



UTHM

Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019**

COURSE NAME : POWER ELECTRONIC
COURSE CODE : BNR 31303
PROGRAMME CODE : BND
EXAMINATION DATE : DECEMBER 2018 / JANUARY 2019
DURATION : 3 HOURS
INSTRUCTION : ANSWER ALL QUESTIONS

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THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

- Q1 (a)** A buck converter has the following parameters: $V_s = 24$ V, $D = 0.7$, $L = 150$ μ H, $C = 200$ μ F and $R = 20$ Ω . The switching frequency is 25 kHz.
- (i) Sketch and label the equivalent circuit of a buck converter. (2 marks)
 - (ii) Calculate the output voltage. (1 marks)
 - (iii) Analyze the maximum and minimum of the inductor ripple currents by identifying each of them. (6 marks)
 - (iv) Determine the output voltage ripple by referring the output voltage. (2 marks)
 - (v) Compare the waveforms of inductor voltage, inductor current and capacitor current for the given buck converter circuit by sketching them in the same y-axis. (2 marks)
- (b) A continuous-current mode boost converter has an output ripple voltage less than 0.5 % when the input voltage is 14 V and the output voltage is 40 V. The load is a resistance of 50 Ω and the inductor has an inductance $L = 120$ μ H. The switching frequency is 25 kHz. From the changes parameters,
- (i) determine the new duty ratio. (1 mark)
 - (ii) analyze the new maximum and minimum inductor currents which give a continuous current mode condition. (4 marks)
 - (iii) specify the suitable value of capacitor. (2 marks)

Assume ideal components for this design.

- Q2 (a)** A single-phase full-wave controlled rectifier consists of four thyristors has a resistive load of $R = 10$ Ω and input voltage of 240 V_{RMS}.
- (i) Draw the schematic rectifier circuit stated in **Q2(a)**. (3 marks)
 - (ii) Derive the expression for the average output voltage of the rectifier. (4 marks)

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- (iii) Determine the firing angle of the thyristor when the average output current is 11 A. (3 marks)
- (b) A flyback converter is designed to produce an output voltage of 42 V from a 5 V source. The transformer turn ratio N_1 / N_2 is 3, the magnetizing inductance is 500 μH , the output capacitor is 200 μF and the load R is 5 Ω . Consider a switching frequency is 40 kHz for this design. Assume ideal components for this design.
- (i) Sketch and label the equivalent circuit of typical flyback converter that includes the magnetizing inductance. (2 marks)
- (ii) Determine the required duty ratio, D . (2 marks)
- (iii) Analyze the average, maximum, and minimum values for the current in L_m by identifying all of them. (4 marks)
- (iv) Calculate the output voltage ripple. (2 marks)
- Q3** (a) Answer briefly the following questions pertaining to AC voltage controllers.
- (i) Explain what an AC voltage controller is. (2 marks)
- (ii) List **TWO (2)** industrial applications of AC voltage controllers. (2 marks)
- (b) Explain the working of a single-phase ac voltage controller feeding a resistive load with appropriate voltage and current waveforms to support the answer. (6 marks)
- (c) A 3-phase, 60 horsepower, 415 V four-pole induction motor driving a centrifugal pump is started and controlled using a three-phase ac voltage controller. Power factor of the motor at full-load output is 0.87 and the efficiency is 82%. The motor current is sinusoidal and the controller and motor are connected in delta. Calculate:
- (i) The rms current rating of the thyristors. (6 marks)

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- (ii) The peak voltage rating of the thyristor. (2 marks)
- (iii) The control range of the firing angle α . (2 marks)
- Q4** (a) (i) List **THREE (3)** types of PWM switching method of an inverter. (3 marks)
- (ii) Explain **TWO (2)** advantages and **TWO (2)** disadvantages of a PWM switching scheme. (4 marks)
- (b) A single-phase full-bridge inverter having an RLC load with $R = 10 \Omega$, $L = 0.1 \text{ H}$ and $C = 4.7 \mu\text{F}$ as shown in **Figure Q4(b)**. The operating frequency is 500 Hz and the DC source voltage is 240 V.
- (i) Determine the instantaneous load current expressed as a Fourier series up to the 5th-order harmonic. (5 marks)
- (ii) Calculate the rms load current at the fundamental frequency. (2 marks)
- (iii) Calculate the THD of the load current. (2 marks)
- (iv) Calculate the power absorbed by the load. (2 marks)
- (v) Calculate the average DC supply current. (2 marks)
- Q5** (a) (i) With the aid of suitable diagram, briefly explain the GTO thyristor switching characteristics. (5 marks)
- (ii) Explain **TWO (2)** functions of the power modulator/power converter and name **TWO (2)** types of it. (2 marks)

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- (b) The rectifier can be used as a battery charger if its output is connected to battery. The input voltage of a battery charger as shown in **Figure Q5(b)** is 120V, 50 Hz, the battery capacity of $E = 12\text{V}$ (240Wh), and the current-limiting resistance of $R=5\Omega$.
- (i) Calculate the conduction angle, δ of the diode. (5 marks)
- (ii) Calculate the average charging current, I_{dc} (3 marks)
- (iii) Calculate the charging time, t_0 in hours. (1 marks)
- (iv) Modify the current-limiting resistance so that the charging time can be reduced up to 50% from the value obtained in **Q5(b)(iii)**. (4 marks)

- END OF QUESTIONS -

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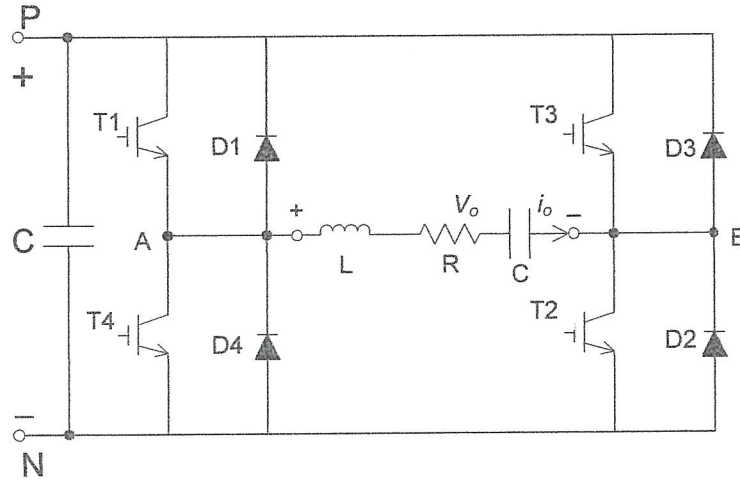


Figure Q4(b)

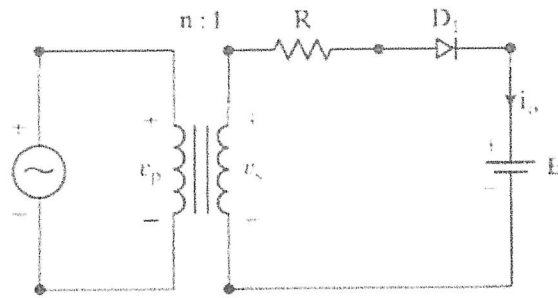


Figure Q5(b)

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