



---

**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) Define power electronic. **(2 marks / markah)**
- b) List **three (3)** of power semiconductor devices. **(3 marks / markah)**
- c) For half-wave rectifier with R-L load,  $R=100\Omega$ ,  $L=0.1H$ ,  $\omega=377\text{rad/s}$ , and  $V_s=100V$ . 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. **(15 marks / markah)**
- a) *Berikan definisi elektronik kuasa.*
- b) *Senaraikan **tiga (3)** peranti semikonduktor kuasa.*
- c) *Bagi penerus separuh gelombang dengan beban R-L,  $R = 100\Omega$ ,  $L = 0.1H$ ,  $\omega = 377\text{rad / s}$ , dan  $V_s = 100V$ . Tentukan:*
- i. *Satu ungkapan untuk arus dalam litar ini.*
  - ii. *Titik di mana diod dimatikan.*
  - iii. *Arus purata.*
  - iv. *Arus pmkd.*
  - v. *Kuasa yang diserap oleh beban R-L.*
  - vi. *Faktor kuasa*

## QUESTION 2 / SOALAN 2

- a) Give **two (2)** applications of controlled rectifier. (2 marks / *markah*)
- b) Sketch and label the I-V characteristic curve for a SCR. (3 marks / *markah*)
- c) The full wave controlled bridge rectifier has an AC input of  $120 V_{\text{rms}}$  at 60 Hz and a  $20 \Omega$  load resistor. The delay angle is  $30^\circ$ . 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.
- (15 marks / *markah*)

- a) Berikan **dua (2)** aplikasi bagi penerus terkawal.
- b) Lakar dan labelkan lengkung ciri I-V bagi SCR.
- c) Penerus terkawal titi gelombang penuh mempunyai masukan AU,  $120 V_{\text{pmkd}}$  pada 60 Hz dan beban rintangan,  $20 \Omega$ . Sudut lengah adalah  $30^\circ$ . 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.

## QUESTION 3 / SOALAN 3

a) Define the AC voltage controller.

(2 marks / markah)

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

(3 marks / markah)

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

- i.  $V_{o(\text{rms})}$
- ii. Input power factor.
- iii. Average input current.

(15 marks / markah)

a) Berikan definisi pengawal voltan AU.

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

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

- i.  $V_o (\text{pmkd})$
- ii. Faktor kuasa masukan.
- iii. Arus masukan purata.

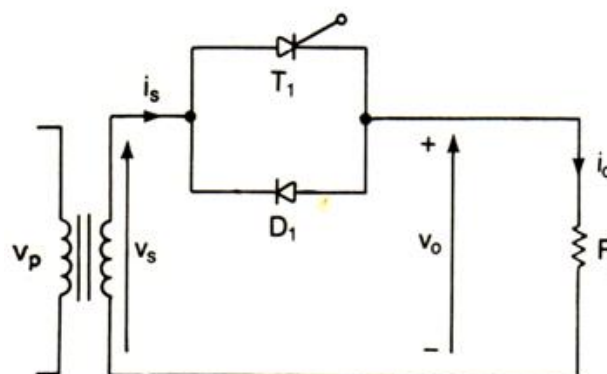


Figure Q3(c) / Rajah Q3(c)

## QUESTION 4 / SOALAN 4

- a) State **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(c)** has a resistive load,  $R = 10 \Omega$  and input voltage,  $V_s = 220 \text{ V}$ . When the chopper switch (SW) remains ON, its voltage drop is  $V_{ch} = 2 \text{ V}$  and chopping frequency is  $f = 10 \text{ kHz}$ . 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,  $\eta$ .
- (15 marks / markah)

- a) Nyatakan **dua (2)** aplikasi pemenggal AT.
- b) Senaraikan **tiga (3)** kelebihan litar pemenggal AT.
- c) Sebuah pemenggal AT Langkah-turun seperti dalam **Rajah Q4(c)** berbeban perintang tulen,  $R = 10 \Omega$  dan voltan masukan,  $V_s = 220 \text{ V}$ . Semasa suis pemenggal (SW) kekal TUTUP, voltan kejatuhannya,  $V_{ch} = 2 \text{ V}$  dan frekuensi pemenggal  $f = 10 \text{ kHz}$ . Jika kitar kerja, adalah 50%, tentukan:
- i. Voltan keluaran purata,  $V_{o,dc}$ .
  - ii. Voltan keluaran pmkd,  $V_{o,pmkd}$ .
  - iii. Kecekapan pemenggal,  $\eta$ .

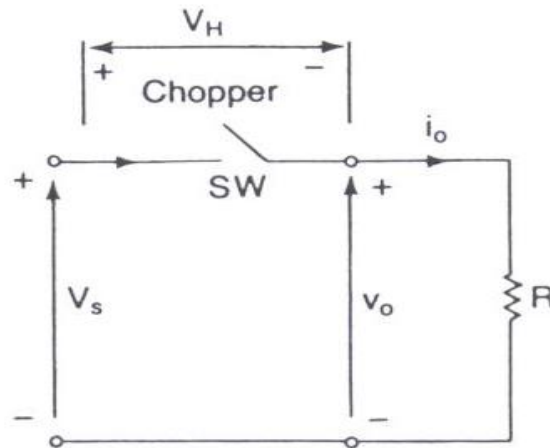


Figure Q4(c) / Rajah Q4(c)

## QUESTION 5 / SOALAN 5

- a) Define an inverter. (2 marks / markah)
- b) State **three (3)** applications of inverter in industrial application. (3 marks / markah)
- c) Referring to **Figure Q5(c)**. Given  $V_s = 220 \text{ V}$  and  $R = 10 \Omega$ , determine:
- i. The rms output voltage at the fundamental frequency,  $V_1$ .
  - ii. The output power,  $P_o$ .
  - 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,  $I_p$ .

(15 marks / markah)

- a) Berikan definisi penyongsang.
- b) Nyatakan **tiga (3)** aplikasi penyongsang dalam aplikasi industri.
- c) Merujuk kepada **Rajah Q5(c)**. Diberi  $V_s = 220\text{ V}$  and  $R = 10\ \Omega$ , tentukan
- Voltan keluaran pmkd pada frekuensi asas,  $V_1$ .
  - Kuasa keluaran,  $P_o$ .
  - Arus purata bagi setiap transistor,  $I_Q$ .
  - Arus pmkd bagi setiap transistor,  $I_1$ .
  - Arus puncak bagi setiap transistor,  $I_p$ .

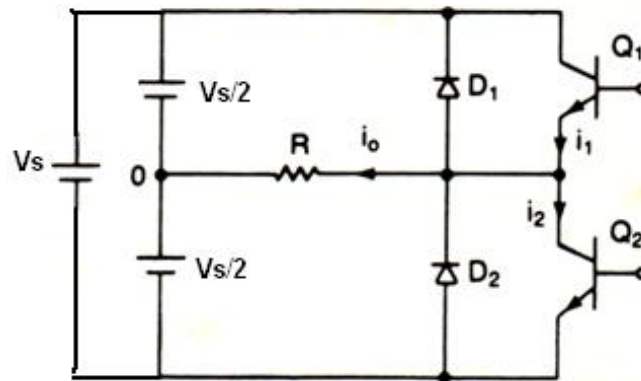


Figure Q5(c) / Rajah Q5(c)

[100 MARKS / MARKAH]

END OF QUESTION PAPER / KERTAS SOALAN TAMAT

## Attachment 1 / Lampiran 1

**Uncontrolled rectifier**

$$\begin{aligned}
 V_{o(\text{dc})} &= 0.318V_m & V_{o(\text{rms})} &= 0.5 V_m \\
 V_{o(\text{dc})} &= \frac{V_m}{2\pi} [1 - \cos(\beta)] & V_{o(\text{rms})} &= \frac{V_m}{2} \sqrt{\frac{\beta}{\pi} - \frac{\sin(2\beta)}{2\pi}} \\
 V_{o(\text{dc})} &= 0.6366 V_m & V_{o(\text{rms})} &= 0.707 V_m \\
 V_{o(\text{dc})} &= 1.654V_m & V_{o(\text{rms})} &= 1.6554 V_m \\
 V_{o(\text{dc})} &= 0.827V_m & V_{o(\text{rms})} &= 0.8407 V_m
 \end{aligned}$$

**Controlled rectifier**

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

**Principle of AC Voltage controller**

$$\begin{aligned}
 V_s &= \sqrt{2}V_s \sin \omega t \\
 V_o &= V_s \sqrt{\frac{n}{m+n}} = V_s \sqrt{k}
 \end{aligned}$$

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

$$V_o(\text{dc}) = \frac{\sqrt{2}V_s}{2\pi} (\cos \alpha - 1)$$

**AC Voltage controller : Single Phase**

$$V_o(\text{rms}) = V_s \left[ \frac{1}{\pi} \left( \pi - \alpha + \frac{\sin 2\alpha}{\alpha} \right) \right]^{1/2} \quad V_o(\text{rms}) = V_s \left[ \frac{1}{\pi} \left( \beta - \alpha + \frac{\sin 2\alpha}{2} - \frac{\sin 2\beta}{2} \right) \right]^{1/2}$$



**AC Voltage controller : Three Phase Half wave**For  $0^\circ \leq \alpha < 90^\circ$  :

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

For  $90^\circ \leq \alpha < 120^\circ$  :

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

For  $120^\circ \leq \alpha < 210^\circ$  :

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

**AC Voltage controller : Three Phase Full wave**For  $0^\circ \leq \alpha < 60^\circ$  :

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

For  $60^\circ \leq \alpha < 90^\circ$  :

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

For  $120^\circ \leq \alpha < 210^\circ$  :

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