

**NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**APPLIED PHYSICS DEPARTMENT**

**SPH 4230 – INDUSTRIAL INSTRUMENTATION**

**EXAMINATION**

*BSc. HONOURS PART IV: MAY 2006*

*DURATION: 3 HOURS*

**ANSWER ALL QUESTIONS FROM SECTION A AND ANY 3 QUESTIONS FROM SECTION B.  
SECTION A CARRIES 40 MARKS AND SECTION B CARRIES 60 MARKS.**

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**SECTION A**

- 1 (a) Give a concise description of a Programmable Logic Controller (PLC). [4]
- (b) A PLC can effectively reduce a number of components. Give examples and discuss some advantages and disadvantages of PLCs. [6]
- (c) Explain using diagrams the difference between a sink and a source sensor when used in PLCs. [6]
- (d) Develop Ladder Logic for a car door/seat belt safety system. When the car door is open, or the seatbelt is not done up, the ignition power must not be applied. If all is safe then the key will start the engine. [4]
- (e) Use the timer in Figure 1 below to answer the following questions.
- (i) What type of timer is shown?
- (ii) Calculate the delay time. [4]

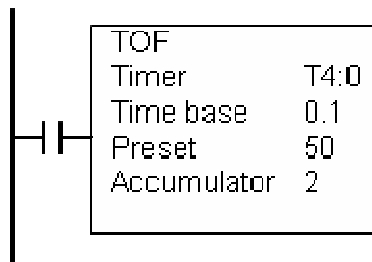


Figure 1.

- (f) Distinguish between Distributed Control System (DCS) and Supervisory Control and Data Acquisition (SCADA) ? [6]
- (g) Explain reasons why a PLC is integrated with a DCS . [6]
- (h) What do you understand by the abbreviation CAN in automation [4]

## SECTION B

- 2 (a) A heating oven with two bays can heat one ingot in each bay. When the heater is on it provides enough heat for two ingots. When only one ingot is present the oven may become too hot so a fan is used to cool the oven when it passes a set point. For this system,
- (i) define the inputs and outputs
  - (ii) derive a Boolean equation
  - (ii) draw a ladder logic program [10]
- (b) (i) Use Boolean algebra to design a burglar alarm for a company warehouse. When the alarm is activated the lights will also be activated to encourage the unwanted guest to leave. The alarm will be activated if an unauthorized intruder is detected by a window sensor and a motion detector. The window sensor is a loop of wire that encircles the window. If the window is broken the wire breaks. The motion detector is designed so that when motion is detected the output will go on.
- (ii) Draw a ladder logic program for your design. [10]
- 3 (a) Design a PLC controlled system, which could be used to maintain the level of a liquid at a constant height. In your design include,
- (i) inputs and outputs
  - (ii) Boolean algebra
  - (iii) ladder logic programme. [10]
- (b) The programme shown in Figure 2 below is used to remove 5 out of every 10 parts from a conveyor using a pneumatic cylinder. Explain how the system operates defining all the symbols. [10]

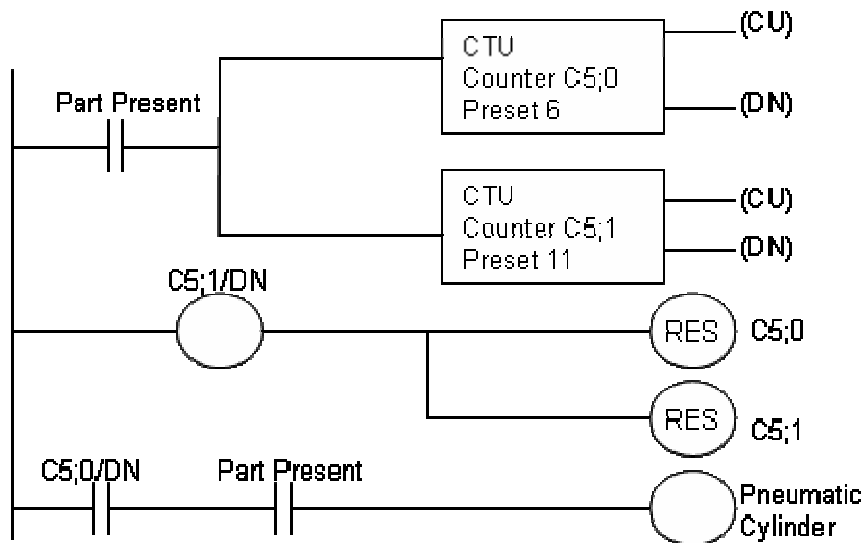


Figure 2

- 4 (a) Draw a block diagram of a PLC showing the main functional items and how buses link them, explaining the function of each block [10]
- (b) What are the main components of a DCS? Outline their functions and limitations. [10]

- 5 (a) One of the approaches for computer – integrated manufacturing is to design the hardware and software for the gateway such that integration of manufacturing or process data and plant management information can be achieved easily.
- (i) Explain the two requirements for such an interface gateway? [4]
  - (ii) Draw the architecture for the hardware connection for this system. [6]
- (b) We will use a PLC to control a cereal box-filling machine. For single runs the quantities of cereal types are controlled using timers. There are 6 different timers that control flow, and these result in different ratios of product. The values for the timer presets will be downloaded from another PLC using the DH+ network. Write the ladder logic for the PLC. [10]
- 6 (a) Explain why networks are important in manufacturing controls. [4]
- (b) List the seven layers of the ISO – OSI network model. [7]
- (b) Describe the following network topologies:
- (i) Ring,
  - (iii) Star,
  - (iv) Bus. [9]

**END OF QUESTION PAPER**