Cork Institute of Technology

Higher Certificate in Engineering in Electrical Engineering – Award

(NFQ – Level 6)

Summer 2007

Industrial Electronics & Automation

(Time: 3 Hours)

Instructions
Answer **FIVE** questions.
Use separate answer books for each Section.
All questions carry equal marks.

Examiners: Mr. M. Hennessy
Dr. E. McQuade
Mr. P. F.O'Murchu

Q 1 (a) Identify and describe four methods which can result in rendering a thyristor conductive in the forward direction. *4 marks*

(b) Explain the terms *latching current* and *holding current,* as applied to a thyristor. *4 marks*

(c) A thyristor is connected in series with a 100Ω load across a 230V, 50Hz supply. A firing angle of 50˚ is chosen. Calculate the r.m.s. value of the load voltage and the total power dissipated in the resistor. *10 marks*

(d) Give a brief explanation on the difference between a thyristor and a triac. *2 marks*

Hint $V_{(LOAD)rms} = \frac{V_m}{2}\sqrt{\frac{1}{\pi}(\pi - \alpha + \frac{Sin2\alpha}{2})}$

Q 2 (a) Explain how a thyristor can be used in the control of load current in a d.c. voltage circuit by employing a second thyristor and a commutating capacitor. *7 marks*

(b) A 120Ω resistive load is connected in series with a thyristor across a 200V d.c. supply. If the load voltage *on-time* is 25 m-seconds and the load voltage *off-time* is 35 m-seconds, find the r.m.s. value of the load voltage and the power dissipated in the load resistor. *10 marks*

(c) Explain clearly why is it necessary in most applications to mount power devices such as triacs and thyristors on heat sinks. *3 marks*

Q 3 (a) Outline clearly the characteristics of an ideal Operational Amplifiers (op-amp) and give typical values for a device such as the μA741. *6 marks*

(b) With reference to the op-amp configuration circuit shown below in Fig. 3, calculate the value of the output voltage Vo.

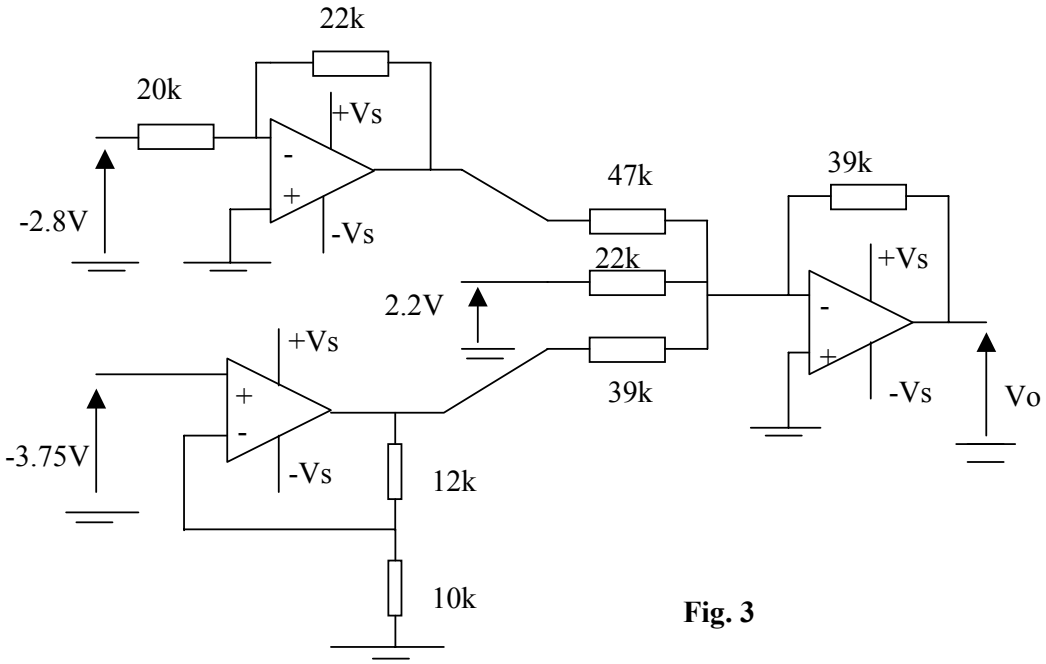

Fig. 3

14 marks

Q 4 (a) Outline, with the use of block diagrams, the fundamental structures of a digital control system as would be used to control the temperature of an electronic test chamber, which is controlled in the closed loop mode. The temperature set point is entered through a keypad and the chamber temperature is measured with a temperature sensor

such as a pt100. The heating element output is controlled with a triac in phase control mode. *10 marks*

(b) Explain in detail the operation of your circuit and describe the advantages of such a control system. *10 marks*

Q 5 (a) With reference to the Mitsubishi FX plc explain how the following functions can be implemented.

(i) Timer operation on an output.

(ii) Counter control.

(iii) Use of SET and RST instructions.

(iv) Use of internal memory locations.

8 marks

(b) A Mitsubishi FX plc is used in an industrial application to automatically start and stop a star delta connected, three phase induction motor. Produce the plc ladder diagram and logic statement program for the above control operation, which will incorporate all safety devices in the circuit. Allow 3 seconds delay between star and delta change-over. *12 marks*

Q 6 (a) Opto-electronic isolation is frequently employed where electronic circuits are used to control power circuits; explain clearly the principle and the application. *6 marks*

(b) Show and explain how opto-electronic drivers can be used to enable a microprocessor output signal to operate a three phase contactor. *7 marks*

(c) A triac, which controls the output power from a heating element, is operated in the burst firing mode and is controlled by a micro-processor. Show and explain how this arrangement can be realised using opto-isolation devices. *7 marks*

Q 7 (a) Describe the principle of operation of the bonded foil strain gauge.

8 marks

(b) In a large industrial plant where electrical power is generated locally with a diesel prime mover and an a.c. alternator, describe and explain a measurement system which can be used to measure the mechanical power output from the prime mover. *12 marks*