Ref. No.: Ex/IEE/PE/B/T/323A/2024

B.I.E.E Third Year Second Semester Examination 2024

Time: **3 hours** Subject: **Industrial Automation Systems** Full Marks: **100**

- Each module is associated with a course outcome.
- Answer all modules.
- Choices if provided, are limited to questions within a module.

Module A: Answer any TWO.	Coverage: Course Outcome 1
Question	Marks
1. Write a PLC program that automates the operation of a pump, used to fill an overhead tank from a sump. The tank's level is monitored by two level switches, one at the top and the other near the bottom. Additionally, a level switch in the sump detects whether it is filled. The program should include a manual mode, that allows manual operation of the pump, irrespective of tank level, using start and stop push buttons. Ensure all variables are declared with their respective data types at the program's outset. You may use any IEC 61131 language to write the program.	10
2. Develop a PLC program for a single-channel alarm annunciator that monitors a Boolean input state. When the input turns true indicating an abnormal condition, a lamp should flash at the rate of 1 Hz until the operator acknowledges the alarm by pressing a button. After the acknowledgement, the lamp should remain steadily lit until the input returns to its normal state. Assume that a 1 Hz internal clock is available in the PLC.	10
3. Identify the main components of a modular PLC and briefly explain their function. Define the "scan time" of a PLC. Name three graphical PLC programming languages compliant with IEC 61131 standards.	5 + 3 +2
Module B: Answer all questions.	Coverage: Course Outcome 2
5. How does the operation of a DC motor differ across the four quadrants of the speed-torque characteristics?	10

<table>
<tr><th>Question</th><th>Marks</th></tr>
<tr><td>6. Draw a block diagram of a DC drive used to control the speed of a motor. Briefly explain how each component contributes to the overall operation of the system.</td><td>9</td></tr>
<tr><td>7. Describe the operating principle of a basic chopper circuit designed to adjust the speed of a DC motor while it operates in the forward motoring mode.</td><td>6</td></tr>
<tr><td>8. Using a schematic diagram, describe the operational principle of a chopper circuit that allows a DC motor to function across all four quadrants of its speed-torque characteristics</td><td>10</td></tr>
<tr><td colspan="2">Module C: Coverage: Course Outcome 3</td></tr>
<tr><td>9. Briefly, describe the architecture and the components of a typical distributed control system.</td><td>10</td></tr>
<tr><td colspan="2">Module D: Answer all questions. Coverage: Course Outcome 4</td></tr>
<tr><td>10. A temperature measurement system is installed in a hazardous area classified as Zone 0 and contains Ethylene in the atmosphere (group IIB gas, auto-ignition temperature 440°C). It uses a Pt-RTD connected to a certified temperature transmitter. This transmitter connects to a mains-powered digital indicator in the control room (safe area), through a certified Zener Barrier. The inter-connecting cable is 300 meters long, with a capacitance of 200 pF/meter and an inductance of 1 μH/meter. Evaluate if the system is intrinsically safe. Specifications of the temperature transmitter and the Zener Barrier are stated below.
<table>
<tr><th>Transmitter</th><th>Zener Barrier</th></tr>
<tr><td>Ex ia IIC T4 Ga</td><td>[Ex ia Ga] IIC</td></tr>
<tr><td>U_i = 30V, I_i = 100mA, P_i = 1W, C_i = 3nF and L_i = 10 μH</td><td>U_o = 28V, I_o = 93mA, P_o = 650mW, C_o= 83nF and L_o = 4.0mH , U_m = 250V.</td></tr>
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</td><td>15</td></tr>
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Question	Marks
11. State three principles used for preventing explosions in hazardous areas caused by electrical apparatus installed within. Name one explosion protection technique that is based on each of these principles**.** Explain the significance of the Equipment Protection Levels as outlined in the relevant IEC standards.	6 + 2 + 4
12. Differentiate between: (**attempt any 2**). a) Intrinsically safe apparatus and I. S. Interface. b) Zone 2 and Zone 20. c) Type X and Type Z pressurization systems.	4 × 2