KOLEJ YAYASAN PELAJARAN JOHOR
FINAL EXAMINATION

COURSE NAME	**:**	**POWER ELECTRONICS**
COURSE CODE	**:**	**DKE 3063**
SESSION	**:**	**NOVEMBER 2020**
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.

Answer the questions in an answering booklet.

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

Sila jawab dalam buku jawapan.

QUESTION 1 / *SOALAN 1*

a. Define power electronic.

Berikan definisi elektronik kuasa.

(2 marks/ *2 markah*)

b. State the function of rectifier circuit and give **two (2)** applications for the circuit.

*Nyatakan fungsi litar penerus dan berikan **dua (2)** aplikasi litar tersebut.*

(3 marks/ 3 *markah*)

c. For half-wave rectifier with R-L load, R=100Ω, L=0.1H, ω=377rad/s, and Vs=100V. Determine:

i. An expression for the current in this circuit.

ii. The point where diode turns off.

iii. The average current.

iv. The rms current.

v. The power absorbed by the R-L load.

vi. The power factor.

Bagi penerus separuh gelombang dengan beban RL, R = 100W, L = 0.1H, w = 377rad / s, dan Vs = 100V. Tentukan:

i. Satu ungkapan untuk arus dalam litar ini.

ii. Titik di mana diod dimatikan.

iii. Arus purata semasa.

iv. Arus pmkd semasa.

v. Kuasa yang diserap oleh beban R-L.

vi. Faktor kuasa

(15 marks/ 15 *markah*)

QUESTION 2 / *SOALAN 2*

a. Give **two (2)** applications of controlled rectifier.

*Berikan **dua (2)** aplikasi bagi penerus terkawal.*

(2 marks/ 2 *markah*)

b. Sketch and label the I-V characteristic curve for a SCR.

Lakar dan labelkan lengkung ciri I-V bagi SCR

(3 marks/ 3 *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 40^{o}. Draw the circuit diagram and sketch 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.

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

i. Arus purata dan pmkd beban.

ii. Kuasa diserap oleh beban dalam watt.

iii. Kuasa bekalan dalam volt-ampere.

iv. Faktor kuasa.

(15 marks/ 15 *markah*)

QUESTION 3 / *SOALAN 3*

a. Define the ac voltage controller.

Berikan definisi pengawal voltan au.

(2 marks/ *2 markah*)

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

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

(3 marks/ 3 *markah*)

c. Single phase AC voltage controller in **Figure Q3(c)** has a resistive load of R = 10 Ω and input voltage is V_s = 120 V, 60 Hz. The delay angle of thyristor T_1 is $\alpha = \pi/2$. Determine:

i. $V_{o(rms)}$

ii. Input power factor

iii. Average input current.

*Fasa pengawal AU voltan dalam **Rajah Q3(c)** mempunyai rintangan beban, R = 10 Ω dan voltan masukan adalah V_s = 120 V, 60 Hz. Sudut lengah thyristor T_1 adalah $\alpha = \pi/2$. Tentukan:*

i. $V_{o\ (pmkd)}$

ii. Faktor kuasa masukan.

iii. Arus masukan purata.

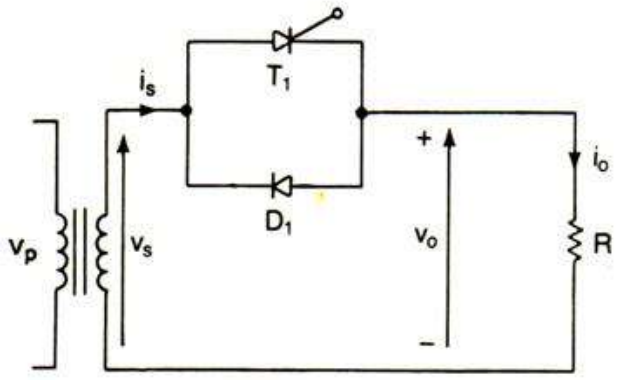

Figure Q3(c) / ***Rajah Q3(c)***

(15 marks/ 15 ***markah*****)**

QUESTION 4 / ***SOALAN 4***

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

Nyatakan ***dua (2)*** *aplikasi pemenggal AT.*

(2 marks/ 2 ***markah*****)**

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

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

(3 marks/ 3 ***markah*****)**

c. The Step-down DC Chopper in **Figure Q4(c)** 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.

Sebuah pemenggal AT Langkah-turun seperti dalam ***Rajah Q4(c)*** *berbeban perintang tulen, 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 kerja, adalah 80%, tentukan:*

i. Voltan keluaran purata, $V_o$dc.

ii. Voltan keluaran PMKD, $V_o$rms.

iii. Kecekapan pemenggal, η.

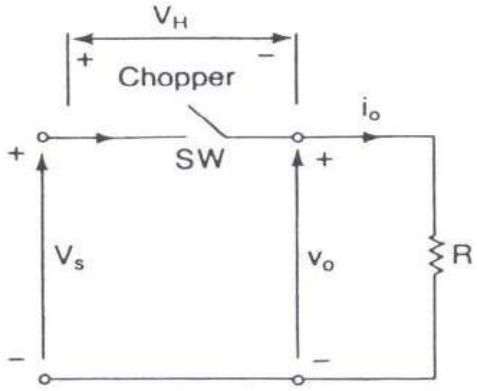

Figure Q4(c) / ***Rajah Q4(c)***

(15 marks/ 15 ***markah*****)**

QUESTION 5 / ***SOALAN 5***

a. Define an inverter.

Berikan definisi penyongsang.

(2 marks/ 2 ***markah*****)**

b. State **three (3)** aplications of inverter in industrial application.

Nyatakan ***tiga (3)*** *aplikasi penyongsang dalam aplikasi industri.*

(3 marks/ ***3 markah*****)**

c. Referring to **Figure Q5(c)**. 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.

*Merujuk kepada **Rajah Q5(c)**. 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.

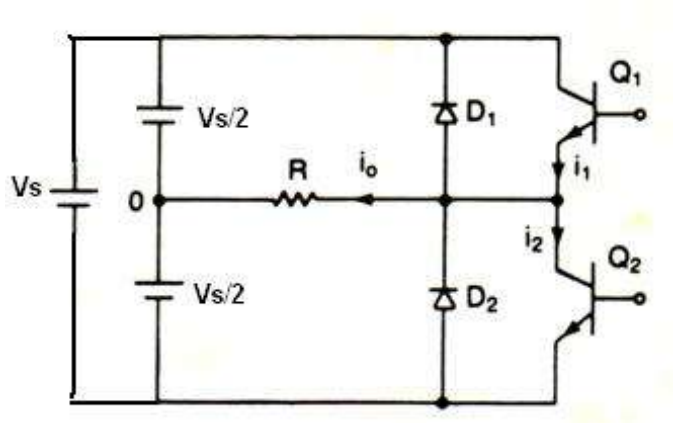

Figure Q5(c) / ***Rajah Q5(c)***

(15 marks/ 15 ***markah*****)**

[100 MARKS/ ***100 MARKAH*****]**

END OF QUESTION PAPER / KERTAS SOALAN TAMAT

Attachment 1 / *Lampiran 1*

Uncontrolled rectifier

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

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

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

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

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

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

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

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

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

AC Voltage controller : Single Phase

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

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° :

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