KOLEJ YAYASAN PELAJARAN JOHOR

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FINAL EXAMINATION

COURSE NAME	:	**POWER ELECTRONICS**
COURSE CODE	:	**DKE 3063**
SESSION	:	**JANUARY 2024**
DURATION	:	**2 HOURS 30 MINUTES**

INSTRUCTION TO CANDIDATES /
ARAHAN KEPADA CALON

1. This examination paper consists of **FIVE (5)** questions. Answer **ALL** questions. /
*Kertas soalan ini mengandungi **LIMA (5)** soalan. Jawab **SEMUA** soalan.*

2. Candidates are not allowed to bring any material/note to the examination hall/room except with the permission from the invigilator. The formula sheet is attached to the back of this question paper. /
Calon tidak dibenarkan untuk membawa sebarang bahan/nota ke dewan/bilik peperiksaan tanpa kebenaran daripada pengawas. Rumus dilampirkan dibelakang kertas soalan peperiksaan.

3. Please check to make sure that this examination pack consist of: /
Pastikan kertas soalan peperiksaan ini mengandungi:

   i. The Question Paper /
   Kertas Soalan
   ii. An Answering Booklet /
   Buku Jawapan
   iii. Attachment 1 /
   Lampiran 1

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO /
JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIBERITAHU

This examination paper consists of **9** printed pages including front page
*Kertas soalan ini mengandungi **9** halaman bercetak termasuk muka hadapan*

This paper contains of **FIVE (5)** questions. Answer **ALL** questions in the answering booklet.

*Kertas soalan ini mengandungi **LIMA (5)** soalan. Jawab **SEMUA** soalan dalam buku jawapan.*

QUESTION 1 / *SOALAN 1*

a. Describe the meaning of the term "power electronic".

(2 marks/ *markah*)

b. Give the definition of diode rectifier circuit.

(3 marks/ *markah*)

c. **Figure Q1**, shows a single phase half wave rectifier with a pure resistive load, R = 10Ω. If the input to the rectifier is a Vs=240V, 50Hz, determine:

i. the output dc voltage and current.
ii. the rms output voltage and current.
iii. the power absorbed by the R load.
iv. the power factor.

(15 marks/ *markah*)

a. Huraikan maksud istilah "elektronik kuasa".

b. Berikan definasi litar penerus.

*c. **Rajah Q1**, menunjukkan penerus separuh gelombang satu fasa dengan beban R = 10Ω. Jika masukan ke penerus ialah Vs=240V, 50Hz, tentukan:*

i. voltan dan arus keluaran at.
ii. voltan dan arus keluaran pmkd.
iii. kuasa yang diserap oleh beban R.
iv. faktor kuasa.

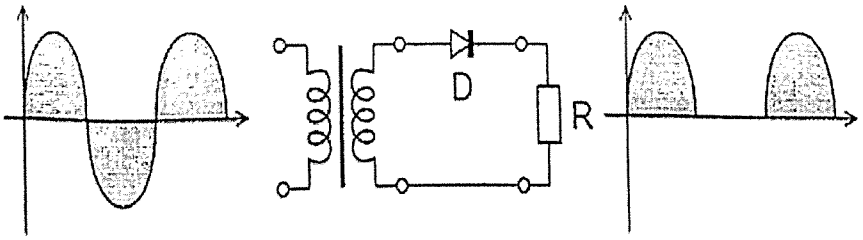

Figure Q1 / *Rajah Q1*

QUESTION 2 / *SOALAN 2*

a. Describe **two (2)** examples of controlled rectifier applications.

(2 marks/ *markah*)

b. Draw the symbol for the following power electronics devices.

i. SCR
ii. Triac
iii. Power diode

(3 marks/ *markah*)

c. The full wave controlled bridge rectifier has an AC input of 120 V_{rms} at 60 Hz and a 20 Ω load resistor. The delay angle is 30°. Sketch the circuit diagram and the output voltage waveform. Determine:

i. average and rms current in the load.
ii. power absorbed by load in watt.
iii. power source in volt-ampere.
iv. power factor.

(15 marks/ *markah*)

*a. Huraikan **dua (2)** contoh aplikasi penerus terkawal.*

b. Lukiskan simbol bagi peranti elektronik kuasa berikut:

i. SCR
ii. Triak
iii. Diod kuasa

c. *Penerus terkawal titi gelombang penuh mempunyai masukan AU, 120 V_{pmkd} pada 60 Hz dan beban rintangan, 20 Ω. Sudut lengah adalah 30°. Lakarkan gambar rajah litar dan gelombang voltan keluaran. Tentukan:*

i. arus purata dan pmkd pada beban.

ii. kuasa diserap oleh beban dalam watt.

iii. kuasa bekalan dalam volt-ampere.

iv. faktor kuasa.

QUESTION 3 / *SOALAN 3*

a. Define the AC voltage controller.

(2 marks/ *markah*)

b. List **three (3)** applications of AC voltage controllers.

(3 marks/ *markah*)

c. An AC voltage controller in **Figure Q3** has a resistive load of R = 10 Ω and the rms phase input voltage is Vs = 120 V, 60 Hz. The thyristors switch is on for n = 25 cycles and is off for m = 75 cycles. Determine:

i. rms output voltage.

ii. input power factor.

iii. average and rms current of thyristors.

iv. output waveform for the circuit.

(15 marks/ *markah*)

a. Takrifkan pengawal voltan AU.

*b. Senaraikan **tiga (3)** aplikasi pengawal voltan AU.*

*c. Pengawal voltan AU pada **Rajah Q3** mempunyai beban R = 10 Ω dan voltan masukan fasa pmkd adalah Vs = 120 V, 60 Hz. Suis thyristor dihidupkan untuk kitaran n = 25 dan dimatikan untuk kitaran m = 75. Tentukan:*

i. voltan keluaran pmkd.

ii. faktor kuasa masukan.

iii. purata dan pmkd arus thyristor.

iv. gelombang keluaran bagi litar.

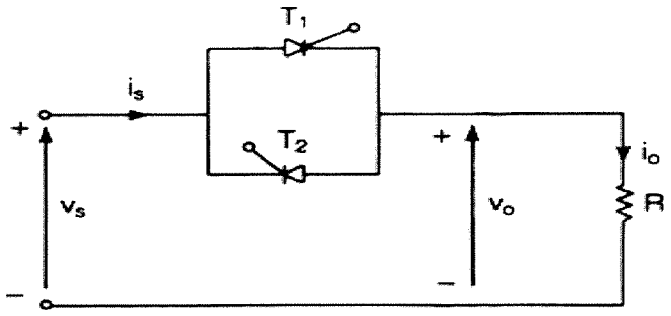

Figure Q3 / *Rajah Q3*

QUESTION 4 / *SOALAN 4*

a. List **two (2)** applications of DC chopper.

(2 marks/ *markah*)

b. List **three (3)** advantages of a DC chopper circuit.

(3 marks/ *markah*)

c. The step-down DC chopper in **Figure Q4** has a resistive load, R =10 Ω and input voltage, V_s= 220 V. When the chopper switch (SW) remains ON, its voltage drop is V_{ch} = 2 V and chopping frequency is f = 10 kHz. If the duty cycle is 50%, determine:

i. the average output voltage, $V_o$dc.

ii. the rms output voltage, $V_o$rms.

iii. the chopper efficiency, η.

(15 marks/ *markah*)

*a. Senaraikan **dua (2)** aplikasi pemenggal AT.*

*b. Senaraikan **tiga (3)** kelebihan litar pemenggal AT.*

*c. Sebuah pemenggal AT langkah-turun dalam **Rajah Q4** mempunyai beban perintang iaitu, R =10 Ω dan voltan masukan, V_s= 220 V. Semasa suis pemenggal (SW) kekal TUTUP, voltan kejatuhannya, V_{ch} = 2 V dan frekuensi pemenggal f =10 kHz. Jika kitar tugas, adalah 50%, tentukan:*

i. voltan keluaran purata, $V_o$dc.

ii. voltan keluaran pmkd, $V_o$pmkd.

iii. kecekapan pemenggal, η.

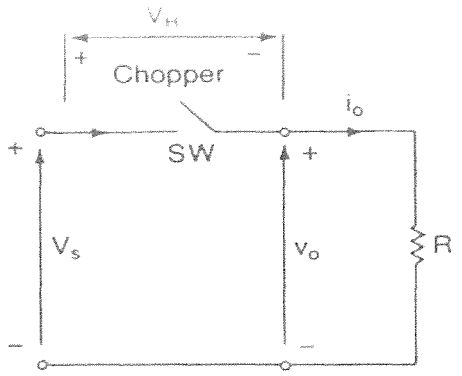

Figure Q4 / *Rajah Q4*

QUESTION 5 / *SOALAN 5*

a. Define the meaning of an inverter.

(2 marks/ *markah*)

b. List **three (3)** applications of inverter in industrial application.

(3 marks/ *markah*)

c. Referring to **Figure Q5**. Given Vs = 220 V and R = 10 Ω, determine:
   i. the rms output voltage at the fundamental frequency, V_1.
   ii. the output power, Po.
   iii. the average current of each transistor, I_Q.
   iv. the rms current of each transistor, I_1.
   v. the peak current of each transistor, Ip.

(15 marks/ *markah*)

a. Takrifkan maksud penyongsang.

*b. Senaraikan **tiga (3)** aplikasi penyongsang dalam aplikasi industri.*

*c. Merujuk pada **Rajah Q5**. Diberi Vs = 220 V and R = 10 Ω, tentukan:*
   i. voltan keluaran pmkd pada frekuensi asas, V_1.
   ii. kuasa keluaran, P_o.
   iii. arus purata bagi setiap transistor, I_Q.
   iv. arus pmkd bagi setiap transistor, I_1.
   v. arus puncak bagi setiap transistor, I_p.

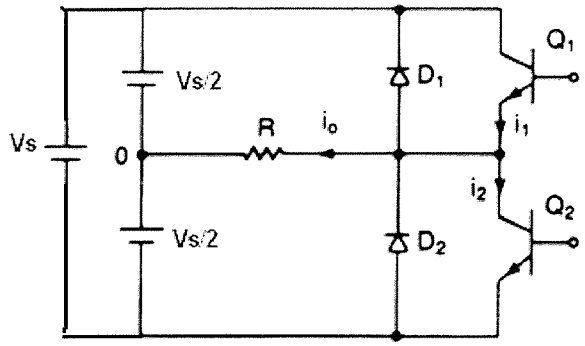

Figure Q5 / *Rajah Q5*

[100 MARKS/ *100 MARKAH*]

END OF QUESTION PAPER / KERTAS SOALAN TAMAT

Attachment 1 / *Lampiran 1*

Uncontrolled rectifier

$V_{o(dc)} = 0.318V_m$ $\quad$ $\mathbf{V_{o(rms)}} = 0.5\,\mathbf{V_m}$

$V_{o(dc)} = \frac{V_m}{2\pi}[1-\cos(\beta)]$ $\quad$ $\mathbf{V_{o(rms)}} = \frac{\mathbf{V_m}}{2}\sqrt{\frac{\beta}{\pi} - \frac{\sin(2\beta)}{2\pi}}$

$V_{o(dc)} = 0.6366\,V_m$ $\quad$ $\mathbf{V_{o(rms)}} = 0.707\,\mathbf{V_m}$

$\mathbf{V_{o(dc)}} = 1.654\mathbf{V_m}$ $\quad$ $\mathbf{V_{o(rms)}} = 1.6554\,\mathbf{V_m}$

$\mathbf{V_{o(dc)}} = 0.827\mathbf{V_m}$ $\quad$ $\mathbf{V_{o(rms)}} = 0.8407\,\mathbf{V_m}$

Controlled rectifier

$V_{o(dc)} = \frac{V_m}{2\pi}(1+\cos\alpha)$ $\quad$ $\mathbf{V_{o(rms)}} = \frac{\mathbf{V_m}}{\mathbf{2}}\left[\frac{1}{\pi}\left(\pi - \alpha + \frac{\sin 2\alpha}{2}\right)\right]^{1/2}$

$V_{o(dc)} = \frac{2V_m}{\pi}\cos\alpha$ $\quad$ $\mathbf{V_{o(rms)}} = \mathbf{V_m}\left[\frac{1}{2} - \frac{\alpha}{2\pi} + \frac{\sin 2\alpha}{4\pi}\right]^{1/2}$

Principle of AC Voltage controller

$\mathbf{Vs} = \sqrt{\mathbf{2}}\mathbf{Vs}\ \sin\omega t$ $\quad$ $\mathbf{Vo} = \mathbf{Vs}\sqrt{\frac{\mathbf{n}}{\mathbf{m}+\mathbf{n}}} = \mathbf{Vs}\sqrt{\mathbf{k}}$

$$\mathbf{Vo(rms)} = \mathbf{Vs}\left[\frac{\mathbf{1}}{\mathbf{2\pi}}\left(2\pi - \alpha + \frac{\sin 2\alpha}{2}\right)\right]^{1/2}$$

$$\mathbf{Vo(dc)} = \frac{\sqrt{\mathbf{2}}\mathbf{Vs}}{\mathbf{2\pi}}(\cos\alpha - 1)$$

AC Voltage controller : Single Phase

$$\mathbf{Vo(rms)} = \mathbf{Vs}\left[\frac{\mathbf{1}}{\pi}\left(\pi - \alpha + \frac{\sin 2\alpha}{\alpha}\right)\right]^{1/2} \qquad \mathrm{Vo(rms)} = \mathrm{Vs}\left[\frac{1}{\pi}\left(\beta - \alpha + \frac{\sin 2\alpha}{2} - \frac{\sin 2\beta}{2}\right)\right]^{1/2}$$

AC Voltage controller : Three Phase Half wave

For 0°≤α<90° :

$$\mathbf{Vo(rms)} = \sqrt{3}\mathbf{Vs}\left[\frac{\mathbf{1}}{\pi}\left(\frac{\pi}{3}-\frac{\alpha}{4}+\frac{\sin 2\alpha}{8}\right)\right]^{1/2}$$

For 90°≤α<120° :

$$\mathbf{Vo(rms)} = \sqrt{3}\mathbf{Vs}\left[\frac{\mathbf{1}}{\pi}\left(\frac{11\pi}{24}-\frac{\alpha}{2}\right)\right]^{1/2}$$

For 120°≤α<210° :

$$\mathbf{Vo(rms)} = \sqrt{3}\mathbf{Vs}\left[\frac{\mathbf{1}}{\pi}\left(\frac{7\pi}{24}-\frac{\alpha}{4}+\frac{\sin 2\alpha}{16}-\frac{\sqrt{3}\cos 2\alpha}{16}\right)\right]^{1/2}$$

AC Voltage controller : Three Phase Full wave

For 0°≤α<60° :

$$\mathbf{Vo(rms)} = \sqrt{6}\mathbf{Vs}\left[\frac{\mathbf{1}}{\pi}\left(\frac{\pi}{6}-\frac{\alpha}{4}+\frac{\sin 2\alpha}{8}\right)\right]^{1/2}$$

For 60°≤α<90° :

$$\mathbf{Vo(rms)} = \sqrt{6}\mathbf{Vs}\left[\frac{\mathbf{1}}{\pi}\left(\frac{\pi}{12}+\frac{3\sin 2\alpha}{16}+\frac{\sqrt{3}\cos 2\alpha}{16}\right)\right]^{1/2}$$

For 120°≤α<210° :

$$\mathbf{Vo(rms)} = \sqrt{6}\mathbf{Vs}\left[\frac{\mathbf{1}}{\pi}\left(\frac{5\pi}{24}-\frac{\alpha}{4}+\frac{\sin 2\alpha}{16}+\frac{\sqrt{3}\cos 2\alpha}{16}\right)\right]^{1/2}$$