CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR

Malaysia France Institute

FINAL EXAMINATION

JULY 2010 SESSION

SUBJECT CODE	:	FLB30203
SUBJECT TITLE	:	POWER ELECTRONICS
LEVEL	:	BACHELOR
DURATION	:	12.30pm – 3.30pm (3 HOURS)
DATE / TIME	:	08 NOVEMBER 2010

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.

2. This question paper is printed on both sides of the paper.

3. Please write your answers on the answer booklet provided.

4. Answer should be written in blue or black ink except for sketching, graphic and illustration.

5. This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer two (2) question only.

6. Answer all questions in English.

THERE ARE 6 PRINTED PAGES OF QUESTIONS EXCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

INSTRUCTION: Answer ALL questions.
Please use the answer booklet provided.

Question 1

(a)   Give the definition of variable frequency drive and draw the basic block diagram of the system.

(3 marks)

(b)   Figure 1 shows a typical power diode with a forward voltage drop of Vd = 1.3 V at Id = 300A. By applying the Shockley equation under a DC steady-state operation, find the diode reverse saturation current (leakage current), *Is* given that the diode emission coefficient is n = 2 and the termal voltage is Vt = 26.7 mV.

Figure 1

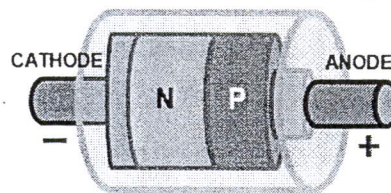(5 marks)

(c)   A single phase half-wave rectifier is supplied with sinusoid source voltage of 220Vrms at a frequency of 60Hz. Given the load is 5Ω, determine:

i.   The average load current

ii.   The average power absorbed by the load

iii.   The power factor of the circuit

(6 marks)

(d)   Briefly explain the characteristic of the following inverters.

i.   Voltage-Fed-Inverter (VFI)

ii.   Current-Fed-Inverter (CFI)

iii.   Variable DC Linked Inverter

(6 marks)

Question 2

(a)   A single-phase diode bridge rectifier shown in Figure 2 has a purely resistive load of
        15Ω. Given the source voltage is $VS = 300 \sin 314\,t$, determine:

      i.   The efficiency of rectification

      ii.   The form factor
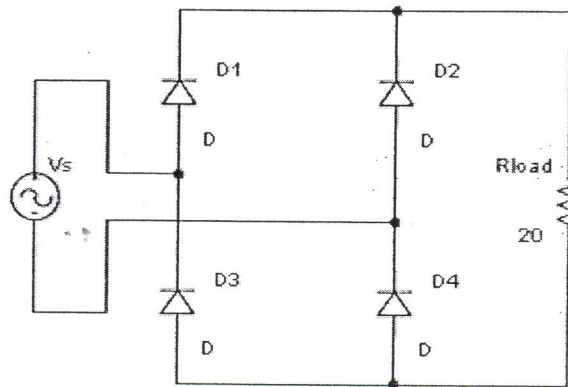
      iii.   The ripple factor

Figure 2

(6 marks)

(b)   A single-phase half-wave thyristor converter is supplied with source voltage of
        240V 60Hz. Determine the power absorbed by the resistive load and the power
        factor given that the circuit produced an average voltage of 40V across a 100Ω
        load.

(8 marks)

(c)   Based on voltage and current flow diagram, explain the characteristics of the
        following converters.

      i.   First Quadrant Converter

      ii.   Second Quadrant Converter

      iii.   Third and Fourth Quadrant Converter

(6 marks)

SECTION B (Total: 60 marks)

INSTRUCTION: Answer TWO (2) questions only.
Please use the answer booklet provided.

Question 3

(a)   Figure 3 shows circuit of a three-phase bridge rectifier with purely resistive load. Calculate the peak value of the phase voltage given the rectifier delivers an output voltage of V_{dc} = 280.7V.
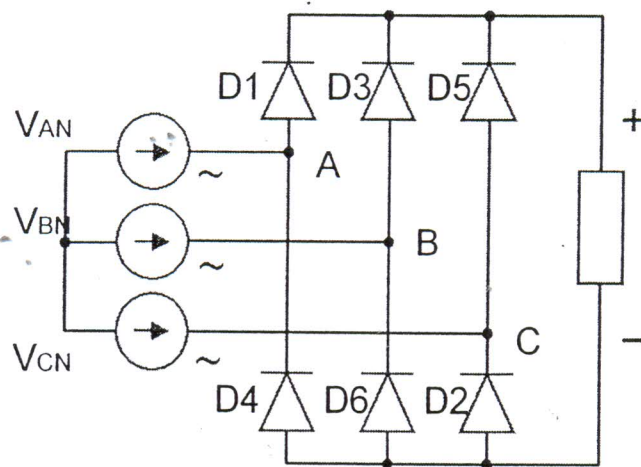

Figure 3

(6 marks)

(b)   A DC chopper is used to charge a 240V battery from 600V DC source. The average battery current is 20A with a peak-to-peak ripple of 2A. Calculate the duty cycle, switch ON time interval and the inductor inductance of the DC chopper given the chopper frequency is 200 Hz.

(6 marks)

(c)   A 200V DC source is connected to a 4-quadrant switching converter operating at a carrier frequency of 8 kHz. It is required to generate a sinusoidal voltage with an effective value of 240V at a frequency of 60 Hz and a phase angle of 35° lagging. Calculate the value of the amplitude modulation ratio, the frequency modulation ratio, and derive an expression for the duty cycle.

(6 marks)

(d)   A rectifier shown in Figure 4 has load of $R=15$ Ω and, $Vs=220$ sin 314 t and unity
transformer ratio. If it is required to obtain an average output voltage of 70 % of the
maximum possible output voltage, calculate:

i.   The delay angle

ii.   The rectification efficiency
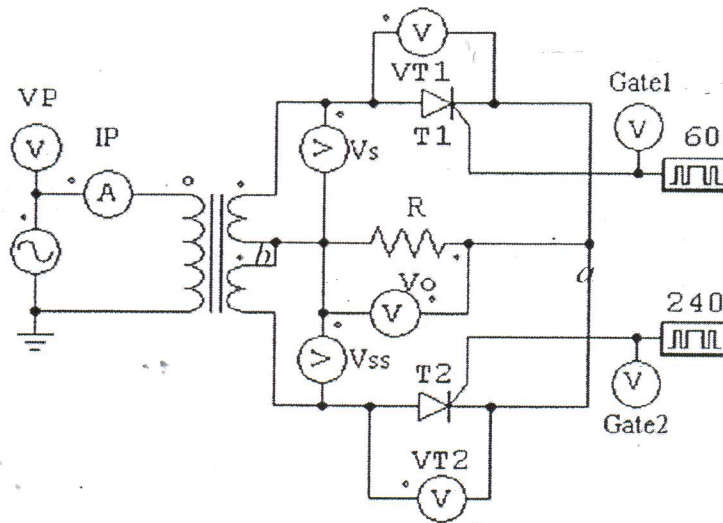
iii.   The ripple factor

Figure 4

(12 marks)

Question 4

(a)   A free-wheeling diode circuit shown in Figure 5 has an AC source of $V_m = 100V$ 60Hz
with resistive load of 2Ω and inductive load of 25mH. Determine:

i.   The average output voltage and output current

ii.   The AC voltage amplitudes

iii.   The Fourier impedance

iv.   Power absorbed by the resistive load
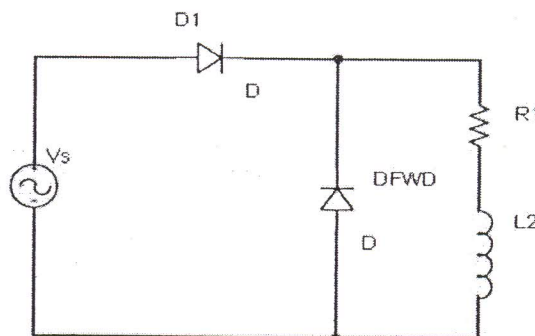

Figure 5

(15 marks)

(b)   A general form of the Fourier series is given as

$$v_o(\omega t) = V_o + \sum_{n=1,2,\ldots}^{\infty} \left(a_n \cos n\omega t + b_n \sin n\omega t \right)$$

Express the output voltage waveform of the square-wave inverter shown in
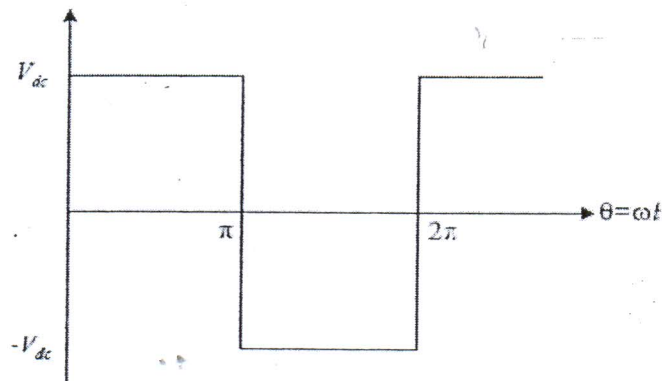Figure 6 as a Fourier series.

Figure 6

(12 marks)

Question 5

(a)   A single-phase bridge rectifier shown in Figure 7 has an AC source of V_m = 240V at
60 Hz and R-L load with R = 10Ω and L = 10mH. Determine the average current in
the load, the first two higher order harmonics of the load current and the power
absorbed by the load.
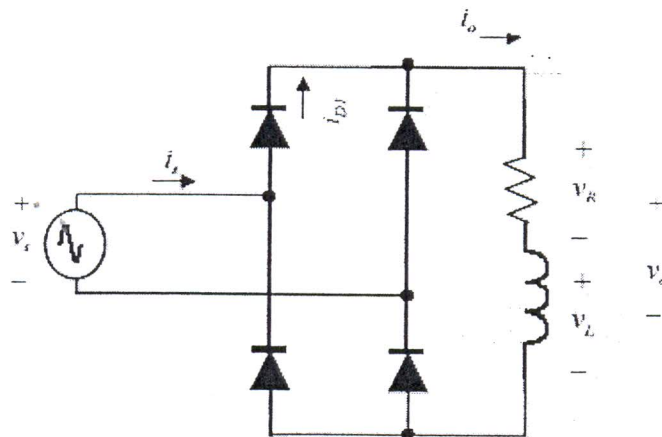

Figure 7

(12 marks)

(b)   A three-phase half wave rectifier shown in Figure 8 is operated from 460 V 50 Hz supply at secondary side and the load resistance is $R=20\Omega$. If the source inductance is negligible, determine:

    i.   The rectification efficiency

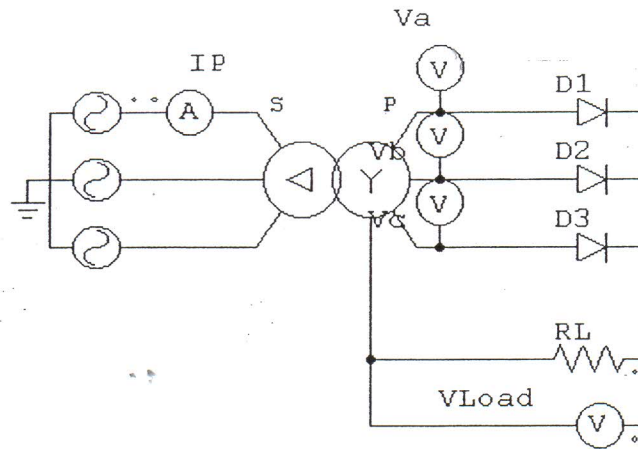   ii.   The form factor

    iii.   The ripple factor

Figure 8

(12 marks)

(c)   The switch of a DC chopper shown in Figure 9 opens and closes at a frequency of 15 Hz and remains closed for 4 ms per cycle. A DC ammeter connected in series with the load indicates a current of 60 A. If a DC ammeter is connected in series with the source, what current will it indicate?
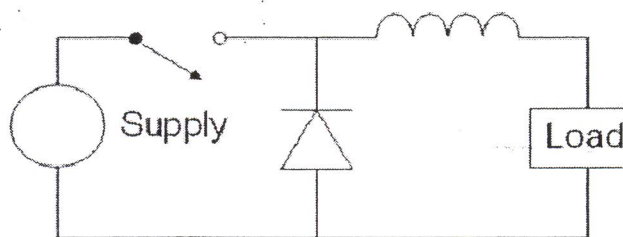

Figure 9

(6 marks)

END OF QUESTION PAPER