

BHAG: Upon completion of this course, students will become efficient PLC programmers capable of collaboratively implementing effective troubleshooting techniques gained through designing, developing, and running an Automation Solution Program used to solve an authentic field-based problem.

Learning Goals	Learning Activities	Assessment Activities
Foundational: 1. Learners will discover principles and fundamentals of PLCs. Learners will analyze how these components will become the foundational base of programming to solve field-based problems.	1. Research and review images, videos, and other online resources on PLC parts and components from various manufacturers. 2. Review wiring diagrams and schematics from previous classes, and redesign them as PLC ladder logic programs 3. Discuss and compare when to use the different PLC instruction types and logic forms.	1. Design the base structure for the Automation Solution Program.
Application: 1. Learners will analyze and evaluate the impact of efficient troubleshooting skills.	1. Collaborate with classmates as they troubleshoot various PLC programs. 2. Discuss automation techniques, solutions, and challenges.	1. Locate, view, and correct errors within the base of the Automation Solution Program. 2. Blog Post on XXXXX.
Integration: 1. Learners will illustrate how their knowledge of PLCs combined with prior learning experiences will benefit their future field work and inspire automation integration.	1. Research, review, and discuss the top field-preferred PLC manufacturers, create a graphic tool comparing the different programming software available for each manufacturer displaying the comparison. 2. Discuss how the fundamental knowledge of PLCs builds and expounds on prior learnings, and will continue to impact future work experience.	1. Blog Post on XXX. 2. Incorporate logical circuits from various systems into the Automation Solution Program.
Human Dimension/Caring:	1. Review and discuss complex PLC instructions such as timers and counters, then split into groups to	1. Collaboratively design and include complex PLC

1. Learners evaluate the beneficial impact their creative PLC programming will have in the automation industry.	practice designing and developing advanced programs to automate processes efficiently. 2. Review learning experiences completed to this point within the class, and discuss what we have, and have not completed that students want to learn more about.	functions into the Automation Solution Program. 2. Blog Post comparing original class reflection to current reflection.
Learning-How-to-Learn: 1. Learners will locate and evaluate outside resources to enhance in-class learning as well as continue future learning.	1. Research and discuss several outside resources, simulation programs, PLC videos, forums, or PLC programming tutorials that will help enhance student learning. 2. Finalize Automation Solution Program.	1. Blog Post on XXXXX. 2. Present Automation Solution Program to the class, as a team, for a shared-lessons learned.

Learning Environment & Situational Factors to Consider

1. Specific Context of the Teaching/Learning Situation

How many students are in the class? Is the course primary, secondary, undergraduate, or graduate level? How long and frequent are the class meetings? How will the course be delivered: live, online, blended, flipped or in a classroom or lab? What physical elements of the learning environment will affect the class? What technology, networking and access issues will affect the class?

- 60 students total- divided into 3 sections of 20 students
- This is an exit level course of an Associate's Degree program
- Two sections meet twice a week for 2 ½ hours, where 1 hour is spent researching, lecturing, working problems, designing programs, and asking/answering questions. The other hour and a half is spent in the lab where students actually program and prove their classroom findings. The other section meets only one night a week for 4 ½ hours, where we spend 2 hours in the classroom setting mentioned above, and 2 and a half hours in lab.
- We currently have communications path issues on several of our PLCs, causing delays in our lab activities, as students are having to partner up. I have IT working on resolving the networking issues, so hopefully each student will have their own machine to work on soon.

2. General Context of the Learning Situation

What learning expectations are placed on this course or curriculum by: the school, district, university, college and/or department? the profession? society?

1. Identify the main parts of a PLC and describe their function.
2. Describe the basic circuitry and applications for I/O modules and interpret I/O and CPU specifications.
3. Define the decimal, binary, octal, and hexadecimal, numbering systems and explain BCD, Gray, and ASCII Codes and be able to convert from one numbering or coding system to another.
4. Convert relay ladder schematics to ladder logic programs and program instructions that perform logical operations.
5. Write and enter ladder logic programs and use internal relay instructions.
6. Explain the operation of sensors and output control devices commonly found in PLC installations.
7. Analyze and interpret typical PLC timer ladder logic programs.
8. Analyze and interpret typical PLC counter ladder logic programs.
9. Apply combinations of counter and timers to control systems.

3. Nature of the Subject

Is this subject primarily theoretical, practical, or a combination? Is the subject primarily convergent or divergent? Are there important changes or controversies occurring within the field?

- This programmable logic controller course is a combination of theoretical and practical applications.
- This is more of a divergent subject than convergent whereas there is an abundant amount of possible solutions that could potentially solve our problems.
- There are continuous updates, changes, and advances in the field as technology and standards are continuously changing, forcing us to adapt and grow with it as leading technicians.

4. Characteristics of the Learners

What is the life situation of the learners (e.g., socio-economic, cultural, personal, family, professional goals)? What prior knowledge, experiences, and initial feelings do students usually have about this subject? What are their learning goals and expectations?

- I normally have a wide variety of students in this class. The ages normally range from students around 17, straight out of high school, to some who are pressing their upper 50s and 60s, some of which are seeking a degree to keep a job, and others looking into a career path change.
- Some students come to me with more years working experience in the instrument field than I have been alive, while others are very fresh with zero work experience; however, by the time they reach my class, they have all completed at least two semesters of core instrumentation classes.
- Most students enter this course excited and eager to learn because they know that excelling in this subject could possibly be the determining factor of landing an amazing job that pays extremely well, and requires very little physical labor.
- Students expect to have the knowledge and ability to program PLCs to operate lights, motors, pumps and more upon completion of this course.

5. Characteristics of the Teacher

What beliefs and values does the teacher have about teaching and learning? What is his/her attitude toward: the subject? students? What level of knowledge or familiarity does s/he have with this subject? What are his/her strengths in teaching?

- I have a passion for teaching students in a way that they truly understand and retain the important information throughout the course as they use it to develop and build the more complex information and experiences as they progress.
- I worked in the instrumentation field for five years after completing my associate's degree where I took several additional PLC classes and worked hand-in-hand with Field Control Specialists designing and troubleshooting PLC programs and equipment installation.
- I feel like my biggest strength is the value that I place in hands-on learning, the time we spend on lab activities, and the importance I place on collaboration and teamwork during those activities to mimic real field-based training and working.

Questions for Formulating Significant Learning Goals

"A year (or more) after this course is over, I want and hope that students will have a thorough understanding of the logic behind designing and writing Programmable Logic Controller (PLC) programs, as well as the ability to program, download, and run the programs on live PLCs."

My Big Harry Audacious Goal (BHAG) for the course is:

Students will become efficient PLC programmers capable of resourcefully collaborating with other team members while implementing effective troubleshooting techniques gained through designing, developing, and running an Automation Solution Program used to solve an authentic, complex, field-based problem.

Foundational Knowledge

- What key information (e.g., facts, terms, formulae, concepts, principles, relationships, etc.) is/are important for students to understand and remember in the future?
 - PLCs were designed to replace hard-wired relay; therefore, ladder logic (the PLC programming language) is meant to mimic relay schematics, but careful attention should be paid to logic and function.
 - Conversions to and from numbering systems such as decimal, binary, octal, hexadecimal, and BCD.
 - Difference between XIC (Examine-if-Closed) and XIO (Examine-if-Open) instructions.
 - Logic Gate terms and functions for AND, OR, NAND, NOR, and NOT gates.
- What key ideas (or perspectives) are important for students to understand in this course?
 - Converting relay schematics to ladder logic programs.
 - Developing ladder logic programs designed to solve field-based word problems can have many possible solutions; however, some are more efficient than others.
 - Although the logic is the same, terminology in this course is extremely unique to all other electrical courses students have previously taken.
 - Attention to detail, checking your work, and reviewing your program before "going-live" could be the determining factor in saving lives one day. Ask questions, get second opinions, and collaborate with classmates to reduce and hopefully eliminate errors and mistakes.

Application Goals

- What kinds of thinking are important for students to learn?
 - ♦ Critical thinking, in which students analyze and evaluate
 - ♦ Students will be given programs containing multiple errors, designed by me, to analyze, evaluate, and troubleshoot until they reach the root of the problem where they will then be able to fix, download, and run the programs after successfully correcting the errors.
 - ♦ Creative thinking, in which students imagine and create
 - ♦ Students will need to create innovative solutions and programs for authentic, real-life, field scenarios using current knowledge and prior experiences to generate new ideas and collaboration-inspired solutions.
 - ♦ Practical thinking, in which students solve problems and make decisions
 - ♦ Students will be given field-based problems, advancing in complexity throughout the course, where they will need to use prior knowledge and information retained from beginning lessons and connect them with more advanced levels of instructions and processes to complete advanced logic programs, providing solutions to automation problems.
- What important skills do students need to gain?
 - Students should complete this course with the ability to design, write, program, evaluate, troubleshoot, and repair PLC programs in response to field-based scenarios and problems.

- Do students need to learn how to manage complex projects?
 - Students will have several projects throughout the course. Each project will increase in complexity. By the end of the course, students will need to be able to manage complex projects with multiple teammates working together to solve a common problem.

Integration Goals

- What connections (similarities and interactions) should students recognize and make...:
 - ♦ Among ideas *within* this course?
 - ♦ Students should recognize that no matter what PLC manufacturer they are using, the programming software is extremely similar and the terminology will be the same.
 - ♦ Instruction types will be the same no matter what type of PLC you are using.
 - ♦ Address formats for PLCs vary depending on the size, type, and manufacturer.
 - ♦ You must ALWAYS download a program to the PLC before you try to run the program.
 - ♦ Among the information, ideas, and perspectives in this course and those in other courses or areas?
 - ♦ The logic used in developing PLC programs is the same as that used in Motor Control circuit wiring, Digital Application circuit building, and several other classes in the Instrumentation program.
 - ♦ The automation of field processes is key to efficiency and various solutions are taught in all courses.
 - ♦ Among material in this course and the students' own personal, social, and/or work life?
 - ♦ Students will be able to utilize the critical, creative, and practical thinking skills developed throughout this course to help them see problems from different perspectives and hopefully create innovative solutions to everyday problems

Human Dimensions Goals

- What could or should students learn about themselves?
 - Students should understand and realize that when they truly understand the beginning information and the foundational framework for the class, the rest of the coursework will be much easier to construct and build as complexity increases.
 - Gain confidence in problem solving and troubleshooting once the understanding is developed. When students find errors and correct them on their own, confidence is created, and responsibility is further developed.
 - Everyone can be creative and innovative if enough subject knowledge is understood, and the environments are beneficial.
- What could or should students learn about understanding others and/or interacting with them?
 - Teamwork is an extremely important asset to develop.
 - Teamwork takes more than delegation- you must trust your teammates.
 - Collaboration and communication is key when working in the industrial field.
 - Good work ethics is as important on classroom teamwork as it is in the work force.

Caring Goals

- What changes/values do you hope students will adopt?

Feelings?

I hope students will feel like this course is beneficial to their future career path.

Interests?

I hope students develop an interest in automation and programming, and how it benefits companies.

Values?

I hope students begin to value challenges. Without challenges they will never be pushed to their limits., and if they are never pushed, they will never truly know what they are capable of. Challenging situations provide amazing learning opportunities, and I want all of my students to yearn for these authentic experiences.

"Learning-How-to-Learn" Goals

- What would you like for students to learn about:
 - ♦ how to be good students in a course like this?
 - ♦ Practice makes perfect! I have the lab open before class, and after class for students to come and practice any lab activities they were not able to complete on other days, or any interesting practice labs they may have found online, or developed on their own.
 - ♦ how to become a self-directed learner of this subject, i.e., having a learning agenda of what they need/want to learn, and a *plan* for learning it?
 - ♦ There are many PLC programming simulation programs that students can download on their own personal computers.
 - ♦ YouTube has a plethora of instructional how-to videos for PLC programming.
 - ♦ There is an extremely large amount of “automation forums” where PLC designers, programmers, and technicians collaborate about the latest and greatest PLC technology.