PLC TECHNICIAN II PROGRAM DESCRIPTION

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Module 1. - Overview of PLCs
This module provides a general overview of PLCs and their application in industry. The origins of the PLC and its evolution are covered in detail. The advantages of PLCs are also outlined, and the main components associated with PLC systems are explored. An introduction to ladder logic is presented and the most common types of PLC signals are covered with an emphasis on practical application.

Learning Outcomes:
* Describe the purpose of a control panel.
* Define a programmable controller.
* List six factors affecting the original design of programmable controllers.
* Name three advantages of PLCs compared to relay logic systems.
* List the three main components in a PLC system.
* Explain the term ladder logic.
* Describe the application of PLC signals
* Explain the difference between a bit and a word

Module 2. - PLC Processors
This course is intended to familiarize the student with the most important aspects of the PLC's central processing unit with a focus on the ControlLogix processor. Topics covered in the course include memory devices, memory storage, and data processing as well as an introduction to tag-based memory. In addition to covering memory utilization and protection, the course also provides detailed information on multiprocessing and PLC scan functions.

Learning Outcomes:
* Explain the difference between a CPU and a MPU.
* Name the four basic functions of a CPU.
* Differentiate between volatile and nonvolatile memory.
* Define “flash memory”.
* Describe the main purpose of the scan cycle in a PLC.
* Name two types of PLC memory protection.
* List the major features of Controllogix controllers.
* Explain the purpose of tag-based memory
* Describe the difference between a project and a task.
* Define the term “scope” and explain its purpose in a tag.

Module 3. - I/O System
This module covers all aspects of the Input/Output system for PLCs including discrete, analog, and data I/O. In addition, the module also presents an overview of I/O addressing and an introduction to Allen-Bradley I/O parameters. Module topics also include the principles of remote I/O and an introduction to scaling and resolution of analog devices and signals.

Learning Outcomes:
* Explain the purpose of the I/O system.
* Describe how I/O addressing is accomplished.
* Define discrete inputs.
* List four tasks performed by an input module.
* Describe the basic operation of a discrete output.
* Explain the purpose of data I/O interfaces.
* Define analog I/O.
* Describe the resolution of an analog I/O module.
* List three applications for advanced I/O.
* Explain the purpose of remote I/O.

Module 4. - Programming Terminals and Peripherals
This module is intended to provide students with an overview of the wide range of programming terminals currently in use and to outline some of the key differences between them. In addition, the module covers topics such as hand-held programming terminals and computer-based software packages. The operation of host computer-based systems is also covered as well as the application of peripheral devices in a PLC network.

Learning Outcomes:
* Define the term programming terminal.
* Describe the application of dedicated programming terminals.
* List the two types of programming terminals.
* Describe the purpose of mini-programmers.
* Define computer-based programming terminals .
* Differentiate between programming software and documentation software.
* Describe the function of a host computer-based PLC system.
* Explain the purpose of peripheral devices.

Module 5. - Installation and Maintenance of PLCs
The purpose of this module is to provide the student with a thorough coverage of the various safety precautions, preventative maintenance, and troubleshooting techniques associated with a typical PLC system. In addition, the module also covers proper grounding techniques, sources of electrical interference, and I/O installation techniques. Field checkout and troubleshooting with an emphasis on practical troubleshooting and problem-solving strategies are covered.

Learning Outcomes:
* List three safety precautions when installing PLC systems.
* Define system layout.
* List three safety measures for PLC installations in control panels.
* Describe proper grounding techniques for PLCs.
* Name three precautions to avoid electrical interference.
* Define cross-talk interference.
* Explain I/O installation.
* Describe the need for I/O documentation.
* Define leakage current and explain the purpose of bleeder resistors.
* Explain the field checkout of PLC systems.
* Provide periodic maintenance for a PLC system.
* Troubleshoot PLCs.
* Describe redundant PLC architecture.

Module 6. - Relay Logic
This module is intended to provide an introduction to relay logic and relay logic diagrams. The basic operating principles of relays are presented as well as detailed information regarding sizing and rating of electromagnetic contactors. Seal-in circuits and their application in control systems is discussed as well as an introduction to timing circuits. In addition, the module covers I/O devices and their application in PLC systems.

Learning Outcomes:
* Name three types of mechanical switches and three types of proximity switches.
* Define inductive arcing and explain how it can be prevented.
* Describe the operating principle of a control relay.
* Explain the purpose of overload relays.
* Define the term holding contact.
* Differentiate between a control relay and a solenoid.
* List three applications of rotary actuators.
* Name three types of time-delay relays.
* Define the term relay logic.

Module 7 - Ladder Logic Programming
This course provides an introduction to ladder logic programming techniques using PLCLogix PLC simulation software. The lab component of the course provides the student with an opportunity to write ladder logic programs and test their operation through PLC simulation. Topics covered in the course include I/O instructions, safety circuitry, programming restrictions, I/O addressing, FORCE instructions and bit status flags.

Learning Outcomes:
* Define ladder logic.
* Convert relay logic schematics to ladder logic.
* Write a ladder logic program using PLCLogix.
* Define the terms *examine* on and *examine off.*
* Explain the purpose of a latching relay instruction.
* Differentiate between a branch and a nested branch.
* Describe the controller scan operation.
* Name two programming restrictions.
* Describe the use of Force instructions in PLC applications.
* Explain the purpose of bit status flags.

Module 8. - Timers
This module is intended to provide students with an overview of PLC timers and their application in industrial control circuits. Allen-Bradley timing functions such as TON, TOF, and RTO are discussed in detail and the theory is reinforced through lab projects using lab simulation software. In addition, students will learn practical programming techniques for timers including cascading and reciprocating timing circuits.

Learning Outcomes:
* Name two types of relay logic timers.
* List the four basic types of PLC timers.
* Describe the function of a time-driven circuit.
* Differentiate between an ON-delay and an OFF-delay instruction.
* Write a ladder logic program using timers.
* Describe the operating principle of retentive timers.
* Explain the purpose of cascading timers.
* Define reciprocating timers.

Module 9. - Counters
This module provides students with a broad overview of PLC counters and their application in control systems. Allen-Bradley counting functions such as CTU and CTD are presented in detail and the theory is reinforced through lab projects using lab simulation software. In addition, students will learn practical programming techniques for counters including cascading counters and combining counting and timing circuits.

Learning Outcomes:
* Name two types of mechanical counters.
* Define the two basic types of PLC counters.
* Write a ladder logic program using CTU, CTD, and RES.
* Explain the terms underflow and overflow.
* Describe the function of an event-driven circuit.
* Design an up/down counter.
* Define cascading counters.
* Explain the advantages of combining timers and counters.

Module 10 - Branch and Loop Control
This course is intended to provide an overview of various branch and loop instructions including MCR, JSR and JMP. The use of PLC simulation software in this course allows the student to program and observe branching operations and to perform troubleshooting tasks. The principles of fault routines are presented with an emphasis on safety considerations and compliance with safety codes and regulations. In addition, the course also provides coverage of subroutines and their application and benefit in complex control problems. Force instructions are presented and demonstrated using PLCLogix simulation software.

Learning Outcomes:
* Define program control instructions.
* Differentiate between master control reset and relay.
* Explain the purpose of a jump instruction.
* Describe the basic operation of a subroutine.
* Use a Force command for troubleshooting.
* Differentiate between a JSR and a JMP.
* Explain the purpose of fault routine.
* List the values associated with a GSV instruction.

Module 11 - Sequencers
This module is designed to provide the student with a clear understanding of the purpose and application of PLC sequencers, both through the theory of operation and through the actual demonstration using lab simulation software. The module will familiarize the learner with masking techniques and the various types of sequencers available including SQO and SQC instructions. In addition, sequencers charts are presented with an emphasis on maintenance and recording of sequencer chart information.

Learning Outcomes:
* Explain the operation of a mechanical drum controller.
* Describe the basic function of a PLC sequencer.
* Explain how time-driven sequencers operate.
* Describe the operation of event-driven sequencers.
* Derive a sequencer chart.
* Define the term matrix.
* Explain the purpose of masking.
* List three types of sequencers.
* Write a ladder logic program using SQO and SQC.

Module 12 - Data Handling
This course provides students with an introduction to the principles of Logix 5000 data handling, including bits, words, and arrays. Using PLCLogix simulation, various aspects of data transfer will be demonstrated and students will program and observe transfer instructions such as MOV, FIFO and LIFO. An introduction to shift registers is also presented with an emphasis on practical applications in industrial control circuits.

Learning Outcomes:
* Name the three main data handling functions.
* Differentiate between words and arrays.
* Convert data from one form to another.
* Explain the purpose of a *move* instruction.
* Write a ladder logic program using an MOV instruction.
* Describe the purpose of an array to array move.
* Name two types of shift registers.
* Differentiate between FIFO and LIFO instructions.
* Transfer data between memory locations.

Module 13 - Math Instructions
This course provides an overview of basic and advanced mathematical functions found in the Logix 5000 PLC. It provides thorough coverage of data comparison instructions such as SQR, EQU, LES, and GRT. In addition, this course provides a foundation for more advanced programming techniques including analog input and output control. Topics such as combining math functions, averaging, scaling and ramping are presented with an emphasis on practical application and are demonstrated using PLCLogix lab simulation.

Learning Outcomes:
* Name the four main PLC mathematical functions.
* List three types of data comparison.
* Add and subtract numbers using PLC instructions.
* Write a ladder logic program using MUL and DIV instructions.
* Define the terms *scaling* and *ramping.*
* Use LES, GRT, and EQU instructions in a ladder logic program.
* Write a program using the SQR instruction.
* List three advanced math operations.
* Describe the purpose of an AVE instruction.

Module 14. - Process Control
The purpose of this module is to provide the student with a thorough understanding of the various aspects of process control and its application to PLC systems. In addition to open-loop and closed-loop systems, the module also covers advanced closed loop techniques including PID control. Analog I/O devices are presented in detail and tuning parameters for PID control systems are demonstrated through practical examples.

Learning Outcomes:
* Define the terms process, process variable, and controlled variable.
* Name four applications for control systems.
* Explain the advantage of using block diagrams.
* Describe the function of the setpoint, error signal, and measured value.
* Differentiate between open-loop control and closed-loop control.
* List the five basic components in a closed-loop control system.
* Name the four variables associated with closed-loop control systems.
* Define dead time.
* Explain the basic operating principles of On-Off and PID control.
* Describe the purpose of feedforward control in process systems.
* Define the terms algorithm and flowchart.
* Explain the basic principle of fuzzy logic.

Module 15 - PLC Communications
This course is intended to provide the student with an introduction to data communication using PLC systems and peripherals. The fundamentals of LANs and data highways are discussed using Windows platform and Rockwell hardware and programming software such as RSLinx. In addition, an introduction to ethernet and network switching is also presented as well as detailed descriptions of topology and the operation of token passing in a data highway. The course also provides an overview of transmission media, response time and the basic principles of proprietary networks including the seven MAP layers.

Learning Outcomes:
* Define the term *data communication.*
* Explain the purpose of a LAN
* Describe the term protocol and its application to PLCs.
* Differentiate between OLE and DDE.
* Name two types of topology.
* List four factors affecting transmission media.
* Define the term response time.
* Describe the basic principles of proprietary networks.
* Name the seven MAP layers.
* List three advantages of using Ethernet.
* Explain the purpose of network switching.
* Name three types of RSLinx diagnostic resources.

Module 16. - Number Systems and Codes
This module is designed to provide the student with a thorough understanding of the various number systems used by PLCs and their application in industrial control. The module covers binary numbers and codes including BCD, Octal, and hexadecimal. In addition, the module also demonstrates through lab simulation how number systems are manipulated by the PLC's processor. Topics also covered in the module include negative binary numbers, parity bit, Gray code, and ASCII.

Learning Outcomes:
* Explain the operation of the binary number system.
* Express a negative number in binary form.
* Differentiate between least-significant bit and most-significant bit.
* Add and subtract binary numbers.
* Multiply and divide binary numbers.
* Convert binary numbers to decimal, and decimal numbers to binary.
* Count using the octal number system.
* Convert octal numbers to binary, and binary numbers to octal.
* Explain the hexadecimal number system.
* Write a program using number system conversion.
* Convert hexadecimal numbers to binary, and binary numbers to hex.
* Differentiate between natural binary and Binary Coded Decimal (BCD).
* Describe the purpose of parity bit, Gray code, and ASCII code.

Module 17. - Digital Logic
This module provides a thorough treatment of digital logic and its application in PLC programming and control. Boolean algebra and the theorems associated with it are presented and demonstrated through a series of programming examples. In addition, the student will become adept at converting digital logic to ladder logic and will apply DeMorgan's theorem to increase circuit efficiency and reduce redundancy.

Learning Outcomes:
* Apply truth tables to troubleshooting digital circuits.
* List five logic gates.
* Describe the basic operation of an inverter.
* Explain the purpose of Boolean algebra.
* Apply logic gate combinations to PLC control.
* Convert digital logic to ladder logic.
* Name eight Boolean theorems.
* Apply DeMorgan's theorem to ladder logic circuits.

Module 18. - Advanced Programming Languages
This module provides students with an introduction to advanced PLC programming languages which are widely used in industrial automation. In addition to graphical languages such as Sequential Function Chart (SFC) and Function Block Diagram (FBD), text-based languages such as Structured Text (ST) and Instruction List (IL) are also presented. Numerous programming examples are discussed using real-world applications and problem-solving techniques. This module also provides an overview of the RSLogix 5000 programming language and controller organizer, including tagnames, alias tags, and various editors (ST, FBD, SFC, etc.).

Learning Outcomes:
* Explain the purpose of the IEC61131-3 programming standard and its application in industry.
* Name two text-based languages and three graphical languages.
* Describe the basic programming and operating characteristics of Sequential Function Chart (SFC).
* List the three main parts of a function and explain their application in Function Block Diagrams (FBD).
* Write a simple Structured Text (ST) program.
* Differentiate between Instruction List (IL) programming and ST.
* Define online editing.
* Describe the function of program tags in the RSLogix 5000 software.
* List the four programming languages used by RSLogix 5000.
* Explain the purpose of the Controller Organizer in RSLogix 5000.

Module 19. - Robotics
This module provides an in-depth look at the industrial robot and the role it plays in industrial manufacturing processes. The origins of the industrial robot and its evolution are described. The types, components, accuracy, programming and applications of robots, among other topics, are thoroughly analyzed. Robot sensors, including vision and tactile detection are covered with an emphasis on practical application. This module also provides an overview of safety considerations including fail-safe operation and work-envelope design. The concept of Artificial Intelligence and how it relates to industrial machines is presented in detail.

Learning Outcomes:
* Define a robot
* Name the three general classifications of robots
* Describe the basic principle of a teach pendant
* Differentiate between a control system and a manipulator
* List the degrees of freedom for a four-axis robot
* Differentiate between pitch, yaw, and roll
* Define the term work envelope
* Name the three basic coordinate systems
* Explain the main differences between PUMA- and SCARA-style robots
* Define, payload, repeatability, and accuracy
* List five functions performed by vision and touch sensors
* Explain how collision protection provides for human safety
* Name six applications for industrial robots
* Define artificial intelligence