Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017

COURSE NAME	:	POWER ELECTRONICS
COURSE CODE	:	BEF 34503
PROGRAMME	:	BEV
EXAMINATION DATE	:	DECEMBER 2016 / JANUARY 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 (a) A buck converter has the following parameters: $V_s = 24$ V, $D = 0.7$, $L = 150$ µH, $C = 200$ µF 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 $L = 120$ µH. 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) In some applications, non-isolated dc-dc converters will give disadvantage due to no isolation between main supply and converter circuit. By considering a transformer, the isolation between main supply and converter circuit can be realized. By analyzing non-isolated and isolated DC-DC converters characteristics, compare the significant parameters between non-isolated and isolated DC-DC converter in terms of the isolation and boost ratio parameters.

(4 marks)

(b) Design a flyback converter 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.

(10 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 percent. The motor current is sinusoidal and the controller and motor are connected in delta. Calculate:

(i) The rms current rating of the thyristors.

(3 marks)

(ii) The peak voltage rating of the thyristor.

(3 marks)

(iii) The control range of the firing angle α.

(4 marks)

Q4 (a) Using a table, provide **two (2)** differences between single phase half wave converter and single phase full wave converter of DC drives.

(4 marks)

(b) Induction motor can be divided into single phase and three phase induction motor.

(i) Explain in detail the working principle of induction motor.

(7 marks)

(ii) Explain why the single phase induction motor is not self-starting whereas the three phase induction motor is self-starting.

(4 marks)

(c) Draw the equivalent circuit of a cage induction motor together with its characteristics.

(5 marks)

Q5 (a) Referring to the High Voltage DC (HVDC) system and the Flexible AC Transmission Systems (FACTS):

(i) Describe the salient features of a typical HVDC system.

(2 marks)

(ii) List **three (3)** main advantages of HVDC transmission.

(2 marks)

(iii) Define what is FACTS.

(2 marks)

(iv) Explain why the TCI is preferred over the thyristor-switched capacitor (TSC) when it is desired to have a reactive compensator with continuous control of the current.

(4 marks)

(b) An inductive load supplied from a single-phase ac supply of 240 V, 50 Hz has current ranging from (4 + j4) to (12 – j11) A. Design a thyristor-controlled inductor to be installed in parallel with the load to make the power factor unity throughout the current range.

(10 marks)

- **END OF QUESTIONS** -