UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	POWER ELECTRONICS
COURSE CODE	:	BEV 30203/BEF 34503
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	DECEMBER 2019/ JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Demonstrate power electronics system by sketching suitable block diagrams. Then, explain the function of each block.

(7 marks)

(b) Explain diode reverse recovery time (t_{rr}) condition. You may consider suitable diagrams to support your answer.

(5 marks)

(c) A power switching device has maximum voltage and current of 280 V and 120 A, respectively. It takes 1.5 μs to fully turn-ON and 3.3 μs to fully turn-OFF. The switching period is 40 μs.

(i) Calculate the switching frequency.

(1 mark)

(ii) If the switching device is a MOSFET, sketch and label drain-source voltage (V_{DS}) and drain-source current (I_{DS}) waveforms with rise time (t_r) and fall time (t_f).

(6 marks)

(iii) Calculate average power dissipation of the switching device based on the parameters given in Q1(c).

(6 marks)

Q2 (a) Explain the operation of the rectifier circuit shown in **Figure Q2(a)**

(4 marks)

(b) A battery of 48 V e.m.f. is charged through 10 Ω resistor as shown in the **Figure Q2 (b)**.

(i) Derive an expression for the average value of charging current, $I_{battery}$ when firing angle is α. Assume the thyristor is fired continuously.

(6 marks)

(ii) For an AC source of 240 V, 50 Hz, find the value of the average charging current $I_{battery}$.

(6 marks)

(iii) Find the power supplied to battery, $P_{battery}$.

(2 marks)

(iv) Sketch the waveforms of:
(a) axis 1: input voltage (V_s), battery voltage (E) and firing angle (α) signal
(b) axis 2: input current (I_s) and battery current ($I_{battery}$)
(c) axis 3: Resistor voltage (V_R) and resistor current ($I_{resistor}$)
All waveforms should be labelled accordingly.

(7 marks)

Q3 (a) State **three (3)** advantages and disadvantages of PWM switching scheme

(3 marks)

(b) A single-phase full-bridge inverter has an input supply of V_{DC}= 230 V and consist of RLC load in series with R=1.2 Ω, ωL=9 Ω and 1/ωC= 8 Ω respectively. The output frequency of the inverter is 60 Hz and the transistor switching scheme is complementary bipolar. Determine:

(i) The instantaneous output voltage and load current expresses as a Fourier series up to 9^{th} order harmonic.

(7 marks)

(ii) amplitude of fundamental rms output current, I_{o1}

(2 marks)

(iii) The power delivered to the load due to the fundamental component

(1 mark)

(c) An inverter that will supply the series R-L load of R=10 Ω and L=25 mH with a fundamental frequency and load current of 50 Hz and 9.27 A respectively. If at the beginning of designing stage, the inverter has very high of Total Harmonic Distortion (THD_i) of load current, modify the inverter so that it has the THD less than 10 %. The analysis must be done up to 9^{th} harmonic numbers.

(12 marks)

Q4 Identify the steps in assessing the performance of the single-phase half-wave AC voltage controller shown in **Figure Q4**. The AC voltage controller has a parallel resistive loads of R1=8 Ω and R2=10 Ω respectively and the input voltage is Vs=230 V_{rms}, 50 Hz. The first experiment is conducted with on-off control when the thyristor switch on is n=115 cycles while the off is m=75 cycles. The second experiment is conducted at delay angle control of thyristor T1 when α=π/2. Compare the performance of AC voltage controller for both experiments in term of,

(a) Experiment 1: with on-off control when the thyristor switch on and off for 115 and 75 cycles respectively, find,

(i) The rms output voltage.

(2 marks)

(ii) The input power factor (PF).

(1 mark)

(iii) The average input current at thyristor.

(5 marks)

(iv) The average current flows in R1 and R2.

(2 marks)

(b) Experiment 2: delay angle control of thyristor T1 when $\alpha = \pi/2$, find,

(i) The rms output voltage.

(6 marks)

(ii) The input power factor (PF).

(4 marks)

(iii) The average input current at thyristor.

(3 marks)

(iv) The average current flows in R1 and R2.

(2 marks)

-END OF QUESTIONS-

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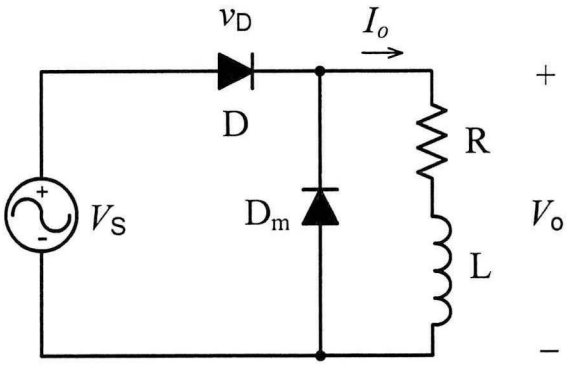

Figure Q2(a)

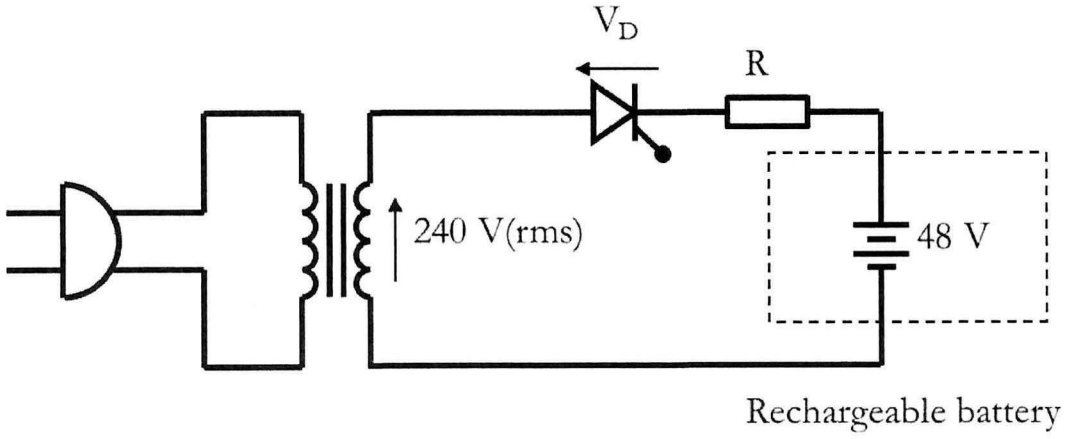

Figure Q2(b)

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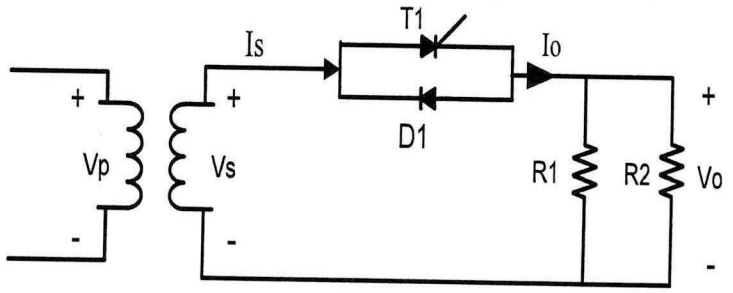

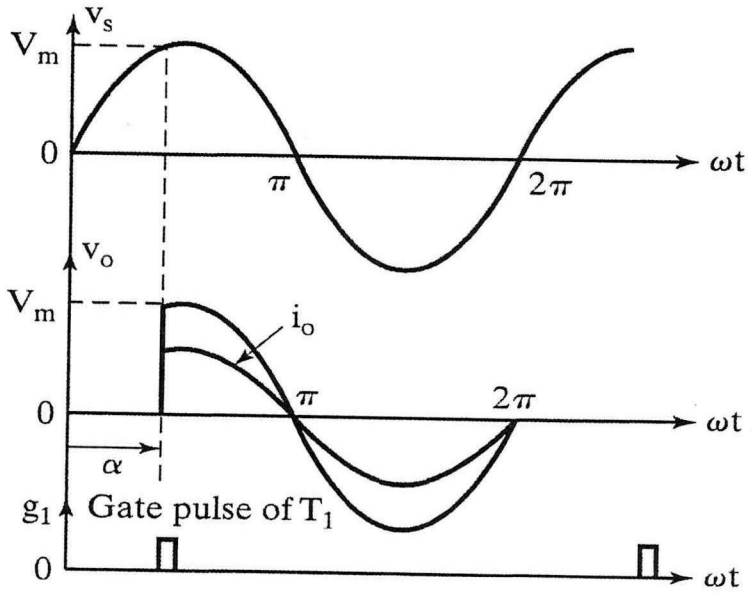

Figure Q4