Department of Electrical and Computer Engineering

EEE4553, PLCs (Elective)

Catalog Description

Design and implementation of industrial controllers, using programmable logic controllers (PLCs). Relay ladder logic, relay characteristics, electrical schematic symbols, and thyristors, starting and stopping of large motors. National Electric Code, operator safety, input/output circuitry, state machines Grafcet, PID controllers. 3 Credit Hours, 2 Lecture Hours, and 1 Lab Hour.

Prerequisites

EEE3314 (Electronics) and EEE4514 (Control Systems and Lab).

Textbook(s) and/or Other Required Material

Thomas A. Hughes, Programmable Controllers, Thomas Henry, Control Circuits.

Course Learning Outcomes

This course is designed to give senior Electrical Engineering students an introduction to relay ladder logic as a language for posing and solving industrial control problems, to introduce them to power electronic circuitry, and to introduce them to the National Electric Code. Students learn to solve problems involving the control of moderately complex industrial automation systems by specifying the necessary hardware and writing the software in relay ladder logic.

Topics Covered

Definition of PLCs, relays, contacts, schematics, ladder diagrams, PLC I/O, PLC scan, switching components, solenoids, arc suppression, snubbers. (2 classes).
Exp 1: Introduction to the equipment, PLC 5 addressing, Allen Bradley 6200 software, editing simple ladder logic programs. (1 week).
Review of binary numbers and logic gates, expression of Boolean functions by relay ladder logic. (2 classes).
Exp 2: Boolean to relay ladder logic conversion. (1 week).
Control circuits, multipole switches, selectors, process sensors, contactors, electrical system grounding, GFI, Ampacity, power switching, reversing DC motors. (2 classes).
Exp 3: Elementary ladder design, and & or logic, sealing rungs, branches, comments, saving ladder diagrams. (1 week).
Case study: garage door opener. (3 classes).
Exp 4: Simulation of momentary contact push buttons, internal relays, multiple branches. (1 week).
Electrical systems in buildings, Three-phase systems. (2 classes).
Exp 5: Elementary ladder design II, more internal relays. (1 week).
Case study: Automatic drilling machine. (2 classes).
Exp 6: Latches, time on delay, time off delay, flashing lamps. (1 week).
BE SURE TO SAVE THIS PROGRAM FOR USE NEXT WEEK!
Time delay relays, Counters. (2 classes).
Exp 7: Extension of the program of Exp. 6. (1 week).
Case study: assembly line paint drying chamber. (3 classes).
Exp 8: Counters, sequencing lamps. (1 week).
Contactors, auto-transformers, current transformers, overload relays, thermal fuses, Per-Unit System. (1 classes)
Exp 9: Design of real time clock. (1 week).
Starting and stopping large motors, plugging, Overloads, short circuit current calculations, Safety techniques, intrinsic safety. (2 classes).
Exp 10: Four way traffic signal simulation (with pedestrian crossing switches). (1 week).
PLC flow control, PLC math. (2 classes).
Exp 11: Sump pump simulation, with fault simulation. (1 week).
PLC I/O. (2 classes).
Exp 12: PLC Math. (2 weeks).
Stage programming, Grafcet. (2 classes).
Exp 13: Elevator Control. (1 week).
Class/Laboratory Schedule

2 lecture sessions per week, 50 minutes per session, 1 lab session per week 100 minutes per session.

Contribution to the Professional Component

College mathematics and basic sciences, 0 credits; engineering topics, 3 credits; general education, 0 credits.

Relationship of Course to Program Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Rating</th>
<th>Rationale for Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>3</td>
<td>Virtually every problem that is presented to the students increases their ability to apply their knowledge of math, science, and engineering to the solution of engineering problems.</td>
</tr>
<tr>
<td>b</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>3</td>
<td>The solution to most exercises is open ended due to the nature of relay ladder logic and Grafcet.</td>
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<tr>
<td>d</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>3</td>
<td>Students are exposed to a very wide variety of engineering automation problems in this course.</td>
</tr>
<tr>
<td>f</td>
<td>2</td>
<td>Many code and safety issues are discussed in this course.</td>
</tr>
<tr>
<td>g</td>
<td>3</td>
<td>Each assignment and exam turned in by the student increases the student's ability to communicate technical information in writing, and many of the assignments require the communication of information graphically.</td>
</tr>
<tr>
<td>h</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>1</td>
<td>A discussion of new and planned types of electrical apparatus reminds students that they must keep current.</td>
</tr>
<tr>
<td>j</td>
<td>2</td>
<td>New manufacturing applications for this material are constantly appearing and are discussed in class.</td>
</tr>
<tr>
<td>k</td>
<td>2</td>
<td>Relay ladder logic is essentially a computer programming language in the context of this course.</td>
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<tr>
<td>l</td>
<td>0</td>
<td></td>
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<tr>
<td>m</td>
<td>2</td>
<td>An important part of this course is to understand the relationship between the Relay Ladder Logic (the software) and the hardware that is being controlled.</td>
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</tbody>
</table>

Key to support ratings: 3 strong emphasis, 2 emphasis, 1 minor emphasis, 0 no emphasis

Program Outcomes

All CE graduates must have

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a computer system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve computer engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for computer engineering practice
(l) an ability to plan, design, simulate, fabricate, construct, and test circuit hardware
(m) an ability to plan, design, test, and debug systems consisting of both software and hardware

Prepared by: Richard Johnston, 2/02/2010