Catalog Description

Design and implementation of industrial controllers using programmable logic controllers. Relay ladder logic, electrical schematic symbols, programmable logic controllers interface circuitry, operator safety, state machines, Grafcet, PID controllers. 3 Credit Hours, 3 Lecture Hours.

Prerequisites

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

Textbook(s) and/or Other Required Material


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. (3 classes).
Review of binary numbers and logic gates, expression of Boolean functions by relay ladder logic. (3 classes).
Control circuits, multipole switches, selectors, process sensors, contactors, electrical system grounding, GFI, Ampacity, power switching, reversing DC motors. (2 classes).
Case study: garage door opener. (3 classes).
PLC DC, TTL, CMOS input circuitry. (2 classes).
Electrical systems in buildings, Three-phase systems. (2 classes).
Thyristors, Commutation, snubbers, PLC AC input circuitry. (3 classes).
PLC DC, TTL, CMOS output circuitry. (2 classes).
PLC AC output circuitry, Power Factor, Transient suppression. (3 classes).
Stepper motors, variable reluctance motors, Remote sensing. (2 classes).
Case study: Automatic drilling machine. (2 classes).
Time delay relays, Counters. (2 classes).
Case study: assembly line paint drying chamber. (3 classes).
Contactors, auto-transformers, current transformers, overload relays, thermal fuses, Per-Unit System. (1 classes).
Starting large DC motors. (3 classes).
Starting large AC motors. (1 classes).
Stopping large motors, plugging, Overloads, short circuit current calculations, Safety techniques, intrinsic safety. (2 classes).
PLC flow control, PLC math. (2 classes).
Stage programming, Grafcet. (2 classes).

Class/Laboratory Schedule

3 lecture sessions per week, 50 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>
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<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>
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<tr>
<td>e</td>
<td>3</td>
<td>Students are exposed to a very wide variety of engineering automation problems in this course.</td>
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<tr>
<td>f</td>
<td>2</td>
<td>Many code and safety issues are discussed in this course.</td>
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<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>
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<tr>
<td>h</td>
<td>0</td>
<td></td>
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<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>
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</tbody>
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Key to support ratings: 3 strong emphasis, 2 emphasis, 1 minor emphasis, 0 no emphasis.

Program Outcomes

All EE 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 an electrical 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 electrical 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 electrical engineering practice
(l) an ability to plan, design, simulate, fabricate, construct, and test circuit hardware

Prepared by: Richard R. Johnston, 10/30/2009