UNIVERSITI SAINS MALAYSIA

Semester I Examination
Academic Session 2010/2011

November 2010

EEE 542 – INDUSTRIAL POWER ELECTRONICS

Time: 3 Hours

INSTRUCTION TO CANDIDATE:

Please ensure that this examination paper contains **SIX** printed pages and **SIX** questions before answering.

This question paper has four three sections, **Section A, Section B, Section C** and **Section D.**

Answer **ONE** question from each **Section A, Section B,** and **Section D.**
TWO question from **Section C**. Answer **FIVE** questions.

Distribution of marks for each question is stated accordingly.

All questions must be answered in English.

Section A: Answer question 1 or 2

1. A three phase semiconverter as shown in Figure 1 is operated from a three phase Y connected 208 V 60 Hz supply and the load resistance is R=10Ω, and L=10mH. If it is required to obtain an average output voltage of 50% of the maximum possible output voltage, calculate

   a) The delay angle

   b) The rms and average output current

   c) The rectification efficiency

   Maximum average output voltage occurs at delay angle of α=0.

   For $\alpha > \pi/3$ the output voltage is discontinuous. Assume E=0

   (100 marks)

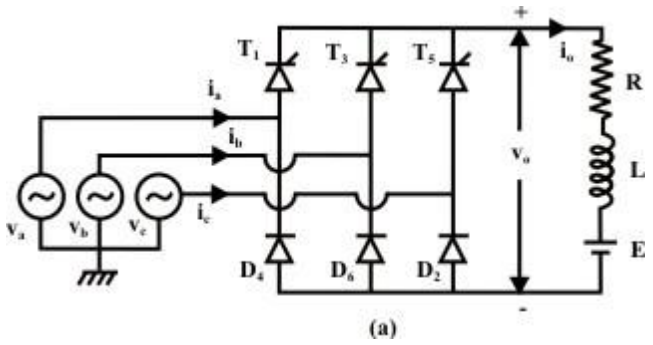

Figure 1: Semiconverter

2. A three phase full converter as shown in Figure 2 is also operated from a three phase Y connected 208 V 60 Hz supply and the load resistance is R=10Ω and L=10mH. If it is required to obtain an average output voltage of 50% of the maximum possible output voltage, calculate

   d) The delay angle

   e) The rms and average output current

   f) The rectification efficiency

   Maximum average output voltage occurs at delay angle of α=0. Assume E=0

   (100 marks)

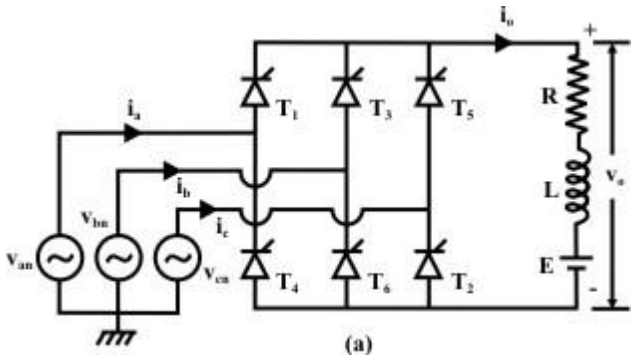

Figure 2: Full converter

Section B: Answer question 3 or 4

3. The three phase half wave ac controller is shown in Figure 3 supplies a wye-connected resistive load of R=10Ω and the line to line input voltage is 208 V (rms), 60 Hz. If the delay angle for the balance system is $\alpha=\pi/3$, determine:

   a) The rms output phase voltage for phase A

   b) The input power factor PF

   Draw the appropriate output voltage and highlight the technique used.

   (100 marks)

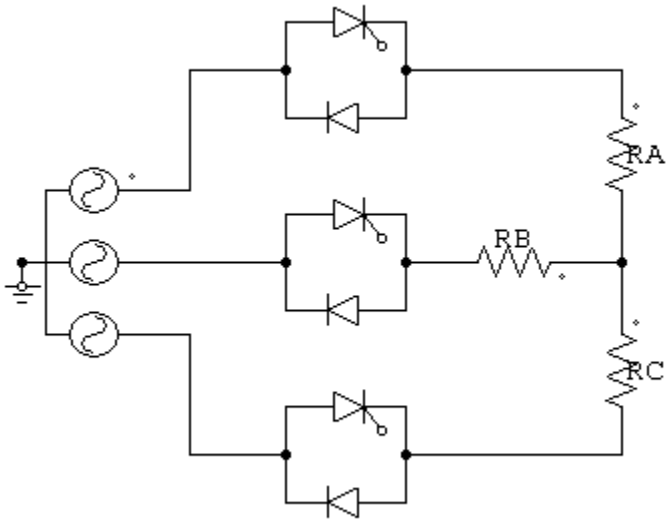

Figure 3: Half wave ac controller

4. The three phase full wave ac controller is shown in Figure 4 supplies a wye-connected resistive load 0f R=10Ω and the line to line input voltage is 208 V (rms), 60 Hz. If the delay angle for the balance system is $\alpha=\pi/3$, determine:

a) The rms output phase voltage for phase B

b) The input power factor PF

Draw the appropriate output voltage and highlight the technique used.

(100 marks)

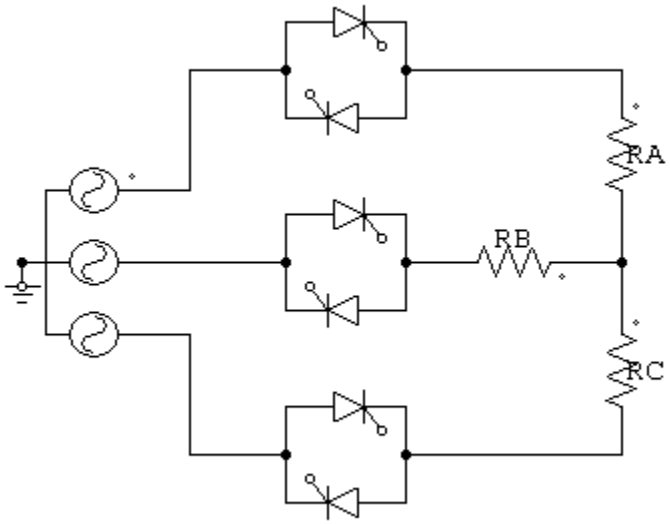

Figure 4: Full wave ac controller

Section C: Answer question 5, 6 or 7

5. The full bridge inverter in Figure 5 has an RLC load with R=5Ω, L=10mH and C=20μF. The inverter frequency f_o=400 Hz and the dc input voltage V_s=220V

   a) Express the instantaneous load current in a Fourier series

   b) Calculate the THD of the load current

(100 marks)

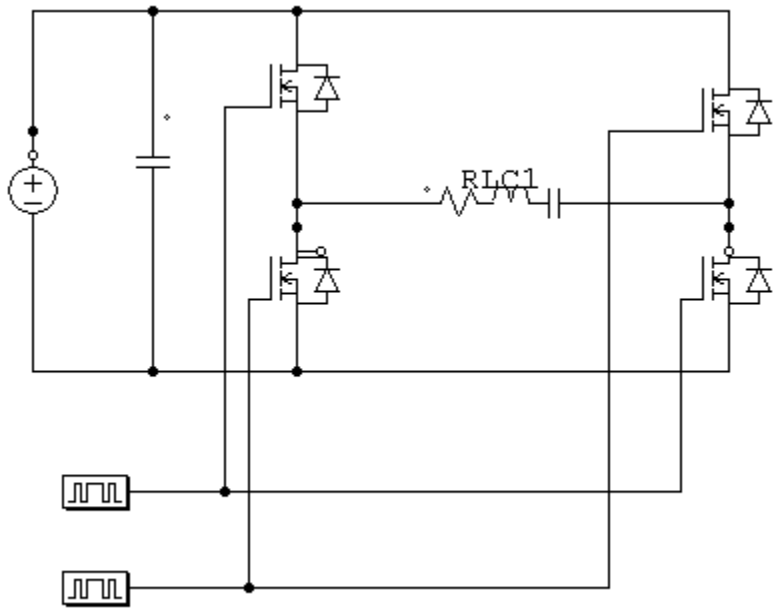

Figure 5: Inverter full bridge

6. Design a three phase inverter and show how a three phase output can be obtained from a configuration of six Mosfet. Applied appropriate control signal for the Mosfet.

   Show the overall circuit diagram of the topology used. Assume Y to Y connection and show the derivation applied.

(100 marks)

7. Construct and design a 5 level multiple inverter. In this design:
   a. State clearly the topology used including the power devices
   b. Draw the equivalent circuit for each of the output level and state the operation in a table.
   c. Draw the switching waveforms and the final output voltage.
   d. Explain how to calculate the inverter THD using PSIM and draw the appropriate harmonics waveforms
   e. Suggest the improvement of your design in order to increase the inverter efficiency.

(100 marks)

Section D: Answer question 8 or 9

8. Design a buck converter such that the output voltage is 28V when the input is 48V. The load is 8 Ohm. Design the converter such that it will be in continuous current mode. The output voltage ripple must not be more than 0.5%. Specify the frequency and the values of each component. Suggest the power switch also.

(100 marks)

9. Design a boost converter to provide an output voltage of 36V from a 24V source. The load is 50Ω. The voltage ripple factor must be less than 0.5%. Specify the duty cycle ratio, switching frequency, inductor and capacitor size, and power device.

(100 marks)

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