Cork Institute of Technology

Higher Certificate in Engineering in Electrical Engineering – Award

(National Certificate in Engineering in Electrical Engineering – Award)

(NFQ – Level 6)

Autumn 2005

Industrial Electronics & Automation

(Time: 3 Hours)

Q1 (a) Show clearly how a stabilised voltage source can be produced using discrete electronic devices. *5marks*

(b) Show how an operational amplifier can be used to sum three different d.c. voltages. *5marks*

(c) Explain briefly the difference between the bi-polar transistor, the thyristor, and the triac. *5marks*

(d) Why are heat-sinks used with some electronic devices? *5marks*

Q2 (a) Describe in detail any two techniques, which can be used for the measurement of displacement. *7marks*

(b) Explain the operation of a bonded foil strain gauge and state the meaning of "Gauge Factor". 7marks

(c) Show how a load cell can be constructed by use of a number of strain gauges. *6marks*

Q3. (a) Explain the principle of opto-isolation and indicate as to where opto-couplers would be used in electrical/electronic applications. *10marks*

(b) A micro-processor I/O device is used to control a 3-phase induction motor automatically. Show the control circuitry including where opto-couplers might be used. *10marks*

Q4. Two thyristors, which are connected in inverse-parallel, are used to control the power dissipated in a 40Ω resistive load. The supply voltage is 230V 50Hz.

(a) Calculate the r.m.s. value of the load voltage and the power dissipated in the load when the firing angle is 35°. *15marks*

(b) If one thyristor becomes open circuited, calculate the variation in power dissipation.

5marks

$$Hint \left[V_{rms} = \frac{V_m}{\sqrt{2}} \left[\frac{1}{\pi} \left(\pi - \alpha + \frac{Sin\, 2\alpha}{2} \right) \right]^{\frac{1}{2}} \right]$$ for thyristor inverse parallel operation.

Q5 (a) Explain how a triac can be used in the control of load current in an a.c. voltage circuit, by using the principle of burst firing (integral control) *8marks*

(b) A 160Ω resistive load is connected in series with a triac across a 230V 50Hz a.c. supply. If the load voltage *on-time* is 26 cycles and the load voltage *off-time* is 48 cycles, find the r.m.s. value of the load voltage and the power dissipated in the load resistor. *12marks*

Q6 (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.

10marks

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

Q7. (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. *8marks*

(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. *12marks*

2