Applications of PLC in Automatic Control Systems

Introduction:

PLC refers to **P**rogrammable **L**ogic **C**ontroller which is an essential part of many automatic control systems. PLC is an electric, digital, logic computer-based device used in all sequential processes or procedures to control various equipment in industrial facilities. The equipment that PLCs control are endless. Few examples are conveyor systems, food processing and packaging machinery, auto assembly lines, Automatic parking systems, ..etc.

Before inventing PLC, in old-traditional industrial automatic control systems, all physical control devices were hard wired directly to each other according to an algorithm (control LAD diagram) showing how the system is supposed to operate. Hard-wiring of all inputs and outputs parts includes sensors, contactors, switches, actuators, timers, coils, counters, relays, .etc. Hard-wiring made error-tracing, problem diagnostics, maintenance& replacing spare hardware parts very hard. In addition to the large size, cost and unpleasant-complicated shape of old control-board, doing new LAD modifications and adding system expansion lines were very difficult and time consuming jobs.

In PLC systems, PLC replaces direct hard wiring between inputs and output/field devices. Thus, instead of being wired directly to each other,physical input/output equipment are wired to PLC. Also allphysical types of timers and counters are replaced by program elements in PLC. Then, a control algorithm pre-stored inside PLC provides the "software-wiring" connection between all input/output devices. Similar to computer systems, PLC must have an operating system & user application software which are used to provide a required control algorithm. The most common languish of PLC control program is also called LAD diagram. This program is stored (downloaded) into PLC's memory to tell PLC what to do as per a repeated scan cycle over all inputs/outputs to the LAD diagram.

In addition to eliminating most of the disadvantages of traditional hard-wired control systems, some important advantages of PLC are that LAD program can be easily modified, expanded and tested for error-tracing and control problem diagnostics on a PC without having the PLC itself. Further, a simulation operation run can be done on the PC displaying on screen the pre-required outputs. As a computer system, all PLC input/output data values, system history, existing errors and program modifications can be easily stored for manipulation and future analysis.
Recently, HMI (Human-Machine Interface) and internet technologies have been integrated with PLCs to add much more advantages and capabilities for basic PLC systems (which are covered in this training course).

Course Objectives:

This applied training course is designed to help participants understand, effectively, the basics of sequential process control and applications of industrial PLC systems. It provides them with essential knowledge and practical skills to all PLC hardware & software components. The objective is to prepare them to implement a PLC system from beginning to end, including planning and design of associated hardware and soft-ware. This course covers the basics of PLCs & related devices/modules used in PLCs. Lectures along with distributed notes, sheets & reports provide professional tool for studying and analyzing various aspects related to using industrial applications of PLC for automatic control of various types of mechanical power systems.

This Course has been designed to give the participants a wide range of knowledge & practical skills to:

- ✓ Understand differences between continuous control systems, conventional DCS and contemporary discrete/digital control systems which are using computer-based programmable controllers (PLCs).
- ✓ Address basics and essentials of discrete and sequential control systems versus common PID control systems.
- ✓ Identify major hardware & software components of industrial PLC systems and describe their control functions.
- ✓ Identify types of discrete/analog inputs/outputs and describe operation of PLC timers & counters.
- ✓ Identify & learn how to select PLC expansion modules and associated special hardware and software auxiliaries.
- ✓ Read, understand&write basic typesof PLC programs (e.g., LAD, ladder logic diagram, STL, statement list diagram & FBD, Function Block diagrams.
- ✓ Identify operational and technical differences between various types PLC devices and models.
- ✓ Identify proper technical manuals to refer to for PLC installation, programming& implementation data.
- ✓ Understand how to write, test, diagnose and run a LAD diagram and then do a simulation for its operation.

The ILO's (Intended Learning Outcomes) of the Course:

a) Knowledge and Understanding:

Having successfully completed this course, the participants should have knowledge and understanding of:

- ✓ Basics of process sequential control and practical applications of industrial PLC Systems.
- ✓ Major functions & various components & expansion modules of different types of PLC systems.
- ✓ Types of PLC discrete or analog inputs/outputs signals and operation of PLC timers and counters.
- ✓ Structure of PLC languishes for the Ladder logic, statement list, and function block diagrams.
- ✓ Basics of programming, running, simulation, diagnostics & trouble-shooting of various PLCs.

b) Intellectual Skills:

Having successfully completed this course, the participants should have the ability to:

- ✓ Select and apply appropriate technical and optimum method in doing engineering design and analysis of automatic control problems using industrial PLC systems.
- ✓ Searching for scientific/technical information and adopting PLC automatic control capabilities.
- ✓ Analyze and compare various PLC components, performance & technical specifications of different PLC systems.
- ✓ Apply the concept of Ladder logic simulation, PLC diagnostics and the operation of PLC system.
- ✓ Compare between practical measurement devices, transducers & methods for signal conditioning, data acquisition and different output displaying/processing systems of PLC systems
- ✓ Solve practical examples on using PLC systems for automatic control problems.
- ✓ Study, describe and compare between different PLC types, models and programming languishes.

c) Professional and Practical Skills:

Having successfully completed this course, the participants should have the ability to do:

- ✓ Identify various types of field devices (sensors, actuators and final control elements) which are essential for the operation of PLC automatic control systems.
- ✓ Suggest possible alternative sensors, actuators & final control elements for PLC systems.
- ✓ Diagnose all possible operation modes, configuration and diagnostics of PLC systems.
- ✓ Design, select, apply and implement various examples of PLC automatic control systems.
- ✓ Diagnose failure and automatic control problems of industrial PLC automatic control systems.
- ✓ Monitor & evaluate performance of different parts & components of PLC control systems.
- ✓ Formulate & analyze heat transfer, energy and flow problems related to PLC control systems.

d) General and Transferable Skills:

Having successfully completed this course, the participants should have the ability to do:

- ✓ Transfer knowledge, Work in group, and Communicate in written & oral forms, in English.
- ✓ Use IT& evolutionary technological tools & PC applications (Excel, Mat lab, Virtual labs, .etc).
- ✓ Prepare &write reports,Manipulate & sort data, Think logically, and continuous self-E-learning.
- ✓ Identify practical problems, compare between different technologies for PLC control systems.
- ✓ Organise & manage time & resources effectively; for short-term and longer-term commitments.

Who Should Attend:

Engineers and Field Personnel involved with design, maintenance, operation, selection installation and maintenance as well as plant reliability, condition monitoring and for the day to day servicing and operational efficiency. Also plant and maintenance engineers, process engineers and maintenance managers. It is also be invaluable to supervisors who are involved in pump and compressor maintenance activities.

The Instructor:

Dr. Mohsen Soliman is an Associate professor of fluid mechanics group in Mechanical Power Engineering Department – Cairo university. He has a Ph.D. degree, 1987 from university of California, Irvine and has a long teaching and research experience in the area of fluid flow, turbo machines, and gad dynamics and has many research

papers published at international conferences and journals. Dr. Soliman has had many years' experience in organizing and lecturing training courses for engineers inside and outside Egypt. The courses cover design pipe lines, valve technology, water hammer and fire fighting systems. Currently, Dr. Soliman is the manager of the Automatic Control Lab, ACC, and the administrator of the Automatic Control Post Graduate Diploma at Mech. Power Engineering Dept. FECU. See the ACC site: www.acc-vlab.cu.edu.eg

Daily Course Program

Day one:

9:00 – 9:30	Registration	
9:30 – 11:00	Lecture 1	Overview for Various and Different Types of Automatic Control Systems.
11:00 – 11:30	Coffee break	
11:30 – 13:00	Lecture 2	Introduction to define what is an industrial PLC systems+Examples+ movies
13:00 – 13:30	Lunch break	
13:30 – 15:00	Lecture 3	Types of PLCs: Micro-system, Mini-systems and Rack-Type Systems.

Day Two:

9:00 – 10:30	Lecture 4	Major PLC components, Functions, Expansion Modules as per applications, Types of PLC memories: ROM, RAM, EPROM and EEPROM
10:30 – 11:00	Coffee break	
11:00 – 12:30	Lecture 5	PLC Input parts (sensors,transducers,keys, relays, switches, contactors, HMI).
12:30 – 13:00	Lunch break	
13:00 – 14:30	Lecture 6	PLC Output components (actuators, relays, audio/visual outputs, LEDs, HMI).

Day Three:

9:00 – 10:30	Lecture 7	Types of Analog and Digital Signals. Basic Logic Functions
10:30 – 11:00	Coffee break	
11:00 – 12:30	Lecture 8	Types and operation modes of PLC Timers, Special Timers, Examples.
12:30 – 13:00	Lunch break	
13:00 – 14:30	Lecture 9	Types and operation modes of PLC Counters, Special Counters, Examples .

Day Four:

9:00 – 10:30	Lecture 10	PLC Programming Languishes: (e.g., LAD, ladder logic diagram, STL, statement list diagram & FBD, Function Block diagrams.
10:30 – 11:00	Coffee break	
11:00 – 12:30	Lecture 11	PLC User Application Software (e.g., for Siemens PLC Micro-win, Semantic..) Operation/technical manuals for PLC, expansion devices and modules.
12:30 – 13:00	Lunch break	
13:00 – 14:30	Lecture 12	Advanced Programming techniques: SFC, Sequential Function Chart. Examples.

Day Five:

9:00 – 10:30	Lecture 13	Parallel Branching and Selective Branching of SFCs.
10:30 – 11:00	Coffee break	
11:00 – 12:30	Lecture 14	Applied PLC Examples with PLC Run Simulations
12:30 – 13:00	Lunch break	
13:00 – 14:30	Lecture 15	Course Review and Course Evaluation.

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مديروحدة ضمان الجودةسابقاً ومرشدأكاديمى د.ع فى قسم ميكانيكا قوى