SULIT

KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI I : 2023/2024

DET40073: POWER ELECTRONICS

TARIKH : 19 DISEMBER 2023
MASA : 11.15 AM – 1.15 PM (2 JAM)

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.
Bahagian A : Subjektif (3 soalan)
Bahagian B : Esei (2 soalan)
Dokumen sokongan yang disertakan : Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

SECTION A: 60 MARKS
BAHAGIAN A: 60 MARKAH

INSTRUCTION:

This section consists of **THREE (3)** subjektif questions. Answer **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **TIGA (3)** soalan subjektif. Jawab **SEMUA** soalan.*

QUESTION 1
SOALAN 1

CLO1

(a) Figure A1(a) shows two devices from the family of THYRISTOR. Compare **TWO (2)** differences between both of the devices.

*Rajah A1(a) menunjukkan dua peranti dari keluarga THYRISTOR. Bandingkan **DUA (2)** perbezaan antara kedua-dua peranti tersebut.*

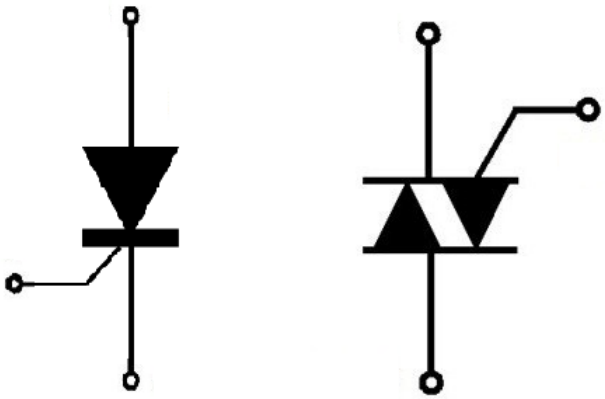

Figure A1(a) / *Rajah A1(a)*

[5 marks]
[5 *markah*]

CLO1 (b) Visualize the characteristic of I-V curve for TRIAC with complete label.

Gambarkan lengkuk ciri I-V bagi TRIAC dengan label yang lengkap.

[5 marks]
[5 *markah*]

CLO1 (c) A Single-Phase Half Wave Controlled Rectifier is used to control 10 Ω resistive load with $\alpha = \pi/6$ and Vs (t) = 120 sin ωt (t). Draw the input voltage waveform, output voltage waveform, and output current waveform. The answer should include the calculation value of the average output voltage and average output current.

Penerus Terkawal Separuh Gelombang Satu Fasa digunakan untuk mengawal beban 10 Ω dengan with $\alpha = \pi/6$ and Vs (t) = 120 sin ωt (t). *Lukiskan gelombang voltan masukan, gelombang voltan keluaran dan gelombang arus keluaran. Jawapan hendaklah merangkumi kiraan nilai purata voltan keluaran dan arus keluaran.*

[10 marks]
[10 *markah*]

QUESTION 2
SOALAN 2

CLO1 (a) Discuss the difference between a step-down and a step-up in DC to DC converter.
Bincangkan perbezaan antara pemenggal langkah turun dan pemenggal langkah naik dalam pengubah AT ke AT.

[5 marks]
[5 *markah*]

CLO1 (b) A waveform of a step-down converter is shown in Figure A2 (b). If the input voltage is 125V, resistive and inductive load is R= 10Ω and L= 200μH respectively, calculate the blocking time (T_{off}), the maximum and minimum inductor current.

Gelombang bagi pemenggal langkah turun di tunjukan pada Rajah A2 (c). Jika voltan masukan adalah 125V, rintangan dan aruhan adalah masing-masing R= 10Ω and L=200μH, kirakan masa sekatan (T_{OFF}) , arus inductor maksimum dan minimum.

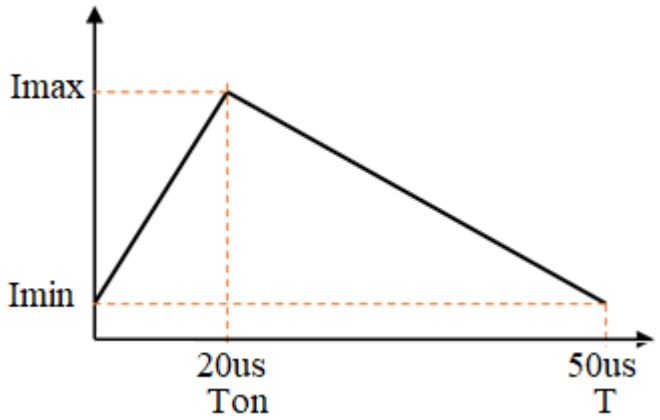

Figure A2 (b) / *Rajah A2 (b)*

[5 marks]
[5 *markah*]

CLO1 (c) A buck converter is supplied from a 50V battery source. Given L=7.5mH, C=100μF, R=10Ω, f=1kHz and T_{on}=400μs. Calculate the average output voltage, Vo , maximum inductor current, I_L max, minimum inductor current, I_L min and the peak-to-peak ripple voltage, ΔVo.

Sebuah pemenggal Langkah turun dibekalkan 220V dari punca bateri. Diberi L=7.5mH, C=100μF, R=10Ω, f=1kHz dan T_{on}=400μs. *Kirakan voltan keluaran purata Vo, Arus maksimum induktor I_L max , arus minimum induktor, I_L min dan Voltan riak puncak ke puncak, ΔVo*

[10 marks]
[10 *markah*]

QUESTION 3

SOALAN 3

CLO1 (a) The inverters can be classified according to the type of output voltage waveform. Compare between the basic concept of switching scheme in the Voltage Source Inverter (VSI) and Current Source Inverters (CSI)

Penyongsang boleh diklasifikasikan mengikut jenis gelombang voltan keluaran. Bandingkan antara konsep asas skema pensuisan dalam Penyongsang Bekalan Voltan (VSI) and Penyongsang Bekalan Arus (CSI).

[4 marks]

[4 *markah*]

CLO1 (b) A 240V inverter is using two IGBT as a switch and having a resistive load, R=100 Ω. With the aids of a suitable circuit diagram calculate the output voltage (V_o) and output current (I_o).

Sebuah penyongsang 240V menggunakan dua biji IGBT sebagai suis dan mempunyai beban rintangan R=100 Ω. Dengan bantuan gambarajah litar yang sesuai,kirakan voltan keluaran (V_o) dan arus keluaran (I_o).

[8 marks]

[8 *markah*]

CLO1 (c) Three phase bridge inverter as being shown in Figure A3(c) is a combination of three single-phase inverters. Table A3(c) shows the operation of switches for three phase VSI 180º conduction mode. Complete the table by writing the value of V_{AN}, V_{BN}, V_{CN}, V_{AB}, V_{BC} and V_{CA}. Sketch the output waveform of V_{AN} and V_{AB}.

Penyongsang tetimbang tiga fasa seperti yang ditunjukkan dalam Rajah A3(c) adalah gabungan tiga penyongsang fasa Tunggal. Jadual A3(c) menunjukkan operasi suis bagi mod pengaliran 180º VSI tiga fasa. Lengkapkan jadual tersebut dengan menuliskan nilai bagi V_{AN}, V_{BN}, V_{CN}, V_{AB}, V_{BC} and V_{CA}. *Lakarkan gelombang keluaran bagi* V_{AN} *dan* V_{AB}.

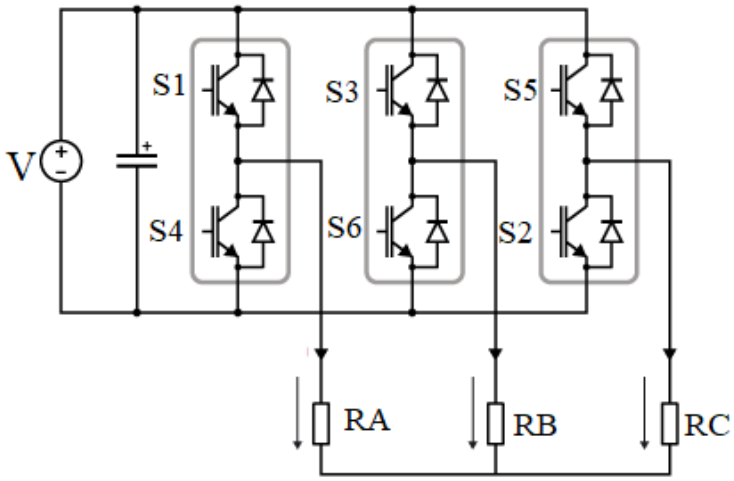

Figure A3 (c) / *Rajah A3 (c)*

PERIOD	S1	S2	S3	S4	S5	S6	VAN	VBN	VCN	VAB	VBC	VCA
0-60	ON	OFF	OFF	OFF	ON	ON						
60-120	ON	ON	OFF	OFF	OFF	ON						
120-180	ON	ON	ON	OFF	OFF	OFF						
180-240	OFF	ON	ON	ON	OFF	OFF						
240-300	OFF	OFF	ON	ON	ON	OFF						
300-360	OFF	OFF	OFF	ON	ON	ON						

Table A3(c) / *Jadual A3(c)*

[8 marks]

[8 *markah*]

SECTION B : 40 MARKS
BAHAGIAN B : 40 MARKAH

INSTRUCTION:
This section consists of **TWO (2)** essay question. Answer **ALL** questions.
ARAHAN:
*Bahagian ini mengandungi **DUA (2)** soalan esei. Jawab **SEMUA** soalan.*

QUESTION 1
SOALAN 1

CLO1

The Average Output Voltage, $V_{o(avg)}$ waveform for a Single-Phase Half Wave Controlled Rectifier with resistive and inductive load shown in Figure B1. Given the triggering angle, α is at $\pi/6$ and the extinction angle, β is at $\pi/3$, illustrate the circuit diagram. The answer should include the derivation of an expression average output voltage, $V_{o\,(avg),}$ and the calculation value of the average output voltage, $V_{o(avg)}$ if the input voltage is 120V. The existence of inductance in the circuit load gives the effect that needs to overcome with added appropriate component. The result should include a method used to overcome a new circuit diagram and the output voltage waveform, $V_{o.}$

Bentuk gelombang Voltan Keluaran Purata, $V_{o(avg)}$ untuk Penerus Terkawal Separuh Gelombang Fasa Tunggal dengan beban perintang dan induktif ditunjukkan dalam Rajah B1. Diberi sudut pencetus, α berada pada $\pi/6$ dan sudut kepupusan, β berada pada $\pi/3$, gambarkan gambarajah litar. Jawapan perlu disertakan dengan terbitan ungkapan voltan keluaran purata, $V_{o(avg)}$ dan nilai kiraan purata voltan keluaran, $V_{o(avg)}$ jika voltan masukan ialah 120V. Kewujudan aruhan dalam beban litar memberi kesan yang perlu diatasi dengan menambah komponen yang sesuai. Jawapan perlu merangkumi kaedah untuk mengatasi, gambarajah litar yang baru dan bentuk gelombang voltan keluaran, $V_{o.}$

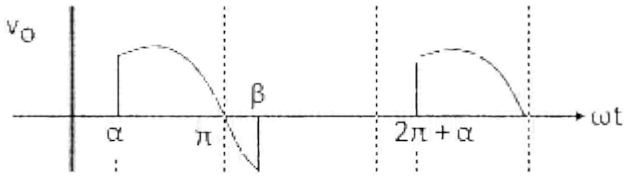

Figure B1/*Rajah B1*

[20 marks]
[20 *markah*]

QUESTION 2
SOALAN 2

CLO1

A single-phase bidirectional AC voltage controller with a resistive load of 80Ω uses phase angle control in its operation. With the aid of a circuit diagram, waveform of input voltage, gate and output voltage, write the operation of the AC voltage controller. If the thyristors are triggered at α1=α2= π/3 with a supply source of 240V, 60 Hz, calculate the output power of the load.

Pengawal voltan AC dwiarah fasa tunggal dengan beban rintangan 80Ω menggunakan kawalan sudut fasa dalam operasinya. Dengan bantuan gambar rajah litar, bentuk gelombang voltan masukan, get dan voltan keluaran, tulis operasi pengawal voltan AC. Jika tiristor dicetuskan pada α1=α2= π/3 dengan sumber bekalan 240V, 60 Hz, hitung kuasa keluaran beban.

[20 marks]
[20 *markah*]

SOALAN TAMAT

FORMULA

$V_{o(avg)} = \frac{V_m}{\pi}$	$V_{o(rms)} = \frac{V_m}{2}$
$V_{o(avg)} = \frac{V_m}{2\pi}(1 - cos\beta)$	$V_{o(rms)} = \frac{V_m}{2}\sqrt{\left(\frac{\beta}{\pi} - \frac{sin2\beta}{2\pi}\right)}$
$V_{o(avg)} = \frac{V_m}{2\pi}(1 + \cos\alpha)$	$V_{o(rms)} = \frac{V_m}{2}\sqrt{1 - \frac{\alpha}{\pi} + \frac{sin(2\alpha)}{2\pi}}$
$V_{o(avg)} = \frac{V_m}{2\pi}(\cos\alpha - \cos\beta)$	$V_{o(rms)} = \frac{V_m}{2}\sqrt{\left[\frac{\beta}{\pi} - \frac{\alpha}{\pi} - \frac{sin(2\beta)}{2\pi} + \frac{sin(2\alpha)}{2\pi}\right]}$
$V_{o(avg)} = \frac{2V_m}{\pi}$	$V_{O(rms)} = \frac{V_m}{\sqrt{2}}$
$V_{o(avg)} = \frac{V_m}{\pi}(1 + \cos\alpha)$	$V_{o(rms)} = V_m\sqrt{\frac{1}{2} - \frac{\alpha}{2\pi} + \frac{sin(2\alpha)}{4\pi}}$
$V_{o(avg)} = \frac{V_m}{\pi}(\cos\alpha - \cos\beta)$	$V_{o(avg)} = \frac{2V_m cos\alpha}{\pi}$
$V_{o(avg)} = \frac{3\sqrt{3}}{2\pi}V_m$	$V_{o(rms)} = \sqrt{\frac{V_m^2}{2\pi}\left[\beta - \alpha - \frac{sin(2\beta)}{2} + \frac{sin(2\alpha)}{2}\right]}$
$V_{o(avg)} = \frac{3\sqrt{3}\,V_m\cos\alpha}{2\pi}$	$Z = \sqrt{R^2 + (\omega L)^2}$
$I_{Lmax} = V_O\left[\frac{1}{R} + \frac{(1-D)}{2Lf}\right]$	$I_{L\,min} = V_O\left[\frac{1}{R} - \frac{(1-D)}{2Lf}\right]$
$I_{Lmax} = \frac{V_S}{(1-D)^2\,R} + \left[\frac{V_S}{2L}DT\right]$	$I_{L\,min} = \frac{V_S}{(1-D)^2\,R} - \left[\frac{V_S}{2L}DT\right]$
$L_{min} = \frac{(1-D)R}{2f}$	$\Delta V_O = \frac{V_O\,(1-D)}{8LCf^2}$
$L_{min} = \frac{D(1-D)^2R}{2f}$	$\Delta V_o = \frac{V_o D}{RCf}$
$V_{o(rms)} = V_s\sqrt{\frac{1}{2\pi}\left[2\pi - \alpha + \frac{sin2\alpha}{2}\right]}$	$V_{o(rms)} = V_s\sqrt{\frac{1}{\pi}\left[\pi - \alpha + \frac{sin2\alpha}{2}\right]}$