KOLEJ YAYASAN PELAJARAN JOHOR
ONLINE FINAL EXAMINATION

COURSE NAME	**:**	**POWER ELECTRONICS**
COURSE CODE	**:**	**DKE 3063**
SESSION	**:**	**DECEMBER 2021**
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. Students are allowed to refer to resources such as lecture notes, books, internet or any other relevant resources. /
   Pelajar dibenarkan merujuk kepada sumber seperti nota kuliah, buku, internet atau mana - mana sumber yang berkaitan.

3. Answer ALL questions in the answer sheet which is A4 size paper (or other paper with the consent of the relevant lecturer). /
   Jawab SEMUA soalan di dalam kertas jawapan iaitu kertas bersaiz A4 (atau lain-lain kertas dengan persetujuan pensyarah berkaitan).

4. Write your details as follows in the upper left corner for each answer sheet: /
   Tulis butiran anda sepertimana berikut di penjuru atas kiri bagi setiap kertas jawapan:
   i. Student Full Name / *Nama Penuh Pelajar*
   ii. Identification Card (I/C) No. / *No. Kad Pengenalan*
   iii. Class Section / *Seksyen Kelas*
   iv. Course Code / *Kod Kursus*
   v. Course Name / *Nama Kursus*
   vi. Lecturer Name / *Nama Pensyarah*

5. Each answer sheet must have a page number written at the bottom right corner. /
   Setiap helai kertas jawapan mesti ditulis nombor muka surat di penjuru bawah kanan.

6. Answers should be handwritten, neat and clear. /
   Jawapan hendaklah ditulis tangan, kemas dan jelas.

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 answer sheet.

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

Sila jawab dalam kertas jawapan.

QUESTION 1 / *SOALAN 1*

a) Name **two (2)** types of circuit converter. .

(2 marks / *markah*)

b) State **three (3)** advantages of a three phase rectifier over a single phase rectifier.

(3 marks / *markah*)

c) If the full wave center tapped rectifier has a purely resistive load of R, determine:

i. The efficiency.
ii. Form factor.
iii. The ripple factor.
iv. Transformer utilization factor.
v. Peak inverse voltage current.
vi. Creast factor for input current.

(15 marks / *markah*)

*a) Namakan **dua (2)** jenis litar penukar.*

*b) Nyatakan **tiga (3)** kelebihan litar penerus tiga fasa berbanding satu fasa.*

c) Sekiranya penerus ketuk pembahagi gelombang penuh mempunyai beban tulen R, tentukan:

i. Kecekapan.
ii. Faktor bentuk.
iii. Faktor riak.
iv. Faktor penggunaan pengubah.
v. Arus voltan puncak balikan.
vi. Faktor puncak arus masukan.

QUESTION 2 / *SOALAN 2*

a) Give **one (1)** difference between Silicon Controlled Rectifier and Diode Rectifier in power electronics.

(2 marks / *markah*)

b) Sketch and label the SCR equivalent circuit (PNP-NPN).

(3 marks / *markah*)

c) If the half wave controlled rectifier has a purely resistive load of R and the delay is $\alpha = \pi/2$, determine:

i. Rectification efficiency.

ii. Form factor

iii. Ripple factor

iv. TUF

v. PIV

(15 marks / *markah*)

*a) Berikan **satu (1)** perbezaan antara Penerus Terkawal Silikon dan Diod Penerus dalam elektronik kuasa.*

b) Lakar dan labelkan litar setara SCR(PNP-NPN).

c) Jika penerus terkawal gelombang separuh mempunyai beban resistif tulen R dan kelewatannya adalah = $\pi/2$, tentukan:

i. Kecekapan pembetulan.

ii. Faktor bentuk.

iii. Faktor riak.

iv. TUF

v. PIV

QUESTION 3 / *SOALAN 3*

a) State **two (2)** methods of controlling an AC voltage controllers.

(2 marks / *markah*)

b) State **three (3)** disadvantages of having a low power factor.

(3 marks / *markah*)

c) An AC voltage controller in **Figure Q3(c**) 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) Nyatakan **dua (2)** kaedah kawalan bagi voltan pengawal AU.*

*b) Nyatakan **tiga (3)** keburukan mempunyai faktor kuasa rendah.*

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

i. Voltan keluaran pmkd.
ii. Faktor kuasa masukan.
iii. Arus purata dan pmkd untuk thyristor.
iv. Gelombang keluaran bagi litar.

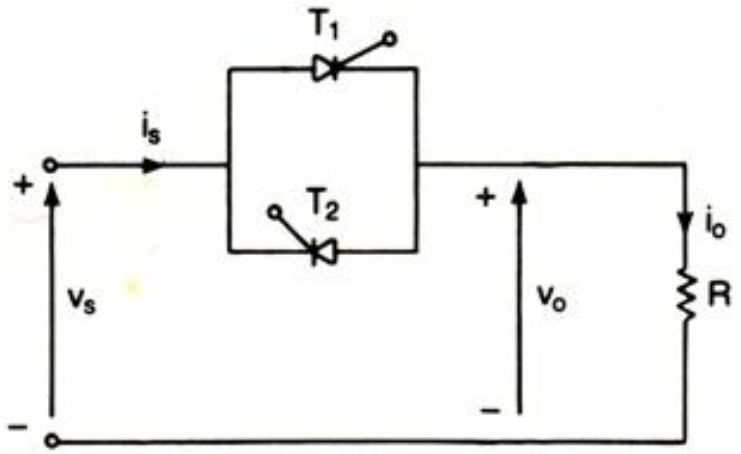

Figure Q3(c) / ***Rajah Q3(c)***

QUESTION 4 / ***SOALAN 4***

a) Define a DC to DC converter.

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

b) Name **three (3)** basic types of switching-mode regulators.

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

c) A boost regulator has an input voltage of V_s = 5 V. The average output voltage V_a = 15 V and the average load current I_a = 0.5 A. The switching frequency is 25 kHz. If L = 150 μH and C = 220 μF. Determine:

i. The duty cycle, k.

ii. The ripple current of inductor ΔI.

iii. The peak current of inductor I_2.

iv. The ripple voltage of filter capacitor ΔV_C.

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

a) Definisikan penukar AT ke AT.

*b) Namakan **tiga (3)** jenis asas bagi pengatur mod-pensuisan.*

c) Pengawal selia mempunyai masukan voltan Vs = 5 V. Purata voltan keluaran Va = 15 V dan purata beban purata arus I_a = 0.5 A. Frekuensi pensuisan ialah 25 kHz. Jika L = 150 μH dan C = 220 μF. Tentukan:

i. Kitar tugas, k.

ii. Arus riak daripada pearuh ΔI.

iii. Arus puncak pearuh I_2.

iv. Voltan riak penapis pemuat ΔV_C.

QUESTION 5 / *SOALAN 5*

a) State the definition of inverter gain.

(2 marks / *markah*)

b) State **three (3)** types of common power electronics devices commonly used in controller inverter converter.

(3 marks / *markah*)

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

i. Name the circuit configuration.

ii. Briefly explain the circuit operation.

iii. Sketch the output waveform, Vo.

(15 marks / *markah*)

a) *Nyatakan definisi gandaan penyongsang.*

b) *Nyatakan **tiga (3)** jenis peranti elektronik kuasa yang umum digunakan dalam penukar songsang terkawal.*

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

i. *Namakan konfigurasi litar tersebut.*

ii. *Terangkan secara ringkas kendalian litar tersebut.*

iii. *Lakarkan gelombang keluaran, Vo.*

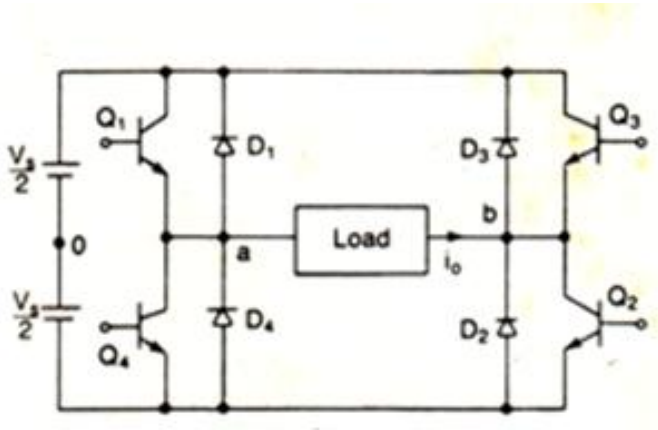

Figure Q5(c) / ***Rajah Q5(c)***

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

END OF QUESTION PAPER / KERTAS SOALAN TAMAT

Attachment 1 / *Lampiran 1*

Uncontrolled rectifier

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

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

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

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

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

Controlled rectifier

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

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

Principle of AC Voltage controller

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

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

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

AC Voltage controller : Single Phase

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

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° :

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