UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2009/2010

November 2009

EEE 542 – INDUSTRIAL POWER ELECTRONICS

Duration: 3 hours

INSTRUCTION TO CANDIDATE:

Please check that this examination paper contains **FIVE (5)** pages of printed material before you begin the examination.

This paper contains **SIX (6)** questions.

Instructions: Answer **FIVE (5)** questions.

Answer to any question must start on a new page.

Distribution of marks for each question is given accordingly.

All questions must be answered in English.

…2/-

Q1. A three phase ac to dc full converter is operated from a three phase Y connected 208V 50 Hz supply. The load consist of R=10Ω and L=100mH.

(a) Draw the complete full converter circuit using power thyristor (10%)

(b) Derive the equations for the average and rms output voltage in term of α. (30%)

(c) If it is required to obtain an average output voltage of 50% of the maximum output voltage,

(i) Calculate the delay angle (20%)

(ii) Draw the output voltage waveform (20%)

(iii) Calculate the rectification efficiency (20%)

Q2. Referring to a three phase half wave AC controller:

(a) Draw a complete circuit diagram for this controller with a Y connected resistive load using thyristors and diodes. Briefly explain the operation of the controller. (20%)

(b) For a three phase balance system draw the output voltage waveform for firing angle of $\alpha=30^0$ at load phase A (40%)

(c) Based on the $\alpha=30^0$ firing angle derive the equation for the rms output voltage

(40%)

Q3. Referring to a three phase full wave AC controller with resistive load, explain the operation for the following mode:

(a) Mode $0<\alpha<60^0$

(b) Mode $60^0<\alpha<90^0$

(where α is the thyristor firing angle)

For each of the operation:

(i) Show the gating signal each of the thyristor (20%)

(ii) Draw the appropriate output voltage (30%)

(iii) Express the output voltage in term of α. (40%)

(c) What is the control range of the delay angle for this topology?

(10%)

Q4 (a) Explain the operation of a single phase full bridge inverter with highly inductive load

(20%)

(b) Refer to the Q5a, given the input voltage V_s=120V, f_0=50 Hz, R=10Ω and L=25mH:

(i) Express the instantaneous equations for load voltage and current in Fourier series

(30%)

(ii) Calculate the rms load current at the fundamental frequency

(20%)

(iii) Calculate the THD of the load voltage and current (30%)

Q5. (a) Explain briefly the operation a three phase inverter referring to 120^0 conduction.

(30%)

(b) A three phase inverter has a wye-connected with RL load of R=10Ω and L=25mH, f_0=50Hz and dc input voltage V_s=200V. If the instantaneous output voltage for 180^0 conduction can be express in a Fourier series as follow:

$$v_{an} = \sum_{n=1,3,5..}^{\infty} \frac{4V_s}{n\pi}\left(1+\cos\frac{n\pi}{3}\right)\sin(n\omega t)$$

Calculate the THD for both voltage and current.

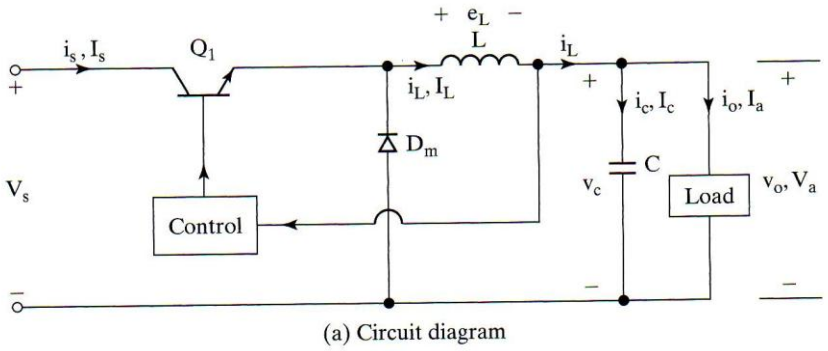
(70%)

Q6. (a) Construct and draw a simple buck circuit. Derive the expression for output voltage.

(30%)

(b) The boost regulator shown in Figure 6(a) has an input voltage $V_{s=}$5V. The average output voltage V_a=15V and the switching frequency is 25kHz. The average load current I_a=0.5A The inductance L=150uH and the filter capacitance C=220uF. Determine (i) The duty cycle (ii) The peak to peak inductor current (iii) The critical value of L for continuous conductor current

(40%)



(a) Circuit diagram

Figure 6(a)

(c) Explain the operation of a fly back converter

(30%)

ooo0ooo