UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	POWER ELECTRONIC CONVERTERS
COURSE CODE	:	BNR 33603
PROGRAMME	:	3 BNE
EXAMINATION DATE	:	DECEMBER 2015 / JANUARY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

Q1 (a) State **THREE (3)** advantages of power diodes.

(3 marks)

(b) The thyristors can be subdivided into different types. Justify minimum **FOUR (4)** types of thyristor.

(4 marks)

(c) Explain the differences between power electronic switches and mechanical switches.

(4 marks)

(d) There are **THREE (3)** methods of switching-off the silicon controlled rectifier, SCR. Justify all of the methods.

(3 marks)

(e) The RC network across the transistor is known as a snubber circuit. As an electronics experts, design a static and dynamic equalisation circuit for series connection of a SCR with snubber circuit.

(11 marks)

Q2 (a) The transistor is a current-driven device. Draw a structure and symbol of bipolar junction transistor (BJT) with detail labelling diagram.

(4 marks)

(b) Based on the power transistor application, sketch and explain the purpose of Darlington pair transistor.

(5 marks)

(c) Describe briefly about an Insulated Gate Bipolar Transistor (IGBT) and the operating principles.

(8 marks)

(d) As an experienced technologist in power electronics, design a power efficient of electrical isolation driver circuit for the case of a power BJT half-bridge converter.

(8 marks)

Q3 (a) The battery voltage in **FIGURE Q3(a)** is E = 12 V and its capacity is 100 Wh. The average charging current should be I_{dc} = 5 A. The primary input voltage is V_p = 120 V, 60 Hz , and the transformer has a turn ratio of n = 2:1.

Calculate:

(i) Conduction angle, δ of the diode.
(ii) Current-limiting resistance, R.
(iii) Power rating, P_R of R.
(iv) Charging time, h_0 in hours.
(v) Rectifier efficiency, η.
(vi) Peak inverse voltage, PIV of the diode.

(13 marks)

(b) A three-phase bridge rectifier of **FIGURE Q3(b),** has a purely resistive load of R.

Determine:

(i) Efficiency, η.
(ii) Form factor (FF).
(iii) Ripple factor (RF).
(iv) Transformer utilization factor (TUF).
(v) Peak inverse (or reverse) voltage (PIV) of each diode.

(12 marks)

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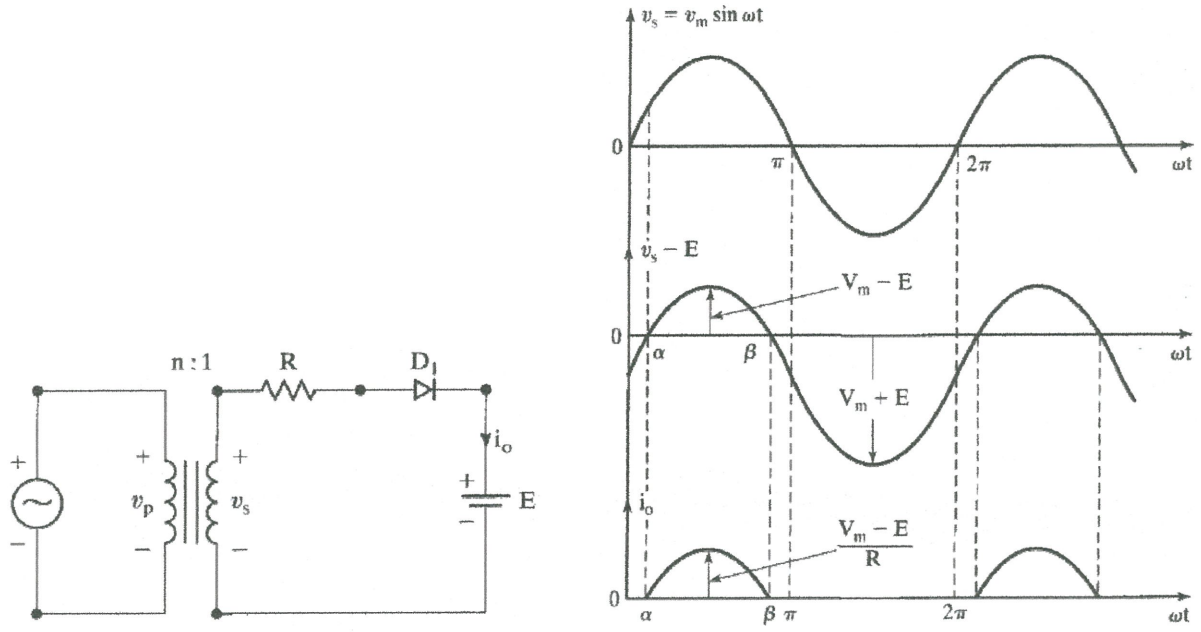

FIGURE Q3(a)

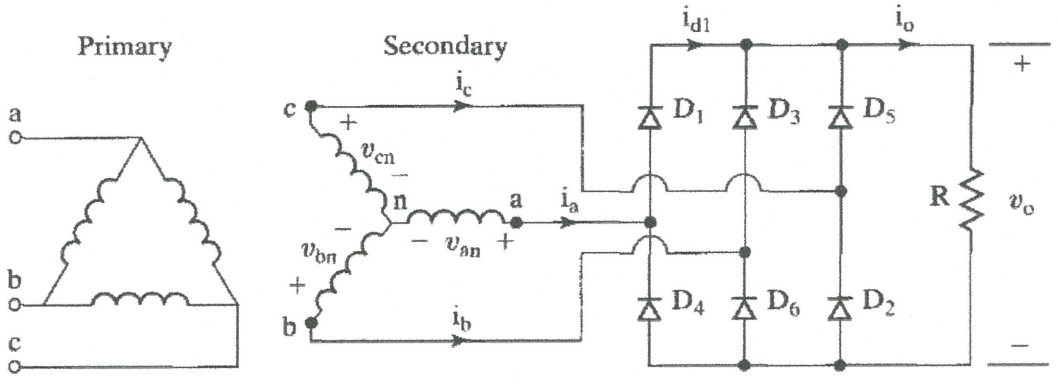

FIGURE Q3(b)

Q4 (a) Draw a block diagram of an inverter with proper notation.

(2 marks)

(b) Show the block diagram of voltage source inverter and current source inverter.

(5 marks)

(c) The single-phase half-bridge inverter has a resistive load of R = 2.4 Ω and the DC input voltage is 48V.

Find:

(i) Efficiency, η.
(ii) Form factor (FF).
(iii) Ripple factor (RF).
(iv) Transformer utilization factor (TUF).
(v) Peak inverse (or reverse) voltage (PIV) of each diode.

(8 marks)

(d) The full-bridge inverter with DC input voltage of 100V, load resistor and inductor of 10Ω and 25mH respectively are operated at 60 Hz frequency.

Compute:

(i) Amplitude of the Fourier series terms for the square-wave load voltage.
(ii) Amplitude of the Fourier series terms for load current.
(iii) Power absorbed by the load.
(iv) Total harmonic distortion (THD) of the load voltage and load current for square-wave inverter.

(10 marks)

Q5 (a) Describe about DC-DC converter with suitable definition and application.

(3 marks)

(b) The buck DC-DC converter of **FIGURE Q5(b),** has the following parameters:

V_s = 50V;
D = 0.4;
L = 400μH;
C = 100μF;
R = 20Ω;
f = 20kHz.

Assuming ideal components, calculate:

(i) Output voltage, V_o.
(ii) Maximum and minimum inductor current.
(iii) Output voltage ripple.

(10 marks)

(c) The Buck-Boost circuit of **FIGURE Q5(c),** has the following parameters:

Vs = 24V;
D = 0.4;
L = 100μH;
C = 400μF;
R = 5Ω;
f = 20kHz.

Determine:

(i) Output voltage, V_o.
(ii) Inductor current.
(iii) Output voltage ripple.

(12 marks)

Q6 (a) State **THREE (3)** major applications of AC voltage controllers.

(3 marks)

(b) Discuss briefly about AC-AC controller based on **FIGURE Q6(b).**

(4 marks)

(c) A single phase 120V AC source control power to a 5Ω resistive load using integral cycle control.

Determine:

(i) Average value of output current
(ii) Maximum switch current
(iii) Maximum power produced
(iv) Duty cycle and the value of T_{on} to produce 1kW power
(v) Power factor for part (iv)

(6 marks)

(d) A 120V source control power to a 5 Ω resistive load using a phase control switch. If the load power required is 1 kW.

Calculate:

(i) Maximum load current.
(ii) RMS value of load current.
(iii) Delay angle α.
(iv) RMS value of switch current if the switch is triac.
(v) Average current in each of the two SCRs .
(vi) Peak reverse voltage rating of the switch.
(vii) Power factor.

(12 marks)

- END OF QUESTION -

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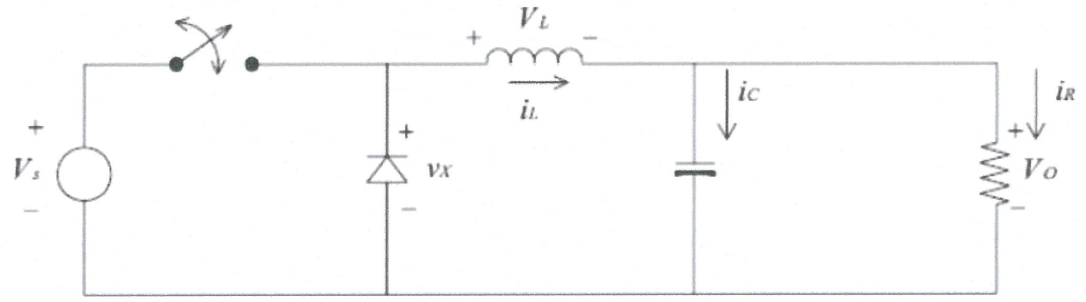

FIGURE Q5(b)

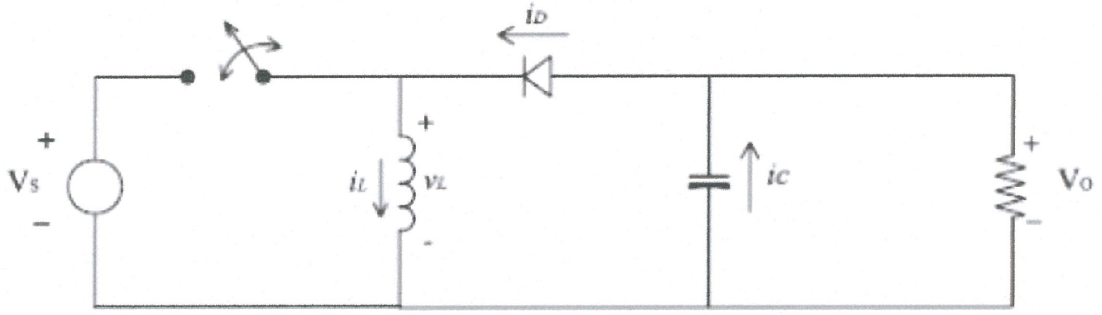

FIGURE Q5(c)

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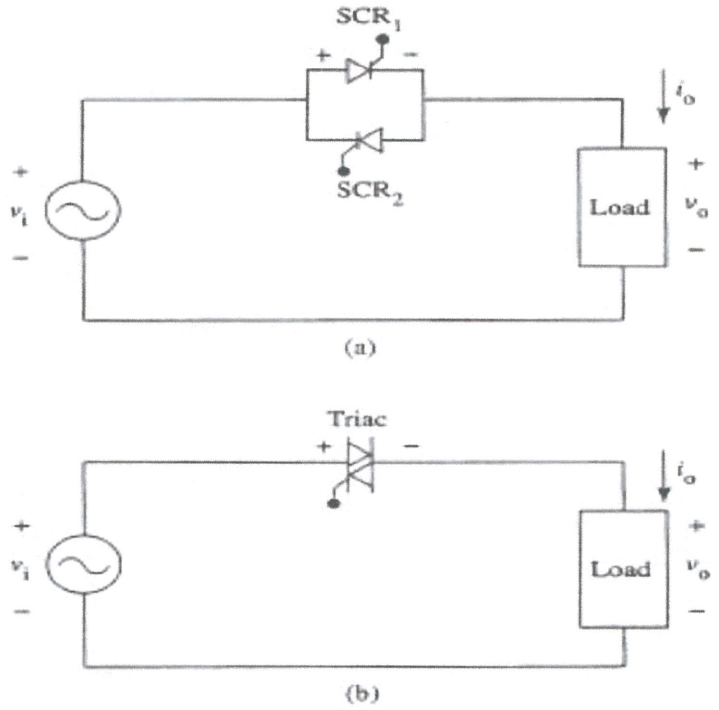

FIGURE Q6(b)