CHAPTER CONTENT

Part 1, titled *Programmable Logic Controller— Fundamental Concepts*, includes nine chapters written to support a first course in programmable logic controllers. Chapter 1 and all subsequent chapters start with chapter goals and objectives. In addition, this chapter defines a PLC and covers a brief history of PLCs, a description of the system and components, an introduction to vendor systems, a description of PLC types and types of input and output modules, and a comparison between relay ladder logic and PLC ladder logic. Every chapter ends with general chapter questions, Web and data sheet questions, and problems divided into general, PLC 5, SLC 500, ControlLogix, and challenge groups.

Chapter 2 focuses on discrete input devices and output actuators and describes the operation of the most frequently used input devices and output actuators in automation control systems. Devices covered include manual and mechanically operated switches, transducers and sensors including proximity and photoelectric devices, interfacing switches and sensors, input wiring, field device current sourcing and current sinking concepts, electromagnetic output and solenoid controlled devices, control relays, contactors, motor starters, pilot lights, alarms, interfacing output devices, and output wiring.

Chapter 3 covers an introduction to PLC programming with the following topics: decimal, octal, and binary number systems, ladder logic fundamentals, addressing rack/slot and tag-based systems, examine if closed and examine if open inputs selection and applications, retentive and non-retentive coil outputs, virtual or internal relays, scan time, multiple inputs, standard input logic, sealing contacts, multiple outputs, latched outputs, and using internal memory bits. In addition, empirical program design is introduced along with programming devices and software. Troubleshooting techniques for PLC-controlled systems and program design are also covered.

Chapter 4 covers programming timers, and the standard ladder logic used for timers. Topics include mechanical and electronic timing relays, and PLC timer instructions, such as on-delay timers, off-delay timers, retentive timers, and the reset instruction. In addition, cascaded timers, empirical design of timer ladders, and troubleshooting of timer ladders and input/output modules are addressed. The use of timers in pneumatic robot control is also described.

Chapter 5 describes the counter function present in PLCs, and the standard ladder logic used for counters. Topics include counter instructions, such as up counters, down counters, up/down counters, and cascade counters; using counter output bits; programming counter instructions; and counter applications. In addition, the reset instruction and one-shot function are covered along with programming and application issues.

Chapter 6 focuses on arithmetic and move instructions available in the PLC instruction set, and the standard ladder logic used for these instructions. Topics include instructions and format for addition, subtraction, multiplication, division, square root, and move instructions; programming these instructions; and application of math and move instructions.

Chapter 7 describes the binary-coded decimal (BCD) and the hexadecimal numbering systems and covers the conversion and comparison instructions. In addition, the standard ladder logic used for these instructions is covered. The instructions for converting to and from BCD numbers are presented. The comparison instructions covered include equal to, not equal to, less than, greater than, less than or equal to, and greater than or equal to. In addition, programming and application of the comparison instructions are addressed.

Chapter 8 focuses on instructions that change the flow of the program execution and covers some special-purpose instructions. In addition, the standard ladder logic used for these

instructions is covered. The program flow instructions described include master control and zone control instructions, jump instructions, subroutines, and immediate input and output instructions. In addition, the clear instruction is covered along with programming and application issues.

Chapter 9 is the last chapter in Part 1 of the text. The addressing modes discussed include direct, indirect, indexed, and indexed indirect. Typical applications for the addressing modes are included to indicate how each mode is used.

Part 2 of the text, titled *Advanced PLC Instructions and Applications*, includes Chapters 10 through 17. The content of Part 2 could be used selectively to enhance a first course in PLCs or it could be used for a second, more advanced PLC offering. Chapter 10 covers instructions related to data handling and shift register applications. In addition, the standard ladder logic used for these instructions is covered. Topics include the copy and fill instructions, the FIFO, LIFO, and FAL functions, bit patterns in a register, changing a register bit status, shift register functions, programming FIFO, LIFO, and shift register instructions.

Chapter 11 addresses the programming and operation of PLC sequencers, and the standard ladder logic used for sequencers. Topics include electromechanical sequencing, the basic PLC sequencer function, PLC sequencer with timing, cascading sequencers, and programming applications for the sequencer function.

Chapter 12 covers analog PLC applications. The concepts covered include analog sensors and actuators, types of PLC analog modules and systems, PLC analog input and output data, programming analog instructions, and analog applications.

Chapter 13 introduces the first of the new IEC 61131 programming languages, Function Block Diagram (FBD). The Allen-Bradley FBD instruction format is used in the description, which includes programming examples and application information. In addition, the standard ladder logic used for these instructions is covered.

Chapter 14 describes how the analog principles from Chapter 12 and FBD instructions from Chapter 13 are applied to the control of on-off and continuous processes. The topics include onoff control, two-position control, floating control, PID principles, fuzzy logic, and programming the PID function.

Chapter 15 introduces the second of the new IEC 61131 programming languages, Structured Text (ST). The Allen-Bradley ST instruction format is used in the description, which includes programming examples and application information. In addition, the standard ladder logic used for these instructions is covered.

Chapter 16 introduces the third of the new IEC 61131 programming languages, Sequential Function Chart (SFC). The Allen-Bradley instruction format is used in the description, which includes programming examples and application information.

Chapter 17 addresses industrial networks and distributive control. The network topics include PLC network architecture, Ethernet/IP, DeviceNet, ControlNet, remote I/O, Data Highway Plus, DH 485, Modbus, and Profibus. In addition, wireless networks and the human-machine interface (HMI) are covered.