
UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2007/2008

October/November 2007

EEU 104 – ELECTRICAL TECHNOLOGY
[Teknologi Elektrik]

Duration: 3 hours
[Masa: 3 jam]

Please check that this examination paper consists of NINE pages of printed material and ONE page APPENDIX before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEMBILAN muka surat bercetak dan SATU muka surat LAMPIRAN sebelum anda memulakan peperiksaan ini].

This paper contains SIX questions.

[Kertas soalan ini mengandungi ENAM soalan].

Instructions: Answer FIVE (5) questions. If a candidate answer more than five questions, only the first five answered will be examined and awarded marks.

[Arahan: Jawab LIMA soalan. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah].

Answer to any question must start on a new page.

[Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru].

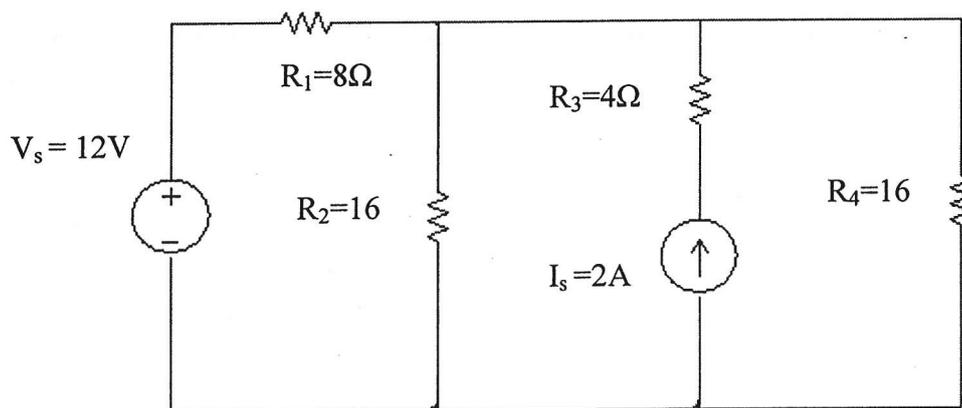
You may answer a question either in bahasa Malaysia or in English.

[Anda dibenarkan menjawab soalan sama ada dalam bahasa Malaysia atau bahasa Inggeris].

1. Cari nilai arus yang melalui R_4 dalam Rajah 1 di bawah, dengan menggunakan teknik;

Find the current that flows through R_4 in Figure 1, using the following to technique;

- (a) Teorem Thevenin
Thevenin theorem (30%)
- (b) Teorem Tindihan
Superposition theorem (40%)
- (c) Analisis nod
Nodal analysis (30%)



Rajah 1
Figure 1

2. Dua kapasitor $C_1 = 1200 \text{ pF}$ dan $C_2 = 2200 \text{ pF}$ disambungkan secara selari dan kapasitor $C_3 = 3400 \text{ pF}$ adalah disambungkan secara bersiri kepada mereka seperti dalam Rajah 2. Kapasitor-kapasitor ini disambungkan kepada satu suis dan punca voltan $V_S = 10 \text{ V d.c.}$ Suis terletak pada sambungan "a" untuk proses pengecasan sehingga kapasitor dicas sepenuhnya. Kemudian, suis dengan secara cepat diubahkan ke sambungan "b" dan cas yang terkumpul dinyahcaskan melalui perintang R_2 .

Two capacitors $C_1 = 1200 \text{ pF}$ and $C_2 = 2200 \text{ pF}$ are connected in parallel and $C_3 = 3400 \text{ pF}$ is connected in series to them as shown in Figure 2. The capacitors are connected with a switch, and voltage source $V_S = 10 \text{ V d.c.}$ The switch stayed at point "a" for charging process until the voltage across capacitor has reached constant value (fully charged). Then, the switch S is immediately moved to point "b" and the accumulated charges are discharged through resistor R_2 .

- (a) Nyatakan tiga bahagian untuk **proses pengecasan** (berikan jawapan dengan ketaksamaan masa, rajah litar dan nilai permulaan).

*State the three domains of the **charging process** (give your answers using time equality, circuit diagram and initial quantities).*

(20%)

- (b) Cari nilai R_1 supaya jumlah tenaga tersimpan dalam kedua-dua kapasitor adalah $25 \text{ } \mu\text{J}$ dalam masa $250 \text{ } \mu\text{s}$ semasa kapasitor itu dicas.

Find R_1 so that the total energy stored in both capacitors is $25 \text{ } \mu\text{J}$ within $250 \text{ } \mu\text{s}$ when the capacitors are charging.

(20%)

...4/-

- (c) Nyatakan tiga bahagian dalam **proses penyahcasan** (berikan jawapan dengan masa ketidaksamaan, rajah litar, dan kuantiti permulaan).

*State the three domains of the **discharging process** (gives answers using time equality, circuit diagram and initial quantities).*

(20%)

- (d) Cari nilai R_2 semasa proses penyahcasan di mana voltan melalui kapasitor turun sebanyak 36.8 % daripada cas penuh dalam masa 1 ms.

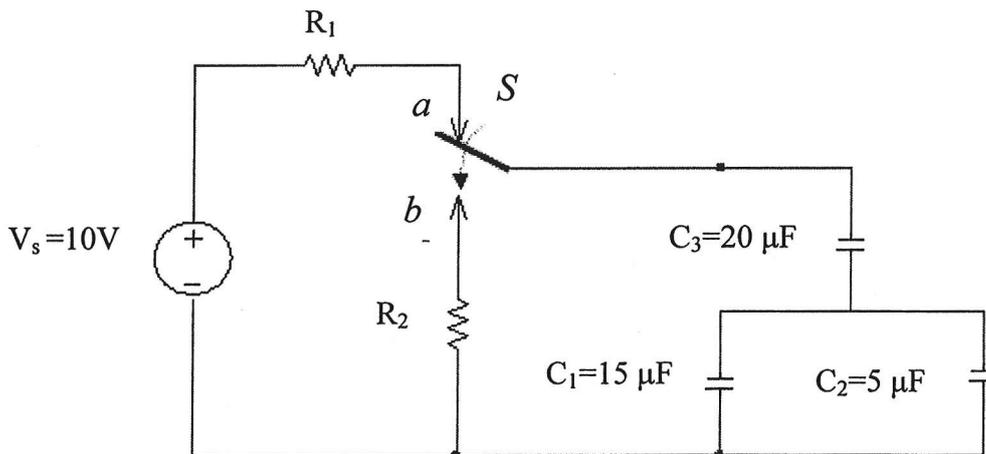
Find R_2 during discharge, the voltage across capacitors fall 36.8% of the saturation (fully charged) condition within 1 ms.

(20%)

- (e) Kira tenaga yang tersimpan dalam kapasitor-kapasitor tersebut setelah 1.5 ms.

Calculate the energy left (stored) in the capacitors after 1.5 ms discharged.

(20%)



Rajah 2
Figure 2

3. (a) Dengan menggunakan kesetaraan di antara e.m.f yang memaksa arus mengalir melalui sebuah perintang dalam satu litar tertutup, terangkan kelakuan fluks magnet dalam litar magnet tertutup yang dipaksa oleh m.m.f. Berikan jawapan anda dalam perkataan dan rajah litar.

Using the analogy between e.m.f. that forces the current to flow through a resistor in closed loop circuit, explain the behaviour of magnetic flux in closed loop ferromagnetic core forced by the m.m.f. Gives explanation in words as well as circuit diagram.

(10%)

- (b) Nyatakan kesetaraan di antara hukum ohm untuk litar arus terus (d.c.) dengan hukum ohm untuk litar fluks magnet. Terangkan persamaan tersebut dari segi persamaan matematik dan setiap angkuabah dalam persamaan.

State the analogy between ohm's law for d.c. circuit and the Ohm's law for magnetic circuit. Explain the analogy in term of their mathematical expressions and each variable in the expression.

(20%)

- (c) Terangkan mengapa jumlah fluks magnet (Φ) dalam teras feromagnet adalah diberikan sebagai $\Phi = N\Psi = \frac{N^2i}{S}$ di mana $\Psi = \frac{Ni}{S}$.

Explain why the total magnetic flux (Φ) in the ferromagnetic core of a magnetic circuit is given by $\Phi = N\Psi = \frac{N^2i}{S}$ where $\Psi = \frac{Ni}{S}$.

(20%)

- (d) Terbitkan persamaan untuk voltan yang diaruhkan pada induktor adalah sebagai $v = L \frac{di}{dt}$ dan persamaan untuk induktans adalah sebagai

$$L = \frac{\mu_r \mu_0 AN^2}{l}.$$

Derive the expression for induced voltage across an inductor as

$$v = L \frac{di}{dt} \text{ and the expression for inductance as } L = \frac{\mu_r \mu_0 AN^2}{l}.$$

(20%)

- (e) Terbitkan persamaan untuk arus daripada persamaan untuk v .

Derive the expression for current from the expression of v .

(20%)

- (f) Terbitkan persamaan untuk tenaga (W).

Derive the expression for energy (W).

(10%)

4. (a) Terangkan apa yang dimaksudkan dengan nilai r.m.s untuk arus ulangalik.

Explain what is meant by the r.m.s value of the alternating current.

- (b) Pada sesuatu litar yang dibekalkan dengan 50 Hz daripada bekalan utama, yang mempunyai perbezaan nilai arus sebanyak 10A. Pada masa permulaan, $t=0$, nilai permulaan bagi perbezaan potensi dan arus adalah 400V dan 4A yang bertambah secara positif.

In a certain circuit supplied from 50 Hz mains, the potential difference has a maximum value of 10A. At the instant $t=0$, the instantaneous values of the potential difference and the current are 400V and 4A respectively, both increasing positively.

- (i) Anggapkan perubahan sinus, nyatakan fungsi trigonometri untuk nilai perbezaan potensi dan arus pada masa t .

Assuming sinusoidal variation, state trigonometrical expression for the instantaneous values of the potential difference and the current at time t .

- (ii) Kirakan nilai permulaan pada $t=0.015$ -s dan cari perbezaan fasa di antara perbezaan potensi dan arus.

Calculate the instantaneous values at the instant $t=0.015$ s and find the angle of phase difference between the potential difference and the current.

- (iii) Lakarkan rajah fasa.

Sketch the phasor diagram.

(100%)

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5. Satu litar induktor 0.1 H dan tidak mempunyai nilai rintangan disambung secara siri dengan perintang pada 25 Ω . Litar itu telah dibekalkan oleh penjana 230 V, 50 Hz. Kirakan:-

A coil of inductance 0.1 H and negligible resistance is connected in series with a 25 Ω resistor . The circuit is energized from 230 V, 50 Hz source. Calculate:-

- (a) Nilai arus dalam litar.
The current in the circuit.
- (b) Nilai perbezaan potensi pada litar tersebut.
The potential difference across the coil.
- (c) Nilai perbezaan potensi pada perintang.
The potential difference across the resistor.
- (d) Sudut fasa pada litar.
The phase angle of the circuit.
- (e) Lukiskan rajah fasa mewakili komponen nilai-nilai arus dan voltan.
Draw a phasor diagram representing the current and the component voltages.

(100%)

6. Transformer satu fasa pada 10 kVA 230 V / 100 V. Apabila terminal menengah litar buka dan gegelung utama dibekalkan dengan voltan biasa (230 V), arus masukan adalah 2.6 A pada faktor kuasa 0.3. Apabila terminal menengah dilitar pintaskan, voltan 18 V dibekalkan pada gegelung utama dan menyebabkan arus penuh beban (100 A) mengalir ke gegelung menengah, Kirakan:

A single-phase transformer is rated at 10 kVA, 230 V/100 V. When the secondary terminals are open-circuited and the primary winding is supplied at normal voltage (230 V), the current input is 2.6 A at a power factor of 0.3. When the secondary terminals are short-circuited, a voltage of 18 V applied to the primary causes the full-load current (100 A) to flow in the secondary, the power input to the primary being 240 V. Calculate:

- (a) Kecekapan transformer pada beban penuh, faktor kuasa uniti.
The efficiency of the transformer at full load, unity power factor.
- (b) Beban apabila kecekapan yang maksimum berlaku.
The load at which maximum efficiency occurs.
- (c) Nilai kecekapan maksimum.
The value of the maximum efficiency.

(100%)

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Appendix

1. $e = -1.602 \times 10^{-19}$ [C]
2. $i = \frac{dq}{dt}$ [A]
3. $Q = \int_{t_0}^t i dt$ [C]
4. $v = \frac{dw}{dq}$ [V]
5. $w = F \times d$ [J]
6. $p = vi$ [W]
7. $C = \frac{Q}{V}$ [F]
8. $i_c = C \frac{dv_c}{dt}$
9. $v_c = \frac{1}{C} \int i_c dt$
10. $v_L = L \frac{di_L}{dt}$
11. $i_L = \frac{1}{L} \int v_L dt$
12. $W = \frac{1}{2} CV^2$
13. $W = \frac{1}{2} LI^2$
14. $v_c(t) = E(1 - e^{-t/\Gamma})$ - voltage during charging capacitor
15. $i_c(t) = \frac{E}{R} e^{-t/\Gamma}$ - current during charging capacitor
16. $v_c(t) = Ee^{-t/\Gamma}$ - voltage during discharging capacitor
17. $i_c(t) = -\frac{E}{R} e^{-t/\Gamma}$ - current during discharging capacitor
18. $v_L = L \frac{di_L}{dt}$ - voltage during increasing inductor current/energy
19. $i_L = \frac{1}{L} \int v_L dt$ - current during increasing inductor current/energy
20. $v_L(t) = -Ee^{-t/\Gamma}$ - voltage during decreasing inductor current/energy
21. $i_L(t) = \frac{E}{R} e^{-t/\Gamma}$ - current during decreasing inductor current/energy