B.Sc. in EEE, 6th Semester/B.Sc.Te (2 Year), 2nd Semester

16 May 2024
10:00 am – 01:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course No.: EEE 4603/EEE 4693
Course Title: Measurement and Instrumentation

Summar Semester, A. Y. 2022-2023
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

Problem Statement:
According to BBC News, "On *the night of 29 February 2024, a fire broke out in a seven-storey shopping mall located on the New Bailey Road in Dhaka, Bangladesh, killing 46 people. Fires in Bangladesh are a common occurrence, causing many fires and explosions due to faulty gas cylinders, electrical wiring and air conditioners".*

Imagine you are an expert designer of Electrical Measurement and Instrumentation systems. Your responsibility is to design a system for power quality monitoring and short circuit detection to avoid fire within the electrical line and avoid any such situation in the future.

Considering the above scenario, answer questions 1, 2, and 3.

1. For a real-world sustainable solution, the following five steps need to be accomplished. By using suitable illustrations, diagrams, and flowcharts, explain and justify how you can accomplish each step for your proposed solution. **40 (CO2, PO2)**

   a) Defining the hypothesis, problem objective, and the expected outcomes (Step 1).
   b) Creating the logical model and/or mathematical model (Step 2).
   c) Creating the proposed simulation model (Step 3).
   d) Developing the prototype of the practical product (Step 4).
   e) Finding the socio-economic impact of the product (Step 5).
   Explain the four validation points, i.e., *i) Technical, ii) Economical, iii) Social, and iv)Policy-making,* to make your proposed technological solution sustainable.

2. i) By adopting the above five steps, discuss the selection of sensors, parameters to monitor, and methods for analyzing power quality issues. **15 (CO2, PO2)**
   ii) Develop methods for real-time data visualization in instrumentation setups.
   iii)Discuss visualization tools, communication protocols, and considerations for effective real-time monitoring. Address challenges related to accuracy, noise, and environmental factors.

3. a) Describe the role of high-frequency current transformers in arc detection for short circuit detection systems. Explain how these sensors operate and their advantages over conventional method **10 (CO1, PO1)**

   b) Describe the impact of using Rogowski coils versus high-precision current transformers (CTs) as current sensors in short circuit detection systems. Consider factors such as accuracy, frequency response, and ease of installation. **10 (CO1, PO1)**

4. a) Define the response parameters of a 'Sample and Hold' circuit with suitable diagram. 6 (CO1, PO1)

b) Sketch the block diagram of a 5-bit successive approximation A/D converter. For this 5-bit successive approximation A/D converter; assume that the reference voltage applied to the D/A converter circuit is VREF = 10 V. For a particular instant of time; if an analog input voltage has the magnitude of VIN = 6 V, determine the output bit pattern of the A/D converter after completing the conversion process. (Show the changes in the output bit pattern after each cycle of the conversion process) 12 (CO2, PO2)

c) Write down the differences between Weighted Resistor DAC and R-2R Ladder DAC. 4 (CO1, PO1)

d) Sketch the circuit diagram of Dual Slope ADC. 3 (CO1, PO1)

5. a) Explain the reason of choosing PLC instead of microcontroller for industrial purpose. 3 (CO1, PO1)

b) Explain PLC scan cycle. 6 (CO1, PO1)

c) Sketch the ladder diagram representation of the following Boolean equations: 6 (CO2, PO2)
(i) $Q = A + \overline{B}$
(ii) $Q = \overline{A}.\ B.\ C + D$
(iii) $Q = A.\ B + C.D$

d) For a PLC program our desire delay is 25s. The timer we have used in our program is T1019. Determine the value of time constant. 4 (CO2, PO2)

e) Write down the names of different types of timer in XGB Ladder Program. Write down short notes on Ring Counter. 2+4 (CO1, PO1)

6. a) Consider that there are 3 participants in a quiz game. If a participant wants to get the chance of answering the question from the host, he must press the answer button on his table first, which will turn on a lamp and a buzzer in his respective table. After buzzing for 2 sec the buzzer will turn off, but the lamp will continue to glow. Inputs from other participants will be invalid if any participant presses the button before them. The host will have an option to Reset the whole system. Sketch a ladder diagram program with respect to the above mentioned requirements. (Clearly define the input/output devices and the respective input/output ports that you are going to use for your program) 7 (CO2, PO2)

b) Consider that some manufactured items are being moved in a particular direction with the help of a conveyor belt. The conveyor belt is driven by a motor. It is required to design a control system to direct 5 items along one path for packaging in a box and then 15 items along another path for packaging in another box. A photocell sensor is used to detect the presence of a moving item. The number of pulses from the sensor has to be counted and depending upon that a deflector plate has to be controlled to guide the item towards a particular box for packaging. The operator should have the option to start or stop the system manually. After packaging a total of 2000 boxes, the system will automatically get deactivated until the operator manually starts the process again. Sketch a ladder diagram program with respect to the above mentioned requirements 6 (CO2, PO2)

.(Clearly define the input/output devices and the respective input/output ports that you are going to use for your program)

c) Consider the crossroad shown in Fig. 6(c). You have to sketch a ladder diagram program to implement the control sequence associated with Fig. 6(c). In this figure, lights of two opposite lanes are considered to be operated simultaneously and thus the corresponding lights are indexed with the same symbol. The operator should have the option of manually activating or deactivating the system. (Clearly define the input/output devices and the respective input/output ports that you are going to use for your program) 12 (CO2, PO2)

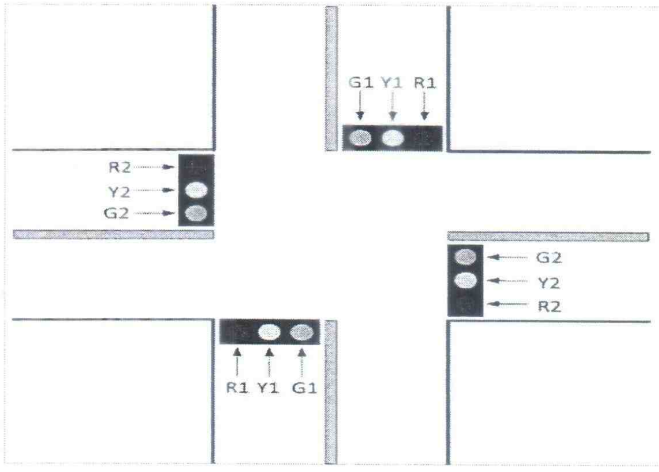

Fig 6(c)

Control Sequence :

(i) Turn on R2 and G1 for 50 sec,

(ii) After 50 sec, turn off R2 and G1 while turning on Y1 and Y2 for 15 sec,

(iii) After 15 sec delay, turn off Y1 and Y2 and turn on G2 and R1 for 50 secs,

(iv) After this 50 sec delay, turn off R2 and G1 and turn on Y1 and Y2 again for 15 sec,

(v) After this 15 sec delay, turn off Y1 and Y2 and continue from step (i).