Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	POWER ELECTRONIC
COURSE CODE	:	BNR 31303 / BND 31303
PROGRAMME CODE	:	BND
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 (a) Power electronics devices can be categorized into two parts which are the controlled components and uncontrolled components.

(i) Draw and label the schematic symbols of SCR and IGBT.

(4 marks)

(ii) State **TWO (2)** conditions to turn-on the SCR.

(2 marks)

(iii) State **TWO (2)** conditions to turn-on the IGBT.

(2 marks)

(b) Rectifier is used to convert the AC input to the DC output. Two common devices can be used as a switching device which are the thyristor and the diode. Both of them can be categorized as controlled and uncontrolled converter.

(i) Identify **ONE (1)** switching device that can be used as a rectifier in order to have variable output voltage.

(1 mark)

(ii) Give **TWO (2)** advantages of full-wave rectifier compared to half-wave rectifier.

(3 marks)

(c) A three phase bridge rectifier with resistive load is shown in **Figure Q1(c)**. The voltage for line to neutral is measured at the secondary side of the transformer and rated as 240 V. The load impedance for the inverter is given as 10 Ω. By considering that the line-to-line voltage leads the phase voltage by 30^0:

(i) shows that the average output voltage is

$$= \frac{3\sqrt{3}}{\pi} V_M$$

(3 marks)

(ii) shows that the rms output voltage is

$$=1.6554 V_m$$

(3 marks)

(iii) determine the peak and rms current through the diode

(2 marks)

(iv) calculate the efficiency

(2 marks)

(v) calculate the form factor

(2 marks)

(vi) calaculate the peak inverse (or reverse) voltage (PIV) of each diode

(1 mark)

Q2 (a) Draw a block diagram of a basic single-phase half-bridge inverter, include with its switching and output voltage waveform.

(4 marks)

(b) The single-phase ~~full~~ half-bridge inverter has a resistive load of $R = 5\ \Omega$ and the DC input voltage is 60V. Determine:

(i) the rms fundamental output voltage

(1 mark)

(ii) the output power

(2 marks)

(iii) the average and peak current of each transistor

(3 marks)

(iv) the THD of the output voltage

(2 marks)

(c) The full-bridge inverter with DC voltage of 100V, load resistor and inductor of 10 Ω and 50 mH respectively. Determine:

(i) the amplitude of the Fourier series term for the square-wave load voltage

(1 mark)

(ii) the amplitude of the Fourier series terms for load current

(3 marks)

(iii) power absorbed by the load. Calculate the power up to fifth harmonics

(4 marks)

(iv) total harmonic distortion (THD) of the load voltage and load current for square-wave inverter

(4 marks)

Q3 (a) DC – DC converters are used to convert a constant dc input to a variable dc output. These converters are used for traction operation such as in electric vehicle, high speed train and etc.

(i) List all types of dc-dc converters.

(2 marks)

(ii) The duty cycle (D) is needed for the dc-dc converters. With the help of the diagram, construct the duty cycle equation for basic dc-dc converter when it is ON and OFF state.

(7 marks)

(iii) Determine the suitable range of the duty cycle for the dc-dc converter

(1 mark)

(b) The buck converter has an output voltage of 28 V when the input is 48 V, the resistor load is 8 Ω and the switching frequency is 25 kHz.

(i) Determine the minimum value of the inductor if continuous inductor current mode operation is applied to the converter.

(3 marks)

(ii) Determine the minimum value of the capacitor for the output ripple less than 0.5%.

(3 marks)

(c) The buck-boost converter has parameter of an inductor of 50 μH, a capacitor of 200 μF and a resistor load of 12 Ω. If the input voltage of the converter is 12 V, the duty cycle of 0.6 and the switching frequency of 40 kHz, determine:

(i) the output voltage

(1 mark)

(ii) the average inductor current

(1 mark)

(iii) the maximum inductor current

(3 marks)

(iv) the minimum inductor current

(3 marks)

(v) the output voltage ripple

(1 mark)

Q4 (a) State **THREE (3)** major applications of AC voltage controllers.

(3 mark)

(b) Based on **Figure Q4(b),** discuss the operational the given AC-AC controller circuit .

(4 marks)

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

(i) the average value of output current

(1 mark)

(ii) the maximum switch current

(1 mark)

(iii) the maximum power produced

(1 mark)

(iv) duty cycle and the value of T_{on} to produce 1 kW power

(2 marks)

(v) the power factor for condition in **Q4(c)(iv)**

(1 mark)

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

(i) the maximum load current

(1 mark)

(ii) the rms value of load current

(1 mark)

(iii) the delay angle, α

rujuk ~~soa~~ soalan yg dikepil ~~pada~~ sekpas m/s 6.

(2 marks)

(iv) rms value of switch current if the switch is triac

(2 marks)

(v) average current in each of the two SCRs

(2 marks)

(vi) peak reverse voltage rating of the switch

(2 marks)

(vii) the power factor

(2 marks)

- END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER / SESSION: SEM I / 2019/2020 PROGRAMME CODE: BND
COURSE NAME : POWER ELECTRONIC COURSE CODE : BNR31303/ BND31303

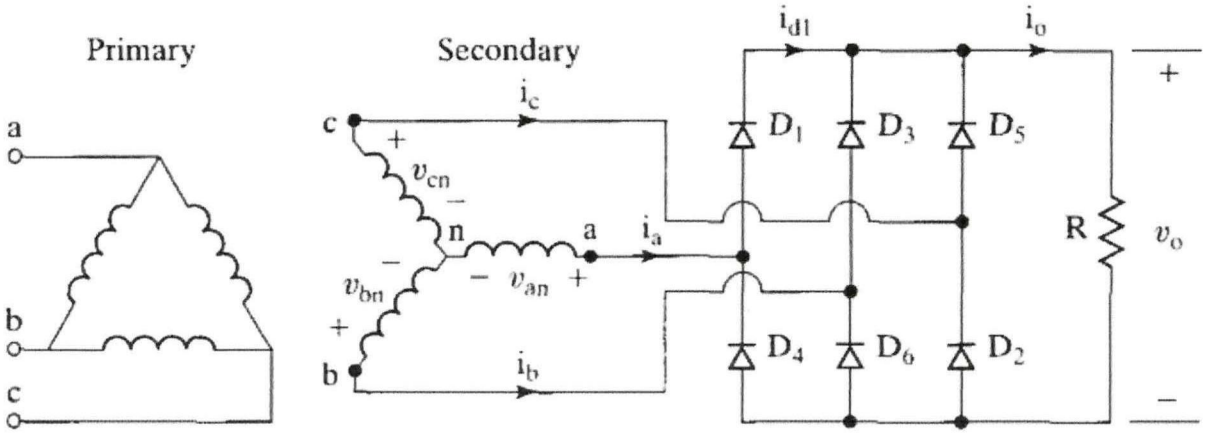
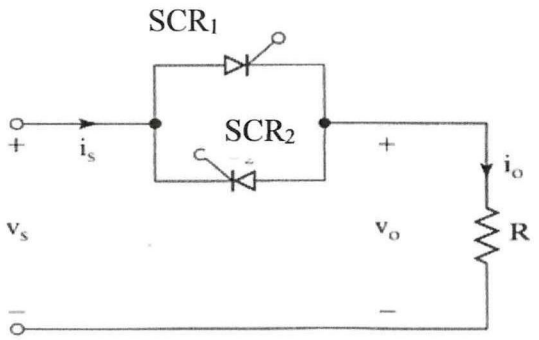
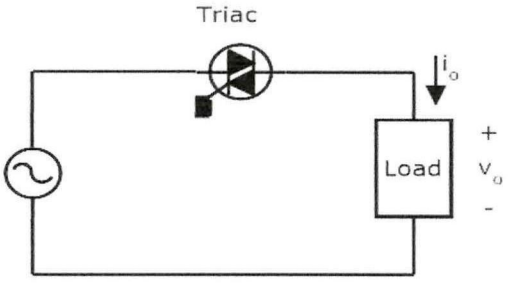


Figure Q1(c)



(a)



(b)

Figure Q4(b)