UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	:	POWER ELECTRONICS
COURSE CODE	:	BEF 34503 / BEX 42303 / BEE 4113
PROGRAMME	:	BEF / BEE
EXAMINATION DATE	:	JUNE 2013
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) List down four (4) function of diode.

(4 marks)

(b) List two (2) important device parameters that must be considered when selecting rectifier diode

(2 marks)

(c) Define peak-inverse-voltage (PIV) in rectifier circuits.

(2 marks)

(d) Sketch the symbol and discuss the features of the following power electronic devices.

(i) Metal Oxide Semiconductor Field-Effect Transistor (MOSFET)
(ii) Silicon Controlled Rectifier (SCR)

(6 marks)

(e) Figure Q1(e) shows the power electronic switch signal and output waveforms that operated at 20 kHz. V_d and I_o are the voltage and current across the output during on and off switch signal. The output power dissipated after the rise time is 3 W where the rise time, t_{fi} is 50 ns. The total power dissipated during switch off (T_{off}) is 9.75 W. If the current flowing through the switch is 4 A during on signal, formulate:

(i) the turn-off interval time, t_{off}, of the switch
(ii) the average switching power loss
(iii) the current rise time, t_{ri}, if the turn-off crossover interval $t_{c(off)}$ = 300 ns. Assume the rise time is equal to fall time

(11 marks)

Q2 (a) List four (4) advantages of bridge rectifier

(4 marks)

(b) A center-tapped transformer uncontrolled rectifier is shown in Figure Q2(b) has an ac input source of $V_s=120\ sin\ \omega t$ at 60 Hz and purely resistive load of $R=30\ \Omega$.

(i) Sketch the waveform of output voltage, *Vo*, output current, *Io* and voltage across diode D_1 and D_2 against ωt (magnitude of each waveform should be note clearly).

(4 marks)

(c) Both of the diode D_1 and D_2 in Figure Q2(b) are then replaced by thyristor T_1 and T_2 and the other parameters are remaining the same.

(i) Demonstrate the average output voltage, $V_{o,avg}$ across the load.
(ii) If the average output current, $I_{o,avg}$ is 2.25A. Formulate the firing angle, α of the thyristor.
(iii) Formulate the rms output voltage, $V_{o,rms}$.
(iv) Calculate peak-inverse-voltage (PIV) of thyristor T_2.
(v) Calculate the power absorbed by the load.
(vi) Calculate the power factor of the circuit.
(vii) Calculate the efficiency of the circuit.

(17 marks)

Q3 (a) List the advantages and disadvantages of Pulse Width Modulation (PWM) in power electronics applications.

(4 marks)

(b) The full-bridge inverter with DC input voltage of 240V, load resistor and inductor of 10Ω and 20mH respectively and operated at 60 Hz frequency. Formulate:

(i) the amplitude of the Fourier series terms for the square-wave load voltage
(ii) the amplitude of the Fourier series terms for load current.
(iii) power absorbed by the load.
(iv) the THD of the load voltage square-wave inverter.
(v) the THD of the load current for square-wave inverter.
(vi) Design the inverter which is produces THD less than 10% and calculate the voltage amplitude at the fundamental frequency, the required DC input supply and the new THD of the current.

(21 marks)

Q4 (a) Explain briefly the operation of the converter in Continuous Current Mode (CCM) and Discontinuous Current Mode (DCM).

(6 marks)

(b) A buck converter has the following parameters: $V_s = 12$ V, $D = 0.6$, $L = 150$ mH, $C = 150$ μF and $R = 10$ Ω. The switching frequency is 40 kHz.

(i) Sketch the equivalent circuit of the buck converter.
(ii) Calculate the output voltage, V_o.
(iii) Derive the maximum and minimum inductor currents.
(iv) Calculate the maximum and minimum inductor currents.
(v) Calculate the output voltage ripple.
(vi) Sketch the waveforms of inductor voltage, inductor current and capacitor current for the given buck converter circuit.
(vii) Based on the calculations in Q4(c)(iv), give your conclusion.

(19 marks)

Q5 Two analysis to find the performance of the single-phase half-wave AC voltage controller as shown in Figure Q5 (b). The AC voltage controller has a parallel resistive loads of R1= 4Ω and R2 = 2Ω respectively and the input voltage is $Vs = 200\ V_{rms}$, 50 Hz. The first experiment is conducted with on-off control where the thyristor switch on is n = 100 cycles while the off is m = 50 cycles. The second experiment is conducted at delay angle of thyristor T1 when $\alpha = \pi/2$. Compares the performance of AC voltage controller for both experiments in term of

(i) the rms output voltage
(ii) the input power factor (PF)
(iii) the average input current at thyristor
(iv) the average current flows in R1 and R2.

(25 marks)

-END OF QUESTIONS-

FINAL EXAMINATION

SEMESTER/SESSION : II/2012/2013
COURSE NAME : POWER ELECTRONICS

PROGRAMME : 3BEF/ 4BEE
COURSE CODE : BEF 34503/ BEX42303/ BEE4113

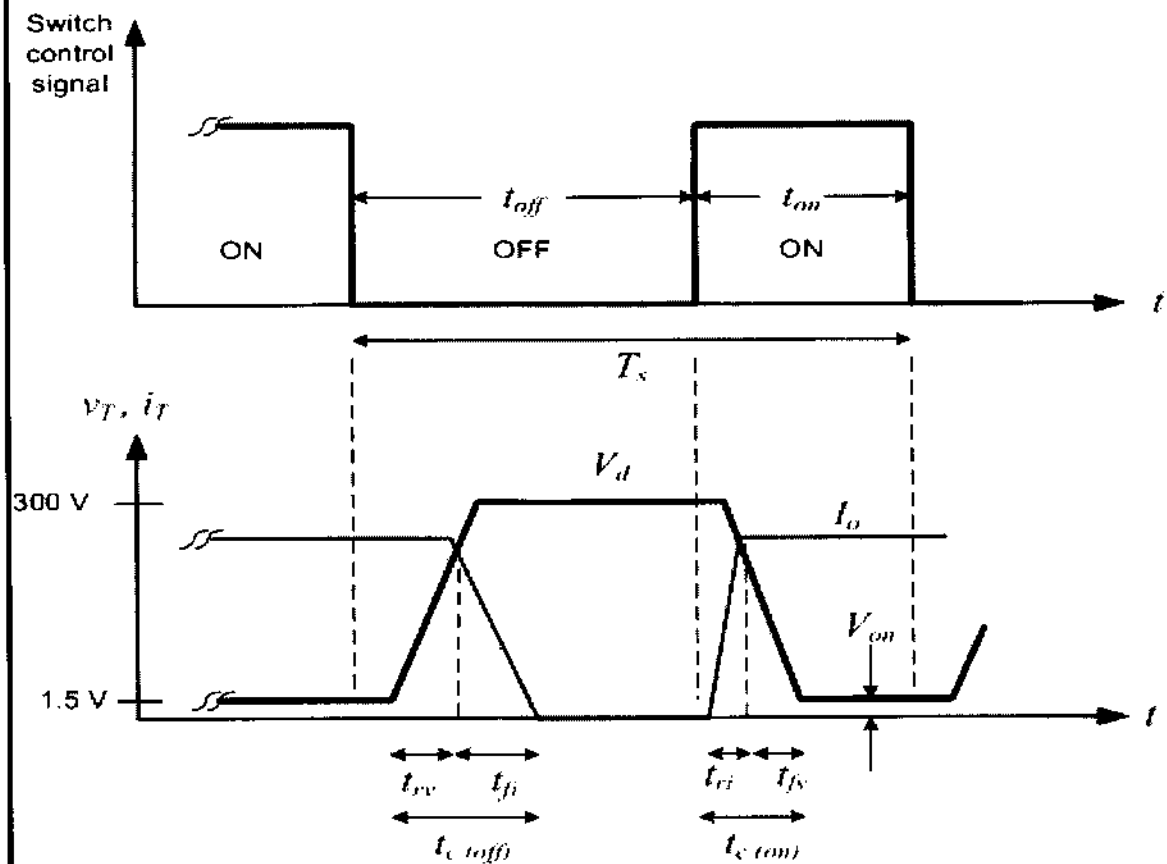


FIGURE Q1(e)

FINAL EXAMINATION

SEMESTER/SESSION : II/2012/2013
COURSE NAME : POWER ELECTRONICS

PROGRAMME : 3BEF/ 4BEE
COURSE CODE : BEF 34503/ BEX42303/ BEE4113

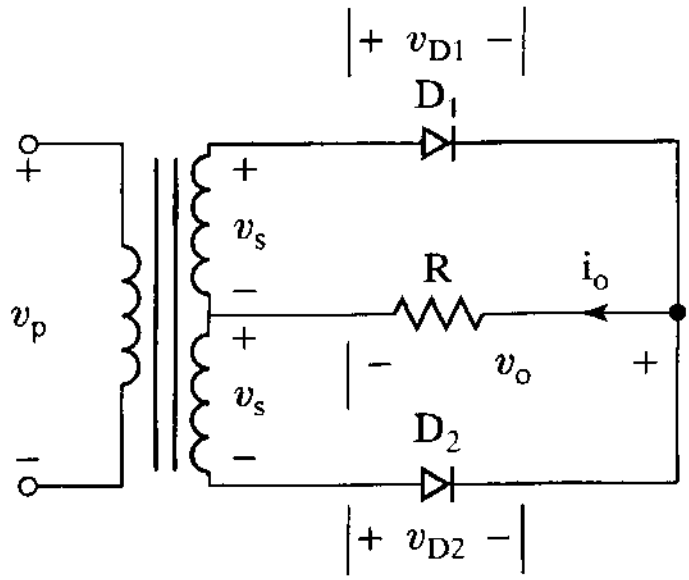
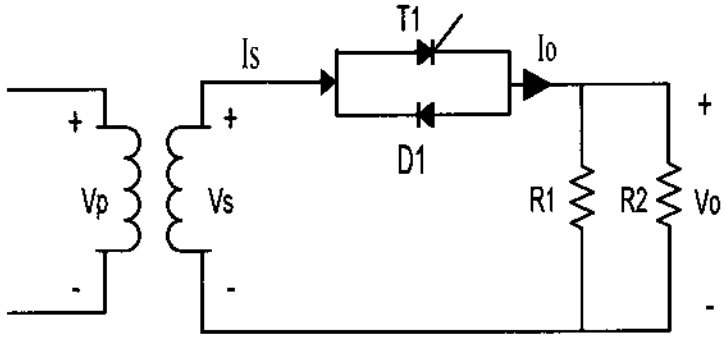


FIGURE Q2(b)

FINAL EXAMINATION

SEMESTER/SESSION : II/2012/2013
COURSE NAME : POWER ELECTRONICS

PROGRAMME : 3BEF/ 4BEE
COURSE CODE : BEF 34503/ BEX42303/ BEE4113



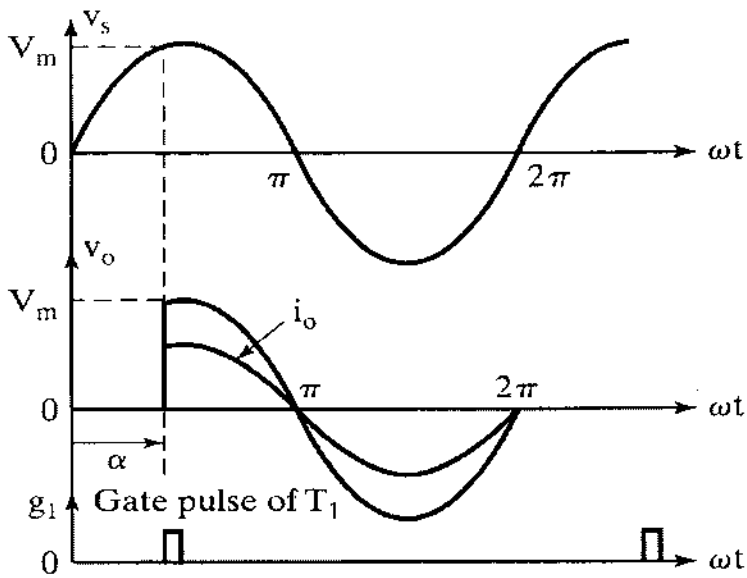


FIGURE Q5(b)