



PROGRAM : *BACHELOR OF ENGINEERING TECHNOLOGY:*
ELECTRICAL

SUBJECT : **Automation A3 - Main**

CODE : **AUTELA3**

DATE : 23 May 2019 08:30 – 11:30

DURATION : 180 minutes

WEIGHT : 40 : 60

TOTAL MARKS : 100

ASSESSOR : Mr. Johan Venter

MODERATOR : Dr. J.W. Lambrechts

NUMBER OF PAGES : 9 PAGES (Cover Page Included)

INSTRUCTIONS TO STUDENTS

PLEASE ANSWER ALL QUESTIONS ON THE QUESTION PAPER.

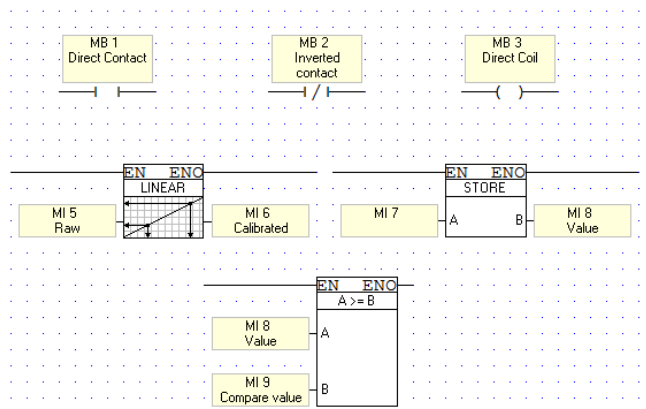
ONLY ONE POCKET CALCULATOR PER CANDIDATE MAY BE USED.

QUESTION 1 /40/

1.1 Design a PLC program that performs the following functions. TAKE NOTE OF THE FOLLOWING SEQUENCE OF EVENTS using Visilogic. (20)

- The start-up of the PLC is only allowed using the power-up bit (**SB2**).
- Check if there is *power* on the furnace via a relay on the **I0** bit (digital input, no need to describe the relay). If there is *no power* on the furnace, SET output bit **O0** and switch off all other outputs.
- If power-up sequence is OK, set **MB1**.
- The temperature sensor supplies a digital output; 1 for high and 0 for OK. Input to the PLC is on the **I1** bit (digital input). If the temperature is high (above the threshold), open the input pump by setting **O2** and **O3** bit (pump out).
- The temperature of the furnace (10 °C to 100 °C) is converted to an analogue voltage (0 V and 10 V), which is supplied to the PLC via the **MI0** memory element. When the temperature is at its lowest permissible value, the sensor output voltage is 1 V. The resolution of the input is 15 bits (i.e. 32767). Store the calibrated value in **MI1**.
 - Separately for this linearization block, state the following values
 - X1, X2, Y1, Y2, X, Y
 - The client requires that the temperature do not exceed 80 °C. When this occurs, disconnect the power to the furnace and SET the **O7** bit.
- The client also requires that the power to the furnace be disconnected at any point in time. For this to occur, **I2** must be switched off.
- If the measured temperature is between 10 °C and 40 °C, set output **O4** bit.
- If the measured temperature is between 40 °C and 60 °C, set output **O5** bit *and* keep **O4** switched on.
- If the temperature is between 60 °C and 80 °C, set output **O6** bit. Keep **O4** and **O5** switched on.

The only blocks that may be used is the **Direct Contact**, **Inverted Contact**, **Direct Coil**, **Compare**, **Linearization** and **Store**. No other blocks may be used. Examples of these blocks are given below.



ANSWER FOR LADDER LOGIC

- 1.2 What communication protocol was used in class to connect the PLC to the PC? (2)
- 1.3 True or false: Can an input address be assigned to a contact and a coil? (2)
- 1.4 For the majority of elements on an HMI, what needs to be assigned in the link block? (2)
- 1.5 For a timer delay of 8 seconds, draw and label the default Ladder Logic to illustrate how the timer time delay works. The Input must be **MB3**, the timer address must be 5 and the Output must be **O8**. (4)
- 1.6 What is the advantage of using a Drum Sequencer as opposed to manually developing the Ladder Logic? (4)
- 1.7 What is the function of the Scan block and the Configuration block of a Drum Sequencer? (4)

- 1.8 How can it be verified that the PLC and PC have been successfully connected? (2)

QUESTION 2 [18]

- 2.1 List three types of control response lags. (6)

- 2.2 Sketch the circuit diagram for integral control. (3)

- 2.3 Sketch the typical response curves on one graph for PI, PD and PID control. Define the horizontal and vertical-axis clearly. (4)

2.4 Sketch a feedback-control block diagram.

(5)

QUESTION 3 [9]

3.1 Describe open loop tuning using process reaction. Refer to the tuning parameters, applicable variables, and the process to calculate the results. (6)

- 3.2 What are the advantages and disadvantage of closed loop type tuning vs open loop type tuning? (3)

QUESTION 4 [21]

- 4.1 List 5 disadvantages of the 4-20 mA current loop analogue communication protocol. (5)

- 4.2 List the two reasons for dividing the network via segment couplers. (4)

4.3 List the 6 network controlling devices. (6)

4.4 For a digital data line, how can noise be perfectly cancelled? You may use a graph to supplement your answer. (2)

4.5 What does the following acronyms stand for? CSMA/CD and TCP/IP. (4)

QUESTION 5 [12]

5.1 List the 6 different boiler losses. (6)

5.2 List 6 factors that may affect measurements of an Electrode Type Conductivity meter. (6)

TOTAL of the Paper = [100]