KOLEJ YAYASAN PELAJARAN JOHOR
FINAL EXAMINATION

COURSE NAME	:	POWER ELECTRONICS
COURSE CODE	:	DEE 2193
EXAMINATION	:	JUNE 2024
DURATION	:	2 HOURS AND 30 MINUTES

INSTRUCTION TO CANDIDATES /
ARAHAN KEPADA CALON

1. This examination paper consists of **ONE (1)** part : / PART A (100 Marks) /
   *Kertas soalan ini mengandungi **SATU (1)** bahagian:* *BAHAGIAN A (100 Markah)*

2. Candidates are not allowed to bring any material to examination room except with the permission from the invigilator. The formula was attached at the back question paper. /
   Calon tidak dibenarkan untuk membawa sebarang bahan/nota ke bilik peperiksaan tanpa arahan/kebenaran daripada pengawas. Rumus dilampirkan di belakang kertas soalan peperiksaan.

3. Please check to make sure that this examination pack consists of: /
   Pastikan kertas soalan peperiksaan ini mengandungi:
   i. Question Paper /
      Kertas Soalan
   ii. Answering Booklet /
      Buku Jawapan

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** muka surat termasuk kulit hadapan*

This part contains of **FOUR(4)** questions. Answer **ALL** questions in the Answering Booklet.

*Bahagian ini mempunyai **EMPAT(4)** soalan. Jawab **SEMUA** soalan di dalam Buku Jawapan.*

QUESTION 1 / *SOALAN 1*

a) **Figure 1a** shows a 6 kVA, 240/400V 50 Hz single phase step-up transformer.

i) Calculate current I_2.

(2 marks / *markah*)

ii) Find the value of R_L.

(2 marks / *markah*)

iii) Calculate the number of primary turns, N_1 if transformer has 125 secondary turns.

(2 marks / *markah*)

iv) If a transformer has copper loss of 48 W and an iron loss of 35 W at a power factor of 0.9, determine the efficiency of the transformer on a full load.

(2 marks / *markah*)

b) i) List **two (2)** advantages of bridge rectifier.

(4 marks / *markah*)

ii) Draw the diagram of a single phase full wave uncontrolled bridge rectifier network supplying a resistive load. By referring to the circuit diagram, briefly explain the operation of the network using the sketch of voltage waveforms for input and output.

(13 marks / *markah*)

*a) **Rajah 1a** menunjukkan satu pengubah fasa tunggal langkah naik 6 kVA, 240/400V 50 Hz.*

i) Kirakan arus I_2.

ii) Cari nilai R_L.

iii) *Kirakan bilangan liltan primer, N_1 jika pengubah mempunyai 125 lilitan sekunder.*

iv) *Sekiranya pengubah kehilangan kuprum 48 W dan kehilangan besi 35 W pada faktor kuasa 0.9, tentukan kecekapan pengubah ketika beban penuh.*

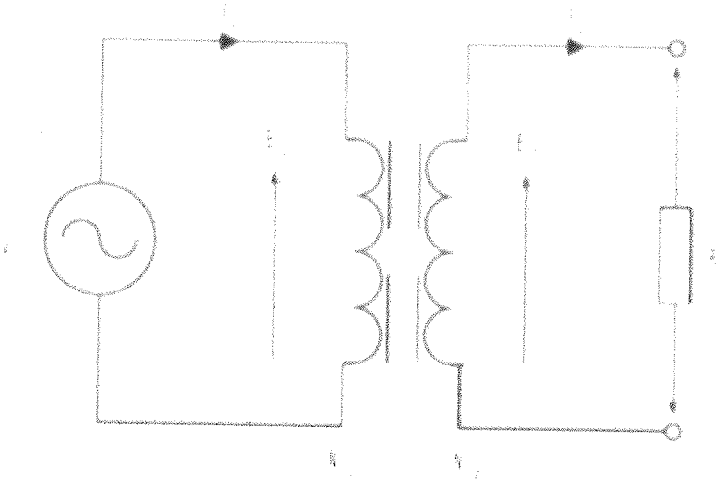

Figure 1a/ *Rajah 1a*

b) i) *Senaraikan **dua (2)** kelebihan penerus tetimbang.*

ii) *Lukiskan gambar rajah rangkaian penerus jambatan tidak terkawal gelombang penuh fasa tunggal yang membekalkan beban perintang. Dengan merujuk rajah litar, terangkan secara ringkas operasi rangkaian menggunakan lakaran bentuk gelombang voltan masukan dan keluaran.*

QUESTION 2 / *SOALAN 2*

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

(3 marks / *markah*)

ii) List **three (3)** advantages of three phase system compared to a single phase.

(6 marks / *markah*)

b) A 50Hz single-phase center tap rectifier with resistive and inductive load as shown in **Figure 2b** is supplied to 240V, resistive and inductive load R = 50Ω and L = 50mH respectively. With extinction angle, β = 45°, calculate:

i) the average output voltage.

(4 marks / *markah*)

ii) the average output current.

(4 marks / *markah*)

c) A 50Hz single-phase controlled full-wave rectifier with resistive load is supplied to 200V, resistive load R = 20Ω. With firing angle, α = 45°, Determine:

i) the average load voltage.

(4 marks / *markah*)

ii) the average load current

(2 marks / *markah*)

iii) power absorbed by the load of the circuit

(2 marks / *markah*)

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

*ii) Senaraikan **tiga (3)** kebaikan sistem tiga fasa jika dibandingkan dengan fasa tunggal.*

*b) Penerus fasa tunggal sadap tengah dengan rintangan dan pearuh beban seperti yang ditunjukkan dalam **Rajah 2b** dibekalkan kepada 240V,*

rintangan dan induktor beban masing-masing R = 50Ω dan L = 50mH. With sudut pengaliran, β = 45°, kirakan :

i) voltan purata keluaran.

ii) arus purata keluaran.

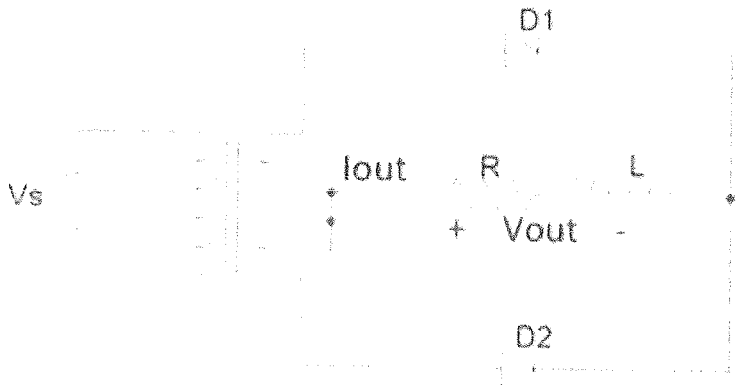

Figure 2b/ *Rajah 2b*

c) *Penerus gelombang penuh terkawal fasa tunggal 50Hz dengan rintangan beban dibekalkan kepada 200V dan rintangan beban R = 20Ω. Dengan sudut cetusan, α = 45°, tentukan:*

i) voltan purata beban.

ii) arus purata beban

iii) kuasa yang diserap oleh beban dalam litar

QUESTION 3 / *SOALAN 3*

a) i) List **two (2)** application of ac voltage controllers.

(4 marks / *markah*)

ii) Give **one (1)** advantage of DC chopper or DC to DC converter.

(2 marks / *markah*)

ii) Sketch and label the equivalent circuit for buck converter.

(4 marks / *markah*)

b) A single-phase power controller as shown in **Figure 3b** is supplying a resistive load. Plot the waveform of the output voltage if the delay angle is 120^0.

(5 marks / *markah*)

c) A buck converter has an input of 60 V and output of 25 V. The load resistor is 9 Ω, the switching frequency is 20 kHz, L = 1 mH and C = 200 μF. Determine:

i) the duty ratio, D.

(2 marks / *markah*)

ii) the average inductor current.

(2 marks / *markah*)

iii) the maximum and minimum inductor current.

(6 marks / *markah*)

a) *i) Senaraikan **dua (2)** aplikasi pengawal voltan au.*

*ii) Berikan **satu (1)** kelebihan pemenggal AT atau penukar AT ke AT.*

ii) Lakar dan labelkan litar setara bagi penukar buck.

b) *Pengawal kuasa fasa tunggal seperti yang ditunjukkan dalam **Rajah 3b** disambung pada rintangan beban. Plotkan gelombang voltan keluaran jika sudut tunda ialah 120^0.*

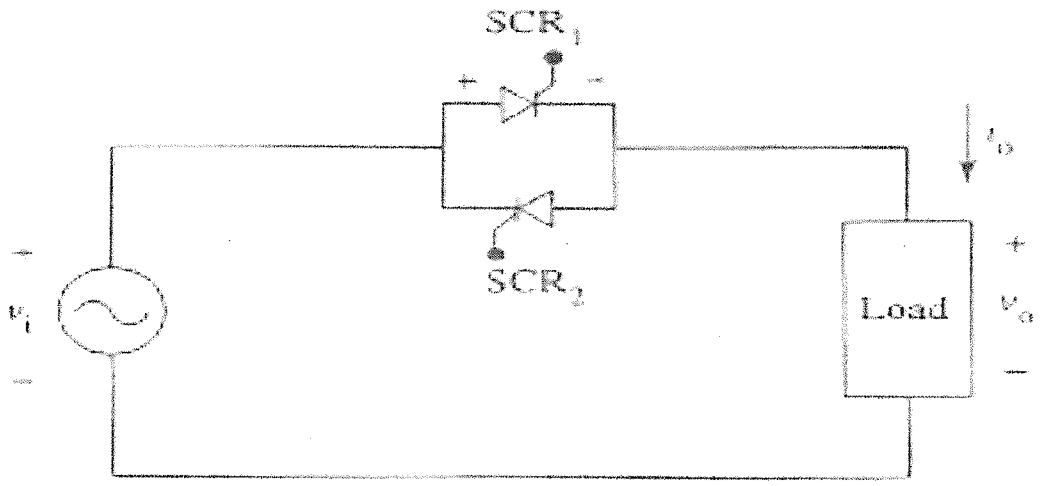

Figure 3b/ *Rajah 3b*

c) *Penukar buck mempunyai masukan 60 V dan keluaran 25 V. Rintangan beban ialah 9 Ω, frekuensi ialah 20 kHz, L = 1 mH dan C = 200 μF. Tentukan:*

i) nisbah kerja, D.

ii) *arus purata pearuh.*

iii) *arus maksima dan minima pearuh.*

QUESTION 4 / *SOALAN 4*

a) i) State the function of inverter and give **one (1)** application of inverter converter.

(4 marks / *markah*)

ii) State **two (2)** performance parameter of an inverter.

(4 marks / *markah*)

b) A single phase full wave ac voltage controller working on ON-OFF control technique has supply voltage of 230V, RMS 50Hz, load = 50Ω. The controller is ON for 30 cycles and OFF for 40 cycles. Calculate:

i) RMS output voltage, $V_{o\,rms}$.

(4 marks / *markah*)

ii) RMS output current, $I_{o\,rms}$.

(2 marks / *markah*)

iii) RMS output power, $P_{o\,rms}$.

(2 marks / *markah*)

iv) Time period, T.

(1 marks / *markah*)

c) Draw a circuit diagram of a single-phase full bridge inverter with a resistive load then explain the circuit operation.

(8 marks / *markah*)

*a) i) Berikan definisi penyongsang dan berikan **satu (1)** aplikasi penyongsang.*

*ii) Nyatakan **dua (2)** prestasi parameter bagi penyongsang.*

b) *Pengawal voltan ac gelombang penuh fasa tunggal bekerja mengikut teknik kawalan HIDUP-MATI yang mempunyai voltan bekalan 230V, RMS 50Hz, beban = 50Ω. Pengawal dihidupkan untuk 30 kitaran dan dimatikan untuk 40 kitaran. Kirakan:*

i) Voltan keluaran RMS, $V_{o\,rms}$.

ii) Arus keluaran RMS, $I_{o\,rms}$.

iii) Kuasa keluaranRMS, $P_{o\,rms}$.

iv) Tempoh masa, T.

c) *Lukis gambar rajah litar penyongsang titi penuh fasa tunggal dengan beban berperintang kemudian terangkan operasi litar tersebut.*

[100 MARKS / *MARKAH*]

END OF QUESTION PAPER/ *KERTAS SOALAN TAMAT*

FORMULA

General Formula

$$\frac{V_P}{V_S} = \frac{N_P}{N_S} = \frac{I_S}{I_P}$$

$$\eta = \frac{V_2 I_2 \cos\varphi_2}{V_2 I_2 \cos\varphi_2 + P_i + P_c}$$

Vm = √2 x Vrms

$$Z = \sqrt{R^2 + X_L{}^2}$$

$$E = 4.44\, f\, N\, \Phi_{max}$$

Uncontrolled rectifier

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

Controlled rectifier

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

AC Voltage Controller

$$V_m = \sqrt{2} V_{rms} \qquad V_{o(rms)} = \frac{V_m}{\pi}(\cos\alpha + 1)$$

$$t_{ON} = n \times T, \qquad t_{OFF} = m \times T$$

$$V_{O(RMS)} = V_{i(RMS)}\sqrt{\frac{t_{ON}}{T_O}} = V_S\sqrt{\frac{t_{ON}}{T_O}} \qquad Vo = Vs\sqrt{\frac{n}{m+n}} = Vs\sqrt{k}$$

T_O = Output time period = $(t_{ON} + t_{OFF}) = (nT + mT)$

DC to DC Converter

Buck Converter

Vo = VsD

$$I_{max} = I_L + \frac{\Delta i_L}{2} = V_o\left[\frac{1}{R} + \frac{(1-D)}{2Lf}\right]$$

$$I_{min} = I_L - \frac{\Delta i_L}{2} = V_o\left[\frac{1}{R} - \frac{(1-D)}{2Lf}\right]$$

Boost Converter

$$V_O = \frac{V_S}{1-D}$$

$$I_{max} = I_L + \frac{\Delta i_L}{2} = \frac{V_S}{(1-D)^2} + \frac{V_S DT}{2L}$$

$$I_{min} = I_L - \frac{\Delta i_L}{2} = \frac{V_S}{(1-D)^2} - \frac{V_S DT}{2L}$$