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Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway
Semester II Examinations 2004 / 2005

Exam Code(s)	4BN
Exam(s)	Final Year Electronic Engineering
Module Code(s)	EE411
Module(s)	Power Electronics
Paper No.	1
Repeat Paper	
External Examiner(s)	Professor S. McLaughlin
Internal Examiner(s)	Professor D. J. Wilcox
	Professor W. G. Hurley
Instructions:	Answer *three* questions
Duration	2 hrs
No. of Pages	3
Department(s)	Electronic Engineering
Course Co-ordinator(s)	Electronic Engineering

Requirements:

MCQ	
Handout	
Statistical Tables	
Graph Paper	x
Log Graph Paper	
Other Material	

1. Figure 1 shows a voltage-source inverter, supplying a reactive load, and associate waveforms.

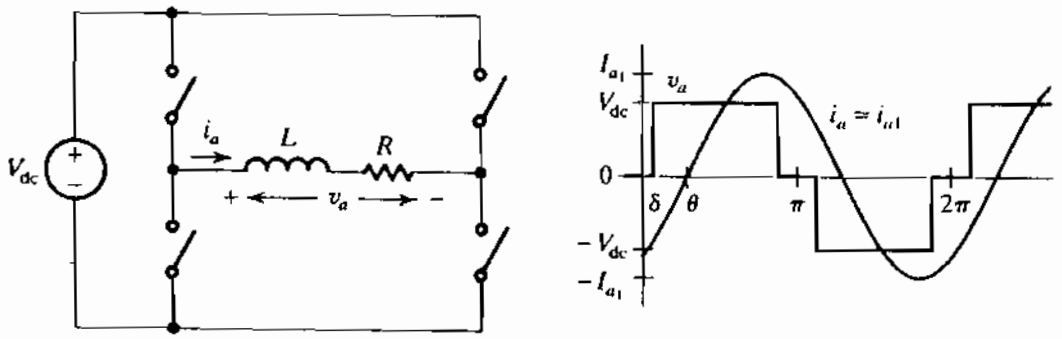

Figure 1

(a) Derive an expression for the fundamental of v_a in terms of V_{dc} and δ. [3 marks]

(b) Derive an expression for the fundamental of i_a in terms of V_{a1}, ω, L and R. [3 marks]

(c) Derive an expression for the average power delivered to the load. [3 marks]

(d) For V_{dc} = 48 V, L = 20 mH, R = 10 Ω calculate the average power delivered to the load at 50 Hz operation. Assume δ =15°. [8 marks]

2. (a) Explain the terms amplitude modulation ratio (depth of modulation) and frequency modulation ratio as they apply to a PWM bridge inverter. [4marks]

(b) Sketch the output voltage V_{ac} for the PWM bridge inverter in Figure 2 and show the switching sequence. [5 marks]

(c) A PWM inverter similar to that shown in Figure 2 operates with an amplitude modulation ratio of 0.9, and input voltage of 100 V. Calculate the r.m.s. value of the output voltage pulse train, the r.m.s. of the fundamental of the a.c. waveform and the THD of output voltage waveform. [8 marks]

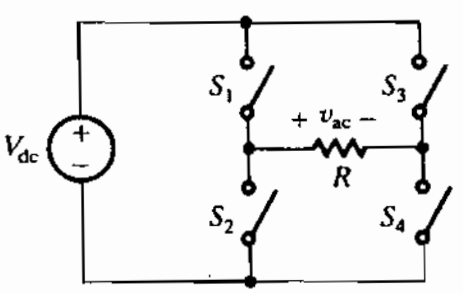

Figure 2

3. Derive an expression for the commutation angle in a half wave rectifier with a highly inductive load and a free wheeling diode in terms of the source reactance. [5 marks]

A half-wave rectifier with free wheeling diode has a 240 V rms 50 Hz ac source. The source inductance is 3.0 mH and the load is constant at 5 A.

(a) Calculate the commutation angle. [4 marks]
(b) Calculate the output voltage. [4 marks]
(c) Sketch the regulation curve for the output. [4 marks]

4. Show that the average output voltage in a phase controlled q-pulse converter is

$$< v_d >= V_{do} Cos\alpha$$

$$V_{do} = \sqrt{2} V_o \frac{q}{\pi} Sin\frac{\pi}{q}$$

Where V_o is the RMS value of the pulsed waveform and α is the firing angle. [3 marks]

A 3-phase full converter is used to control the speed of a 200 hp, 600 V, 1500 rpm separately excited dc motor. The converter is operated from a 3-phase 480 V, 50 Hz supply. The motor parameters are R_a=0.1 Ω, L_a=5 mH and K'=0.35 V/rpm. The machine draws rated current and runs at 1500 rpm. Assume the motor current is ripple free, calculate

(a) the firing angle of the SCR's [8marks]
(b) the power factor of the supply.
1 hp = 746 W [6 marks]