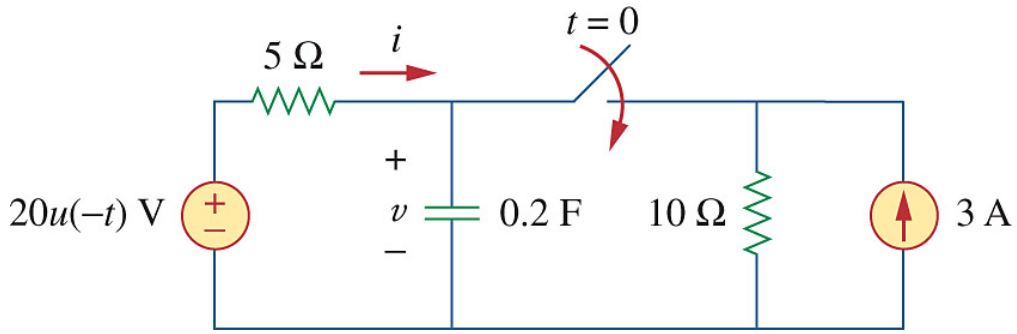
3. Suis dalam litar berikut [Rajah 3(a)] ditutup pada t = 0.

Diberi:

$u(-t) = 1$ for $t < 0$

$u(-t) = 0$ for $t > 0$

$u(-t) = 1 - u(t)$



Rajah 3(a)

Untuk t <0

(a) lakarkan litar setara, (10 markah)

(b) dapatkan i (t) (10 markah)

Untuk t > 0, dapatkan,

(c) lakarkan litar setara dengan menukar sumber arus kepada sumber voltan (10 markah)

(d) $v(\infty)$ (10 markah)

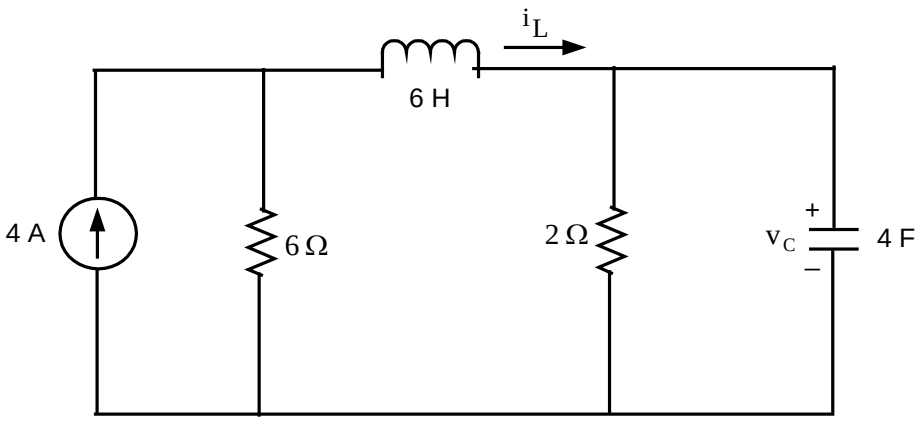
(e) R_{th}, (10 markah)

(f) pemalar masa , (10 markah)

(g) arus $i(t)$ (20 markah)

(h) $v(t)$ (20 markah)

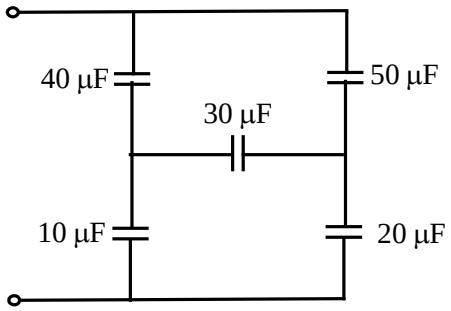
4. (a) Dapatkan v_c, i_L dan tenaga terkumpul di dalam kapasitor dan induktor di litar berikut [Rajah 4(a)].



Rajah 4(a)

(30 markah)

(b) Dapatkan kapasitan setara dalam rangkaian yang ditunjukkan dalam Rajah 4(b)

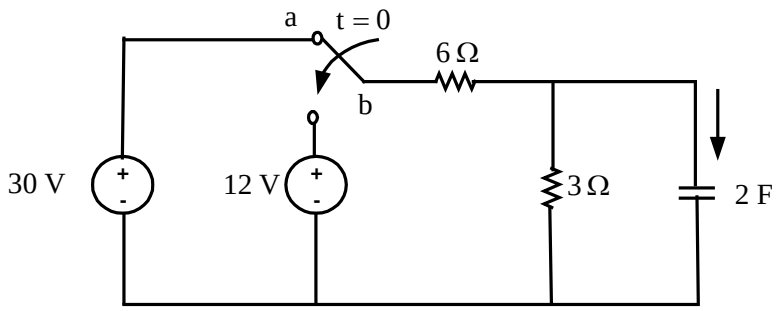


Rajah 4(b)

(30 markah)

(c) Suis dalam litar berikut [Rajah 4(c)] telah berada dalam kedudukan a untuk masa yang lama. Pada t = 0, ia bergerak ke kedudukan b. Untuk t > 0, lakarkan litar setara, dapatkan C_{eq}, pemalar masa τ dan kira i (t) untuk semua t> 0.

(40 markah)



Rajah 4(c)

5. Berpandukan kepada litar AC 1-fasa yang ditunjukkan dalam Rajah 5:

(a) Kirakan galangan . (5 markah)

(b) Kirakan galangan . (5 markah)

(c) Kirakan galangan . (5 markah)

(d) Tentukan galangan keseluruhan sepertimana dilihat oleh sumber voltan

(10 markah)

(e) Lukiskan segitiga galangan bagi litar tersebut. (5 markah)

(f) Tentukan . Jawapan akhir hendaklah dalam domain masa. (10 markah)

(g) Dengan menggunakan aturan pembahagian arus, dapatkan Jawapan akhir hendaklah dalam domain masa.

(15 markah)

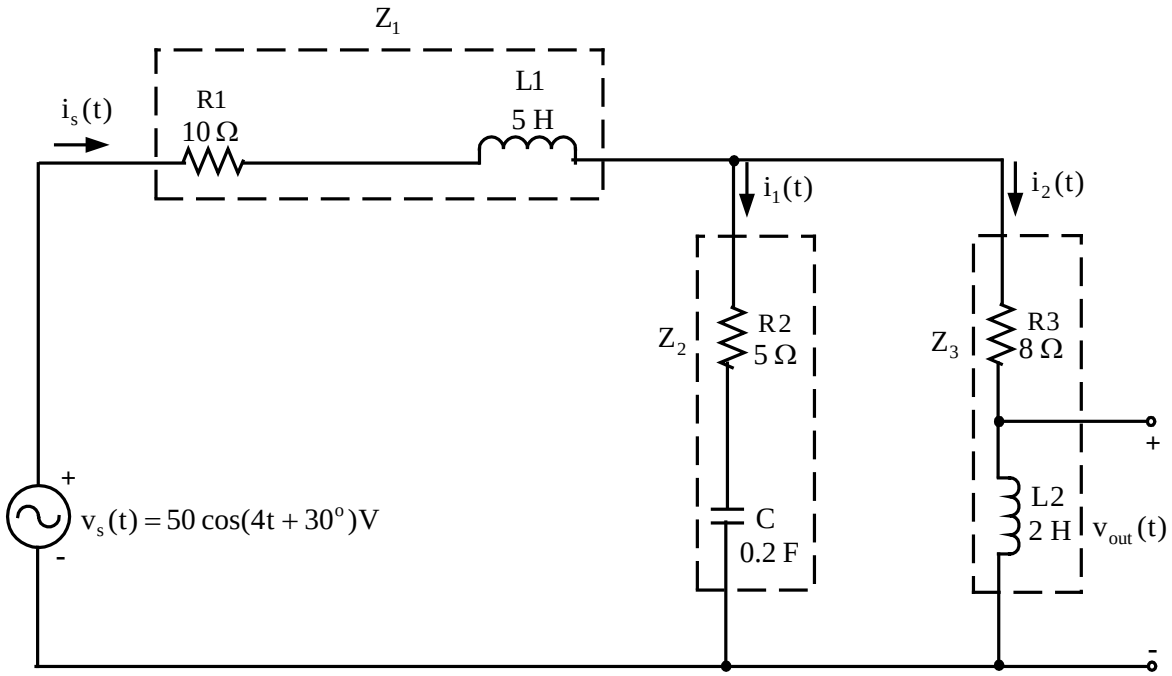
(h) Dengan menggunakan hukum arus Kirchhoff, dapatkan . Jawapan akhir hendaklah dalam domain masa.

(15 markah)

(i) Analisa litar tersebut, dan tentukan nilai pada masa

(15 markah)

(j) Kirakan kuasa aktif P yang digunakan oleh litar tersebut. (15 markah)



Rajah 5

6. (a) Rajah 6(a) menunjukkan satu sistem tiga fasa dengan sumber seimbang yang disusun dalam sambungan-Y. Sistem ini beroperasi pada frekuensi, f 60 Hz dan mempunyai nilai voltan RMS talian-ke-neutral Sumber voltan ini disambungkan kepada beban terdiri daripada pemuat 0.1F yang bersiri dengan perintang . Kirakan:

(i) Arus-arus talian (15 markah)

(ii) Voltan-voltan talian-ke-talian (15 markah)

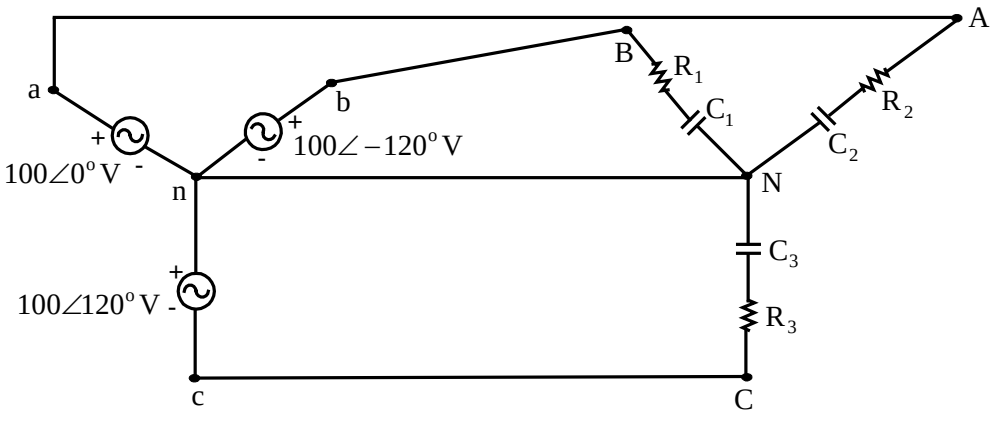
(iii) Tenaga aktif keseluruhan, P, yang digunakan oleh beban (5 markah)

(iv) Tenaga reaktif keseluruhan, Q, yang dihantar kepada beban (5 markah)

(v) Arus yang mengalir melalui talian neutral, . (5 markah)

(vi) Nilai arus yang mengalir melalui CN pada masa t=3 s. Diberikan bahawa

(10 markah)



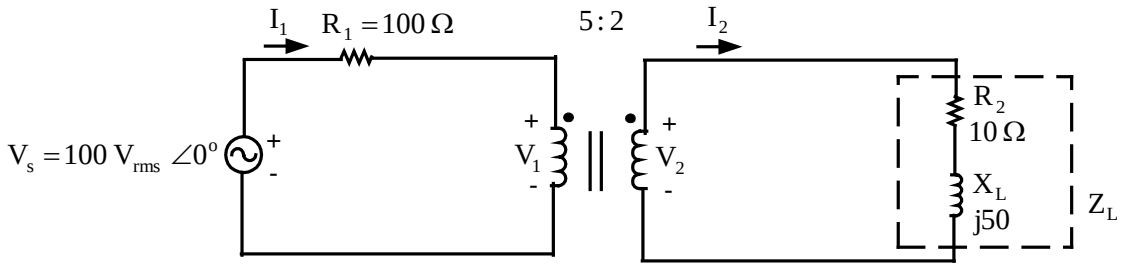
Rajah 6(a)

(b) Rajah 6(b) menunjukkan litar dengan pengubah unggul. Berpandukan litar tersebut, kirakan:

(i) Arus fasor (15 markah)

(ii) Voltan-voltan fasor (15 markah)

(iii) Tenaga yang dibekalkan kepada beban (15 markah)



Rajah 6(b)

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