

Ollscoil na hÉireann, Gaillimh

National University of Ireland, Galway

SEMESTER II EXAMINATIONS, 2000/2001

B.E. DEGREE (ELECTRONIC)

POWER ELECTRONICS

Professor L.E. Davis
Professor D.J. Wilcox
Professor W.G. Hurley

Duration of examination: *One Hour and Thirty Minutes*

Instructions: Answer *three* questions.

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

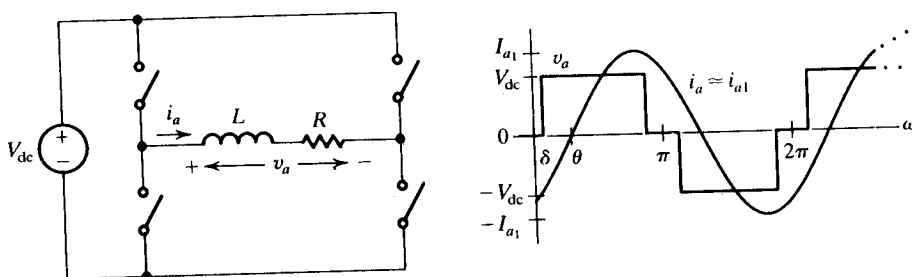


Figure 1

- Derive an expression for the fundamental of v_a in terms of V_{dc} and δ .
- Derive an expression for the fundamental of i_a in terms of V_{a1} , ω , L and R .
- Derive an expression for the average power delivered to the load.
- For $V_{dc} = 24$ V, $L = 4$ mH, $R = 5$ Ω calculate the average power delivered to the load at 100 Hz operation. Assume $\delta = 10^\circ$.

- 2 Define the term *transient thermal impedance*.

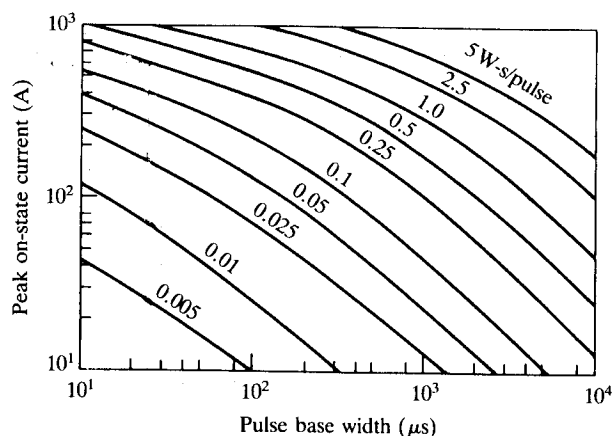
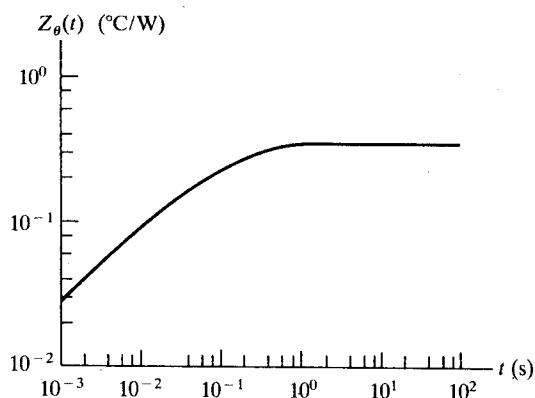


Figure 2

A C149 SCR operating at 80°C is suddenly subjected to a 100 μ s rectangular pulse of current. With the aid of the manufacturer's data given in Figure 2, calculate

- the transient thermal impedance to the pulse
- the maximum power dissipation for $T_{JMAX} = 125^\circ\text{C}$
- the peak value of the current during the transient

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

$$\langle v_d \rangle = V_{do} \cos \alpha$$

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

where V_o is the RMS value of the pulsed waveform and α is the firing angle.

A 3-phase full converter is used to control the speed of a 100 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 $R_a = 0.1 \Omega$, $L_a = 5 \text{ mH}$ and $K' = 0.3 \text{ V/rpm}$. The machine draws rated current and runs at 1500 rpm. Assume the motor current is ripple free, calculate

- the firing angle of the SCR's
- the power factor of the supply.

1 hp = 746 W

- 4 Write a short note on two of the following power semiconductor devices under the following headings

- Circuit symbol
- Device physics
- Device characteristics
- Device applications

- Schottky diode
- IGBT
- Silicon Controlled Rectifier (SCR)