KOLEJ YAYASAN PELAJARAN JOHOR

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FINAL EXAMINATION

COURSE NAME	:	**POWER ELECTRONICS**
COURSE CODE	:	**DKE 3063**
SESSION	:	**DECEMBER 2022**
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 **8** printed pages including front page
*Kertas soalan ini mengandungi **8** 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. Name **two (2)** different kinds of circuit converters.

(2 marks/ *markah*)

b. Explain **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 perbezaan litar penukar.*

*b. Terangkan **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. Identify **one (1)** difference between Silicon Controlled Rectifier and Diode Rectifier in power electronics.

(2 marks/ *markah*)

b. Sketch 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. *Kenalpasti **satu (1)** perbezaan antara Penerus Terkawal Silikon dan Diod Penerus dalam elektronik kuasa.*

b. *Lakarkan litar setara SCR(PNP-NPN).*

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

i. kecekapan pembetulan.

ii. faktor bentuk.

iii. faktor riak.

iv. TUF.

v. PIV.

QUESTION 3 / *SOALAN 3*

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

(2 marks/ *markah*)

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

(3 marks/ *markah*)

c. An AC voltage controller in **Figure 1** 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. *Senaraikan **dua (2)** kaedah kawalan bagi voltan pengawal AU.*

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

c. *Pengawal voltan AU pada **Rajah 1** 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.

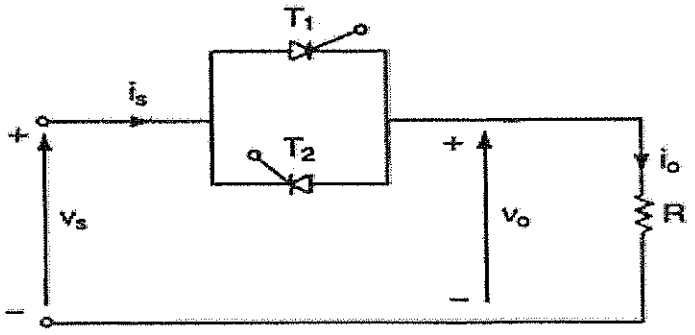

Figure 1 / *Rajah 1*

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 ΔVc.

(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 ΔVc.

QUESTION 5 / *SOALAN 5*

a. Define an inverter gain.

(2 marks/ *markah*)

b. Name **three (3)** different types of power electronics devices that are commonly used in controller inverter converters.

(3 marks/ *markah*)

c. This question based on the single phase bridge inverters.
   i. Sketch the circuit diagram for single phase bridge inverters.
   ii. Show the operation of the circuit based the circuit diagram.
   iii. Sketch the output waveform, Vo.

(15 marks/ *markah*)

a. Definisikan gandaan penyongsang.

*b. Namakan **tiga (3)** jenis peranti elektronik kuasa yang biasa digunakan dalam penukar penyongsang terkawal.*

c. Soalan ini berdasarkan penyongsang titi fasa tunggal.
   i. Lukiskan litar bagi penyongsang jambatan fasa tunggal.
   ii. Tunjukkan kendalian litar tersebut berdasarkan rajah litar.
   iii. Lakarkan gelombang keluaran, Vo.

(15 marks/ 15 *markah*)

[100 MARKS/ *100 MARKAH*]

END OF QUESTION PAPER / KERTAS SOALAN TAMAT

Attachment 1 / *Lampiran 1*

Uncontrolled rectifier

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

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

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

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

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

Controlled rectifier

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

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

Principle of AC Voltage controller

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

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

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

AC Voltage controller : Single Phase

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

AC Voltage controller : Three Phase Half wave

For 0°≤α<90° :

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

For 90°≤α<120° :

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

For 120°≤α<210° :

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

AC Voltage controller : Three Phase Full wave

For 0°≤α<60° :

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

For 60°≤α<90° :

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

For 120°≤α<210° :

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