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ELECTRICAL TECHNICIAN (POWER OPTION) LEVEL 6

ENG/OS/PO/CR/05/6

Automate an Electrical Machine

November/December 2025

TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION COUNCIL (TVET CDACC)

WRITTEN ASSESSMENT

TIME: 3 HOURS

INSTRUCTIONS TO CANDIDATE

1. This paper consists of **TWO** sections: **A** and **B**.
2. Attempt **ALL** questions in section A and **ANY THREE (3)** questions in section B.
3. Marks for each question are indicated in the brackets.
4. Candidates are provided with a separate answer booklet.
5. **DO NOT** write on this question paper.

This tool consists of FOUR (4) printed pages.

The candidate should check the tool to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A (40 MARKS)

Answer ALL questions in this Section

1. Ladder logic is a programmable logic controller language used to train at a basic level. State the other FOUR programming languages used in PLCs. (4 marks)
2. A programmable logic controller is a system of interconnected networks used in automation. Briefly explain how a distributed control system (DCS) is used in industrial automation. (3 marks)
3. Servo systems are used to monitor machine operations in a closed-loop system. Explain how a position control servomechanism works. (3 marks)
4. Ladder logics are widely used in automation to program electrical systems by technicians and engineers. Outline FOUR advantages of using ladder logic. (4 marks)
5. Noise causes high fluctuations of sensor readings when installing machine programs. Explain FOUR other challenges likely to be experienced in the automation of machines. (4 marks)
6. Supervisory control and data acquisition (SCADA) systems are used in control processes for maximum production in a firm. State the other FOUR functions of the SCADA system. (4 marks)
7. An electrical engineer automated an electrical machine conveyor belt using sensors to monitor inputs and output variables. State FOUR types of sensors likely to have been used in this operation. (4 marks)
8. Input digital devices are those which are controlled by PLCs through input modules. Highlight FOUR examples of input digital devices used in PLCs. (4 marks)
9. A software engineer is carrying out a survey to automate machines in a manufacturing plant using a PLC. Outline FOUR factors he will consider while selecting the appropriate PLC for this purpose. (4 marks)
10. Computers are examples of Human Machine Interface (HMI) located at strategic positions in a processing line. Explain TWO functions of Human-Machine Interface (HMI) in automation of processing lines. (4 marks)
11. Indexers are commonly used in machining operations, assembly lines and inspection systems. Differentiate between rotary indexing tables and Linear indexers in industrial automation. (2 marks)

SECTION B (60 MARKS)

Answer any THREE questions in this Section

12. A software engineer won a contract to design and automate a milk processing line. He incorporated use of PLCs and SCADA systems to actualize the mandate.

    a) If the engineer used the functional block diagram (FBD) shown in figure 1 to program the first PLC command, deduce its equivalent ladder logic diagram. (5 marks)

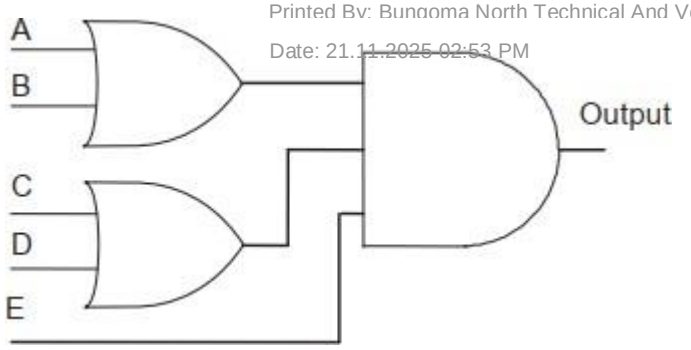

Figure 1

    b) Describe THREE types of PLC designs he is likely to adopt and give THREE advantages of each. (15 marks)

13. PLC and SCADA systems are made up of a memory consisting of the system microprocessor and input/output circuitry that are software-simulated.

    a) Outline FIVE factors to consider in PLC program development for machine automation. (10 marks)

    b) Explain FIVE ways in which SCADA improves industrial automation. (10 marks)

14. Coastal Bottlers Company employed the use of PLCs and SCADA systems to automate, monitor and control filling of water bottles.

    a) Outline FOUR components of SCADA system the company is likely to use during automation. (4 marks)

    b) If the company used the assembly in Figure 2 for water bottle filling process, draw a ladder logic diagram for simulation of this operation. (8 marks)

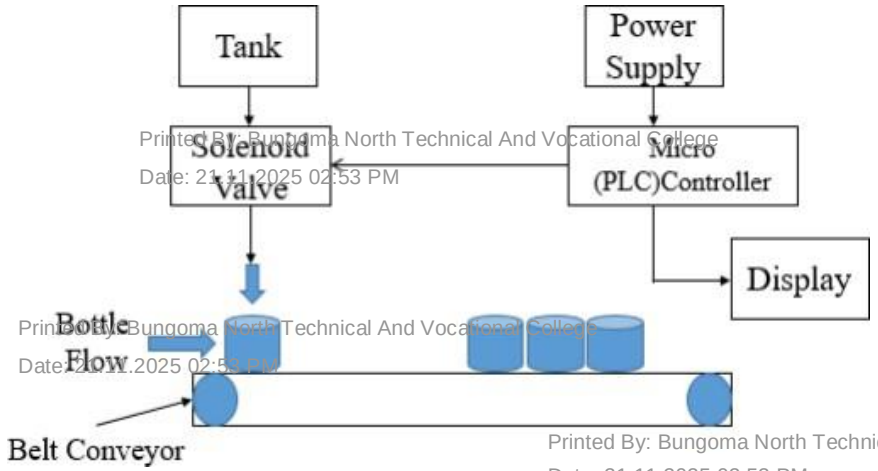

Figure 2

c) The company decided to use automation control systems over manual control. Discuss FOUR advantages of this decision. (8 marks)

15. Jogging or inching is the momentary ON operation of a motor for accomplishing a small movement of the driven machine. Figure 2 shows a jog control circuit requiring a double-contact jog pushbutton—one NC contact and one NO contact. When the 'Jog' button is pressed, the seal in circuit to the starter coil (M) is opened by the NC contacts of the 'Jog' pushbutton. As a result, the starter coil (M) will not lock in; instead, it can only stay energized as long as the 'Jog' button is fully pressed. As a result, a jogging action can be obtained.

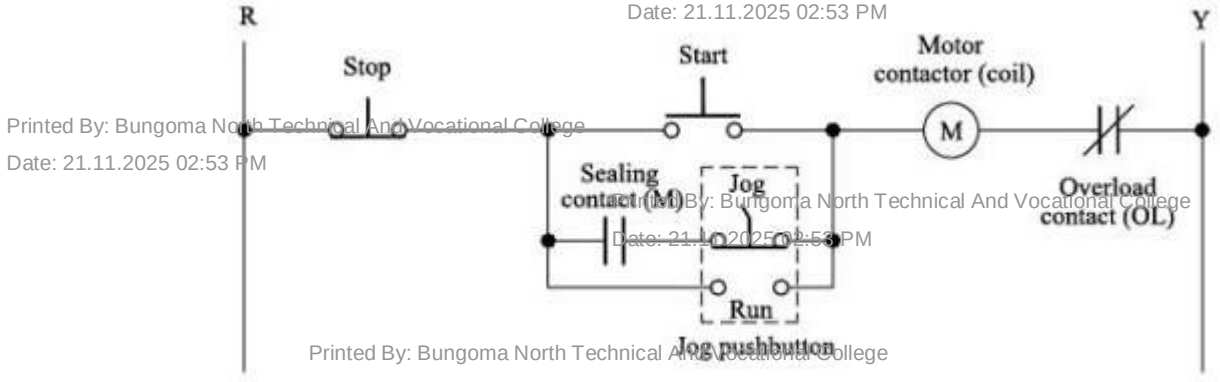

Figure 3

a) Draw a PLC connection diagram for the system shown in Figure 3, showing all the inputs and outputs. (10 marks)

b) Draw a ladder diagram for the system shown in Figure 3. (10 marks)