UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang Akademik 1995/96

Oktober - November 1995

EEE 441 - Elektronik Kuasa

Masa : [3 jam]

ARAHAN KEPADA CALON :

Sila pastikan bahawa kertas peperiksaan ini mengandungi 12 muka surat bercetak dan **ENAM (6)** soalan sebelum anda memulakan peperiksaan ini.

Jawab **LIMA (5)** soalan.

Agihan markah bagi soalan diberikan di sut sebelah kanan soalan berkenaan.

Jawab semua soalan di dalam Bahasa Malaysia.

...2/-

1. (a) **Apakah langkah-langkah yang terlibat di dalam rekabentuk peralatan elektronik kuasa?**

What are the steps involved in designing power electronics equipment?

(15%)

(b) **Apakah kesan-kesan sampingan dari peralatan elektronik kuasa?**

What are the peripheral effects of power electronics equipment?

(15%)

(c) **Bentuk gelombang pulihan TUTUP (turn off) suatu peranti ditunjukkan oleh Rajah 1-1. Jika Q_{rr} ialah cas pulihan seperti ditunjukkan oleh kawasan lorekan, I_{RM} ialah arus balikan puncak, t_{rr} ialah masa pulih balikan dan t_1, t_2 merupakan bahagian dari t_{rr}. Terbitkan ungkapan untuk t_{rr} dan I_{RM} dalam sebutan Q_{rr} dan di/dt untuk pulihan pentas dan pulihan lembut.**

The waveforms for turnoff recovery of a device is shown in Figure 1-1. If Q_{rr} is the recovered charge shown in the shaded area, I_{RM} is the peak reverse current, t_{rr} is the reverse recovery time, and time t_1 and t_2 are subdivisions of t_{rr}. Derive the expressions for t_{rr} and I_{RM} in term of Q_{rr} and di/dt for abrupt recovery and a very soft recovery.

(40%)

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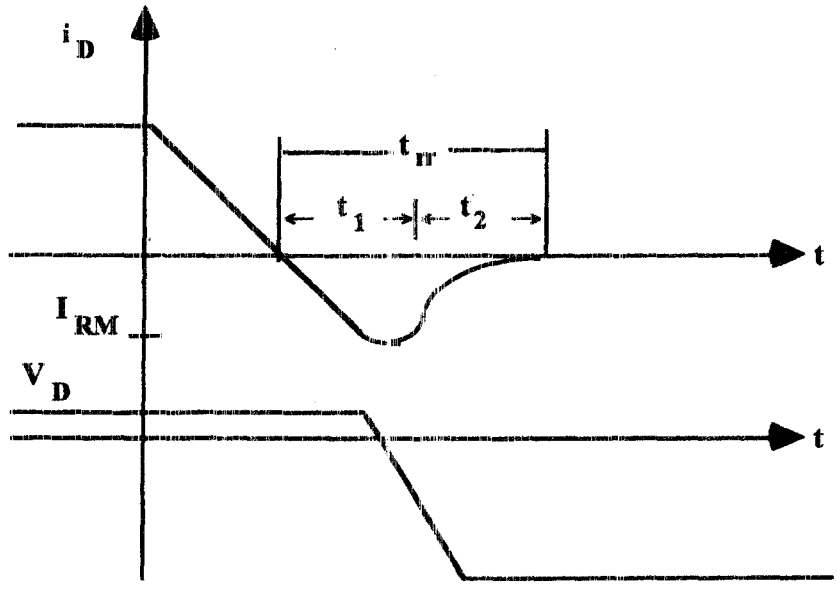

Rajah 1-1
Figure 1-1

(d) **Peranti BJT dikendalikan untuk suatu kala dan kehilangan pensuisannya ditunjukkan oleh Rajah 1-2. Nilai r(t) boleh ditentukan dari Rajah 1-3.**
Diberi: R_{JC} = 0.8°C/W, R_{CS} = 0.5°C/W, dan T_A = 85°C.
Tentukan:

A BJT is operated in a periodic manner with the losses as shown in Figure 1-2. The value of r(t) may be determined from Figure 1-3, R_{JC} = 0.8°C/W, R_{CS} = 0.5°C/W, and T_A = 85°C. Find:

(i) **Nilai puncak (T_J - T_C)**
the peak value of (T_J - T_C), and

(ii) **Nilai R_{SA} supaya nilai puncak T_J dihadkan kepada 150°C.**
the value of R_{SA} that limit the peak value of T_J at 150°C.

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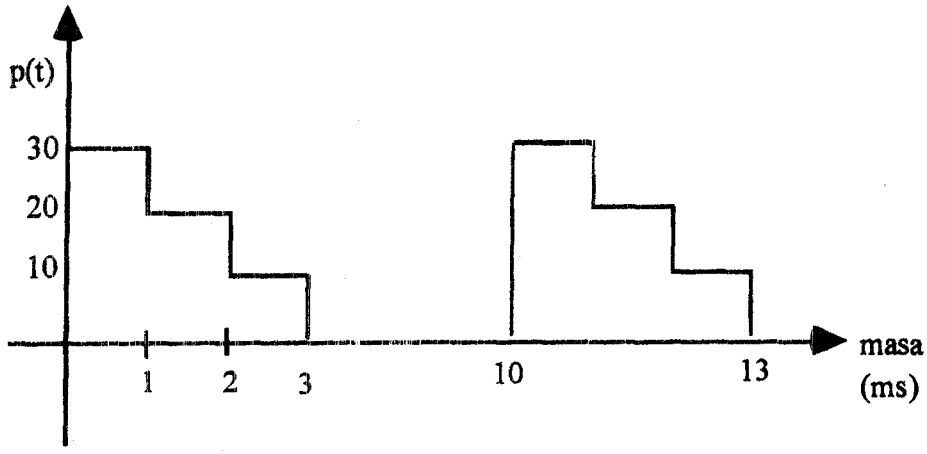
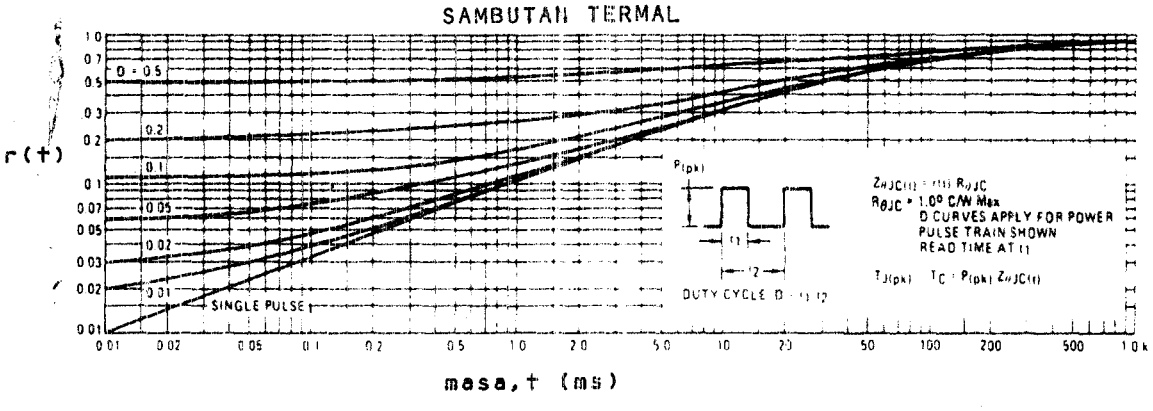


Rajah 1-2

Figure 1-2



Rajah 1-3

Figure 1-3

(30%)

2. (a) Apakah ciri v-i bagi thiristor?
Apakah model dua transistar bagi thiristor?

Explain what is the v-i characteristic of thyristors?
Explain what is the two transistors model of thyristors?

(30%)

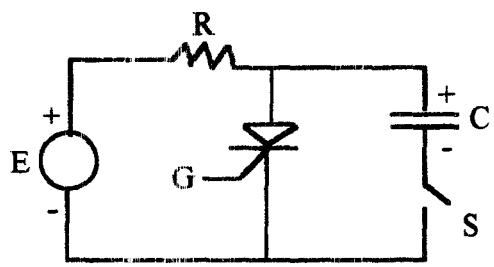
(b) Apakah kaedah-kaedah untuk menghidupkan thiristor? Apakah tujuan kawalan di/dt dan dv/dt?

What are the means of turning-on thyristors?
What are the purpose of di/dt and dv/dt protections?

(40%)

(c) Litar mudah untuk menghidupkan thiristor ditunjukkan oleh Rajah 2-1. Bentuk gelombang arus dan voltan untuk proses tersebut ditunjukkan oleh Rajah 2-2. Diberi: E = 100 V, R = 10 Ω , C = 4μF dan t_q = 30μs. Adakah thiristor tersebut berada dalam keadaan pincang balikan yang mencukupi supaya berlaku 'turn-off'.

A simple circuit to turn off thyristor is shown in Figure 2-1. The current and voltage waveform for the process is shown in Figure 2-2. In Figure 2-1, E = 100 volts, R = 10 Ω , C = 4μF and required t_q = 30μs. Is the thyristor reverse biased long enough for turn-off to occur? Describe why?



Rajah 2-1
Figure 2-1

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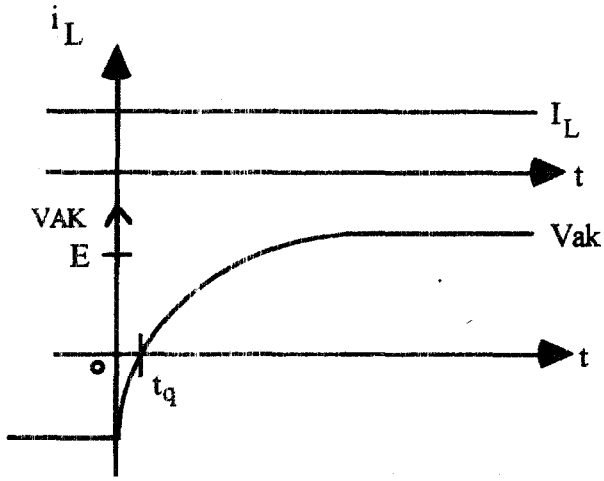

Rajah 2-2

Figure 2-2

(30%)

3. (a) Terangkan operasi bagi semikonverter satu fasa? Terbitkan persamaan untuk voltan keluaran purata dan rms bagi semikonverter satu fasa.

Explain the operation of a single phase semiconverter? Derive the expressions for the average and rms output voltages of a single phase semiconverter.

(40%)

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(b) Konverter penuh tiga fasa di dalam Rajah 3 dikendalikan dari punca 3 fasa sambungan Y 208V, 60Hz dan rintangan beban ialah R = 10Ω. Jika voltan keluaran purata yang diperlukan ialah 60% dari voltan keluaran maksimum, kirakan:

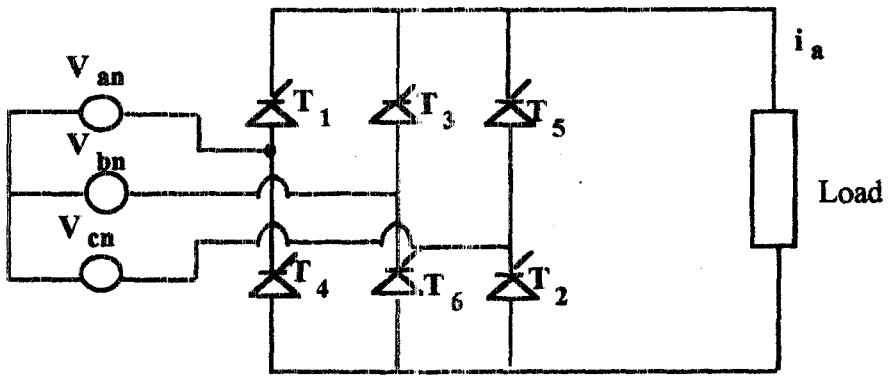
A three phase full converter in Figure 3 is operated from a three phase Y connected 208V, 60Hz supply and the load resistance is R = 10Ω. If it is required to obtain an average output voltage of 60% of the maximum possible output voltage, calculate.

(i) sudut lengah α
the delay angle α,

(ii) arus keluaran rms
the rms output current

(iii) arus keluaran purata, dan
the average output current, and

(iv) kecekapan penukaran
the rectification efficiency.



Rajah 3
Figure 3

(60%)

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4. (a) **Apakah parameter-parameter keupayaan bagi pemenggal?**

What are the performance parameters of a chopper?

(20%)

(b) **Bagi pemenggal Buck seperti ditunjukkan oleh Rajah 4 terbitkan:**
For the Buck Chopper shown in Figure 4 derive:

(i) **hubungan voltan keluaran, dan**
the output voltage relation, and

(ii) **hubungan arus maksimum I_{max} dan arus minimum I_{min}.**
circuit current relation, I_{max} and I_{min}.

(40%)

(c) **Pemenggal Buck, seperti ditunjukkan oleh Rajah 4, dikendalikan pada 10kHz, membekalkan 100W pada 12V ke beban dari punca 20V. Tentukan:**

A Buck Chopper as shown in Figure 4, operating at 10kHz, supplies 100W at 12V to a load from a 20V source. Find:

(i) **nilai induktans untuk arus induktor yang berterusan**
the inductance for continuous inductor current

(ii) **I_{mak} - I_{min}, dan**
I_{max} - I_{min}, and

(iii) **nilai kapasitans yang diperlukan supaya $\Delta V_c = 0.1V$.**
the value of capacitance needed for $\Delta V_c = 0.1V$.

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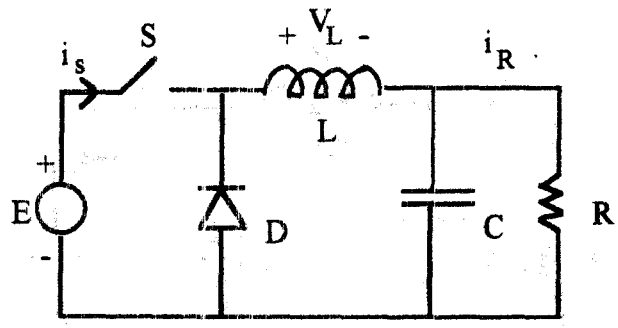

Rajah 4

Figure 4

(40%)

5. **(a)** **Huraikan kawalan BUKA-TUTUP dalam kawalan ac.**
Explain the ON-OFF control in ac controller.

(20%)

(b) **Pengawal voltan ac satu fasa separuh gelombang di dalam Rajah 5-1 mempunyai beban perintang R = 20Ω dan voltan masukan V_s = 208V(rms), 60Hz. Jika kuasa keluaran P_o = 2kW diperlukan.**

The single-phase half wave ac voltage controller in Figure 5-1 has a resistive load of R = 20Ω and the input voltage is V_s = 208V(rms), 60Hz. If the desired output power is P_o = 2kW.

(i) **Terbitkan persamaan sudut lengah dalam sebutan α**
Derive the equation for delay angle in term of α

(ii) **Kira faktor kuasa masukan PF (Jika $\propto = \frac{\pi}{2}$)**
Find the input power factor PF (if $\propto = \frac{\pi}{2}$).

(40%)

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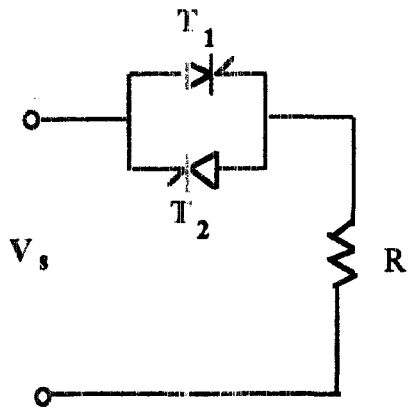

Rajah 5-1
Figure 5-1

(c) Litar di dalam Rajah 5-2 dikawal oleh penukar tap sinkronis. Voltan utama ialah 240V (rms), 60 Hz. Voltan sekunder ialah V_1 = 120V dan V_2 = 100V. Jika beban perintang R = 25Ω, voltan beban rms ialah 200V dan α = 95°, tentukan.

The circuit in Figure 5-2 is controlled as a synchronous tap changer. The primary voltage is 240V (rms), 60Hz. The secondary voltages are V_1 = 120V and V_2 = 100V. If the load resistance is R = 25Ω, the rms load voltage is 200V, and α = 95°, determine

(i) arus rms thiristor T_1 dan T_2,
the rms current of Thyristor T_1 and T_2,

(ii) arus rms thiristor T_3 dan T_4
the rms current of Thyristor T_3 and T_4, and

(iii) faktor kuasa masukan, PF.
the input power factor PF.

(40%)

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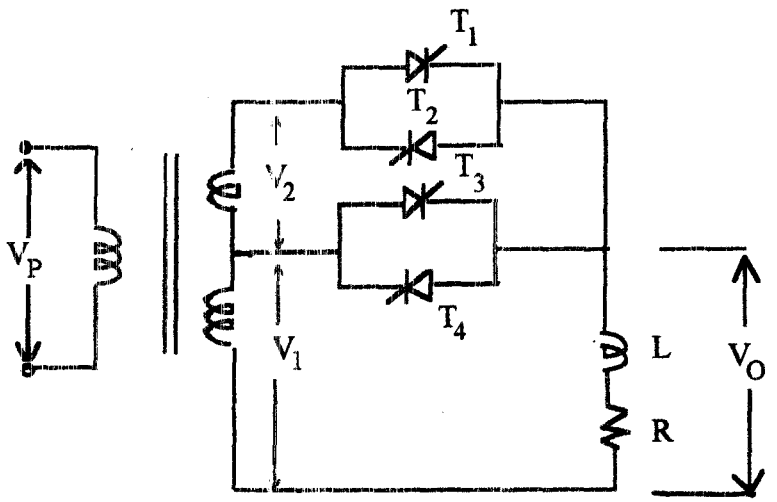

Rajah 5-2
Figure 5-2

6. (a) **Apakah prinsip operasi bagi suatu inverter? Apakah fungsi diod suapbalik di dalam litar inverter?**

Describe is the principle of operation of an inverter? What are the purposes of feedback diodes in inverter?

(30%)

(b) **Apakah kaedah untuk menghasilkan voltan keluaran tiga fasa dari suatu litar inverter? Terangkan untuk pengaliran 180°.**

What are the arrangements for obtaining three phase output voltages? Explain for 180 degree conduction.

(40%)

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(c) Apakah kaedah-kaedah untuk mengawal voltan di dalam inverter satu fasa. Terangkan dua dari kaedah-kaedah yang digunakan.

What are the methods for voltage control within the inverters? Explain two of the techniques used.

(30%)

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