
UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2007/2008

October/November 2007

EEK 361 – POWER ELECTRONICS
[Elektronik Kuasa]

Duration: 3 hours
[Masa: 3 jam]

Please check that this examination paper consists of TEN pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH muka surat bercetak 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. (a) Terangkan secara ringkas objektif elektronik kuasa.
Briefly explain the objective of power electronic. (20%)

- (b) Sebuah pengatur voltan menerima masukan kuasa sebanyak 2 W dan membekalkan kuasa kepada beban sebanyak 0.8 W. Hitung kecekapan bagi litar tersebut.

A voltage regulator received an input power of 2 W and delivers 0.8 W to the load. Calculate the efficiency of the circuit.

(20%)

- (c) Lakarkan ciri voltan arus bagi peranti semikonduktor berikut:

Sketch the symbol and voltage current characteristic for the following semiconductor devices:

(i) Diod
Diode

(ii) Tiristor
Thyristor

(iii) BJT
BJT

(20%)

- (d) Terangkan fungsi suis kuasa yang ideal.
Explain the function of an ideal power switch.

(20%)

- (e) Satu diod mempunyai kejatuhan voltan hadapan $V_D = 1.1$ V pada arus $I_D = 250$ A. Sekiranya $n = 2$ dan $V_T = 25.8$ mV. Hitung arus penepuan bagi diod tersebut.

A diode with a forward voltage drop of $V_D = 1.1$ V at a current of $I_D = 250$ A. If $n = 2$ and $V_T = 25.8$ mV. Calculate the saturated current of the diode.

(20%)

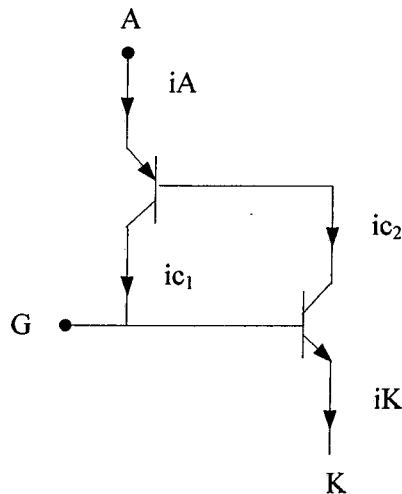
...3/-

2. (a) Jelaskan kaedah untuk mematikan tiristor menggunakan kapasitor.
Explain the method to off the thyristor by using the capacitor. (20%)

(b) Berpandukan gambarajah, terangkan apakah cas pulihan balikan bagi sesuatu diod.

With the aid of block diagram, explain the reverse recovery charge for a diode. (25%)

(c) Berdasarkan Rajah 1, jelaskan konsep operasi sebuah tiristor.
Based on Figure 1, explain the operation concept of the thyristor. (25%)



Rajah 1
Figure 1

(d) Terangkan kaedah untuk menghidupkan MOSFET dan kebaikan MOSFET berbanding peranti lain.

Explain the techniques to turn ON the MOSFET and an advantage of MOSFET in comparison with other devices.

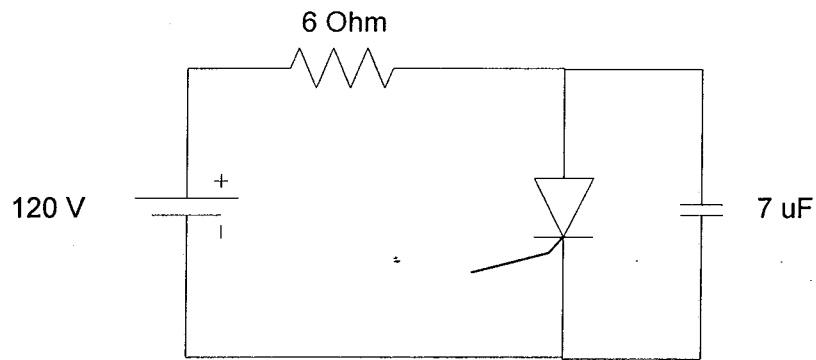
(15%)

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- (e) Merujuk kepada Rajah 2, jika t_q yang diperlukan adalah $15 \mu\text{s}$, tentukan samada tiristor mempunyai masa yang mencukupi untuk tutup:

Referring to Figure 2, if required t_q is $15 \mu\text{s}$, determine whether the thyristor has enough time to turn off.

(15%)



Rajah 2
Figure 2

3. (a) Merujuk kepada Rajah 3, hitung:

Referring to Figure 3, calculate:

- (i) R_B yang menghasilkan ketepuan dengan ODF 5.

R_B that gives saturation with ODF 5.

- (ii) β_{forced} .

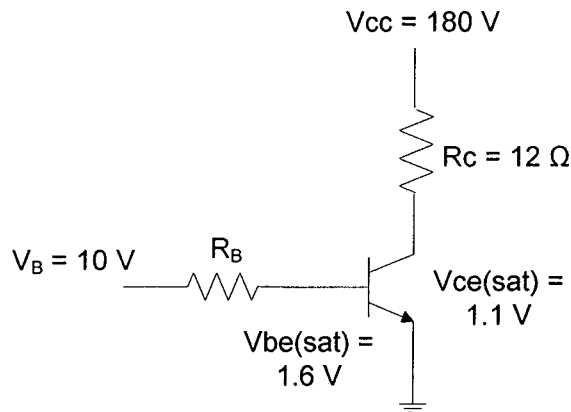
β_{forced} .

- (iii) Kehilangan kuasa transistor.

Power loss of the transistor.

(30%)

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Rajah 3
Figure 3

- (b) Dua plat kuprum yang diletakkan secara selari pada jarak $5\ \mu\text{m}$. Sekiranya ketelusan elektrik adalah $10\ \text{pF/m}$, hitung keluasan plat yang diperlukan untuk menghasilkan kapasitor bernilai $40\ \text{pF}$.

Two copper plate located in parallel at a distance of $5\ \mu\text{m}$. If the electrical permeability is $10\ \text{pF/m}$, calculate the area of the plate to produce a capacitor of $40\ \text{pF}$.

(20%)

- (c) Sekiranya setiap plat kapasitor dalam soalan 3(b) disambungkan ke dawai sepanjang $10\ \text{mm}$ dan rintangan dawai adalah $0.05\ \Omega/\text{cm}$. Rintangan bocor bagi kapasitor di atas adalah $0.04\ \Omega$ dan beroperasi pada $100\ \text{kHz}$. Hitung:

If the plates of the capacitor in question 3(b) were connected to $10\ \text{mm}$ long wire and the resistance of the wire is $0.05\ \Omega/\text{cm}$. A leakage resistance of the abovementioned capacitor is $0.04\ \Omega$ and operating at $100\ \text{kHz}$. Calculate:

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(i) ESR bagi kapasitor.
ESR of the capacitor.

(ii) Faktor lesapan.
Dissipation factor. (30%)

(d) Suatu perintang belitan dawai dibentuk dari dawai nikrom yang panjangnya 0.5 m bersaiz #30 AWG dengan kerintangan $1.1\mu\Omega$ bergarispusat 0.0254 cm. Hitung nilai rintangan bagi perintang di atas.

A wire wound resistor was made from a 0.5 m #30 AWG nicrom wire with a resistivity of $1.1\mu\Omega$ having a diameter of 0.0254 cm. Calculate a resistance for the resistor.

(20%)

4. (a) (i) Terangkan prinsip operasi bagi langkah turun penukar dc-dc yang termudah. Penjelasan anda perlu mengandungi persamaan bagi voltan keluaran, nilai rms voltan keluaran dan kuasa masukan dan keluaran bagi penukar ini.

Explain the operation of the simplest step-down operation of dc-dc converters. Your explanation should include the equation for average output voltage, the rms of output voltage and the input and output power of the converter.

(30%)

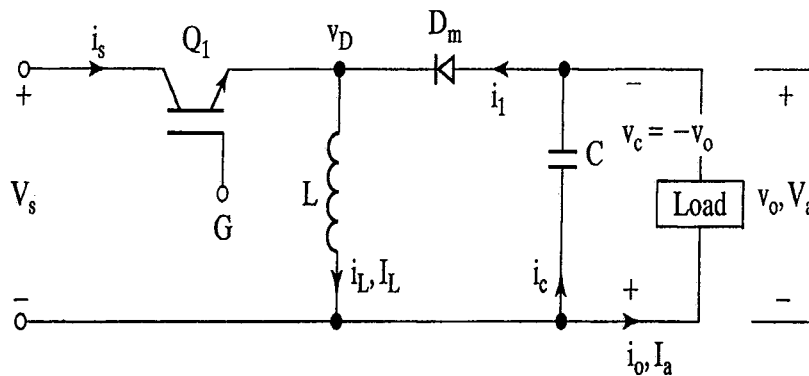
- (ii) Satu penukar dc-dc dalam 4(a)(i) yang mempunyai rintangan beban, $R=10$ ohm dan voltan masukan, $V_s=220$ V. Apabila suis penukar tersebut masih tertutup, jatuhan voltan $V_{ch}=2$ V dan frekuensi pemenggal $f=1$ kHz. Sekiranya kitar tugas ialah 50%, tentukan:-

A dc-dc converter in 4(a)(i) has a resistive load of $R=10$ ohm and the input voltage is $V_s=220$ V. When the converter switch remains on, its voltage drop is $V_{ch}=2$ V and the chopping frequency is $f=1$ kHz. If the duty cycle is 50%, determine:-

- (a) Voltan keluaran purata
The average output voltage
- (b) Voltan keluaran rms
The rms output voltage
- (c) Kecekapan penukar
The converter efficiency
- (d) Rintangan input berkesan bagi penukar
The effective input resistance of the converter (30%)

- (b) (i) Terangkan prinsip operasi bagi litar di bawah.

Explain the principle operation of the following circuit



Rajah 4(a)
Figure 4(a)

(30%)
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- (ii) Buktikan bahawa purata voltan keluaran seperti ditunjukkan di bawah.
Prove that the average output voltage is as given below.

$$V_a = \frac{V_s k}{1 - k}$$

Di mana k ialah kitar tugas

Where k is the duty cycle

(10%)

5. (a) Jelaskan apakah inverter satu fasa. Penjelasan mesti merangkumi prinsip operasi titi penuh, parameter prestasi, bentuk gelombang, terbitan persamaan untuk nilai rms voltan keluaran dan terbitan persamaan untuk voltan keluaran ketika.

Explain what is a single phase inverter. Explanation should cover the principle of operation, performance parameters, waveforms, derivation of the root mean square (rms) output voltage and the instantaneous output voltage equations.

(50%)

- (b) Rekabentuk satu penyongsang kawalan mikropengawal yang lengkap bagi satu 12-V bateri kereta untuk menghasilkan output 230 V, 50 Hz. Penjelasan anda perlu dibantu oleh satu rajah skematik sistem yang dicadangkan.

Design a complete microcontroller-controlled inverter for a 12-V car battery to produce 230 V, 50 Hz output. Your explanation should be supported by a schematic diagram of your proposed system.

(50%)

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- (b) Rektifier titi 3 fasa ditunjukkan oleh Rajah 6(b) mempunyai beban rintangan tulin R.

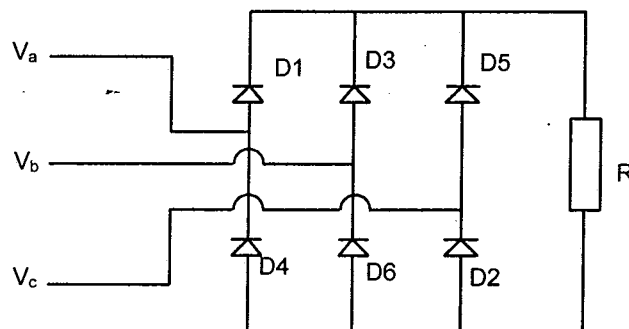
A three phase bridge rectifier shown in Figure 6(b) has a pure resistive load of R.

- (i) Lukis bentuk gelombang voltan-voltan fasa dan bentuk gelombang beban.

Draw the phase voltages waveforms and the load waveform.

- (ii) Tentukan kecekapan litar tersebut.

Determine the efficiency of the circuit.



Rajah 6(b)
Figure 6(b)

(60%)

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