STATE UNIVERSITY OF NEW YORK
COLLEGE OF TECHNOLOGY
CANTON, NEW YORK

MASTER SYLLABUS

ELEC 141 - INDUSTRIAL CONTROLS

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CANINO SCHOOL OF ENGINEERING TECHNOLOGY
ELECTRICAL ENGINEERING TECHNOLOGY & ENGINEERING SCIENCE
DEPARTMENT
FALL 2018

ELEC 141 - INDUSTRIAL CONTROLS

A. TITLE: Industrial Controls

B. COURSE NUMBER: ELEC 141
SHORT TITLE:

C. CREDIT HOURS: (Hours of Lecture, Laboratory, Recitation, Tutorial, Activity)

Credit Hours: 2
Lecture Hours: per week
Lab Hours: (2) two hours labs per week
Other: per week

Course Length: 15 Weeks

D. WRITING INTENSIVE COURSE: NA

E. GER CATEGORY: NONE

F. SEMESTER(S) OFFERED: Spring

G. COURSE DESCRIPTION: A hands-on study of devices and systems used in the control of industrial machinery. The student is introduced to the theory and use of electromechanical control circuits by use of traditional "hardwire circuits." The programming of the Allen-Bradley Micrologix 1000 type of programmable logic controller (PLC) is practiced. An introduction to sequencer systems that enable complex control and monitoring of machines is given. Emphasis is on learning the ability to program the equipment for effective control. Four hours laboratory per week.

H. PRE-REQUISITES: Electric Circuits 1 and Laboratory (ELEC 101/109) OR Electricity (ELEC 261), Digital Circuits (ELEC 111) OR a basic electricity course (i.e. ELEC 261) with an introduction to three phase systems, basic logic gates, binary

and hexadecimal number systems or permission of instructor.

CO-REQUISITES: NONE

I. STUDENT LEARNING OUTCOMES:

Institutional Student Learning Outcome (ISLO's)

(1) Communication Skills (2) Critical Thinking (3) Foundational Skills

(4) Social Responsibility (5) Industry, Professional, Discipline-Specific Knowledge and Skills.

Accreditation Board for Engineering and Technology ABET- Student Outcomes (a-k)

Course Objectives	ABET- Student Outcomes (a-k)	ISLO's
1. To understand and explain the fundamentals of control pilot devices and basic hard-wire control circuits using ladder diagrams. 2. To identify control circuit and logic symbols and implement appropriate documentation procedures.	(a) An ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities.	(5) Industry, Professional, Discipline-Specific Knowledge and Skills.
3. To apply the fundamentals of basic control logic to the study of complex control circuits. 4. To successfully construct, troubleshoot and evaluate PLC ladder diagrams. 5. Be competent in using an industry accepted PLC (eg. Allen-Bradley Micrologix 1000 controller) and software (e.g. RS Logix 500).	(a) An ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities. (c) An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes.	(2) Critical Thinking (5) Industry, Professional, Discipline-Specific Knowledge and Skills.

J. APPLIED LEARNING COMPONENT: CLASSROOM/LAB

K. TEXTBOOKS:

1. Programmable Logic Controllers: Hardware and Programming, 3rd Edition, with LogixPro 500 CD, Max Rabiee, **ISBN:** 978-1-60525-945-1, Goodheart-Wilcox (2013)

L. % REFERENCES:

1. Industrial Motor Control, Herman and Alerich, Fourth Edition
2. Programmable Logic Controllers, Second Edition, Frank D. Petruzella
3. Programmable Logic Controllers, Third Edition, John W. Webb and Ronald A. Reis
4. Industrial Motor control Fundamentals, Fourth Edition, McIntyre-Losee
5. Programmable Controller Circuits, Roger M. Bertrand
6. Motor Control Software in Laboratory PC's

M. % EQUIPMENT: Personal Computer, Allen-Bradley Φlogix 1000 Programmable Logic Controller, RS Logix 500 Software, Electro-Mechanical Relays (DPDT), Solid-State Relays (SSR), Push Button Stations (Single and Double contact), Color-Coded Stackable Banana Plug Patch Cords, Across-The-Line Magnetic Starters (Reversing/Non-Reversing), Various Color Lamps and Mounting Bases (120 VAC, 12 VDC), Fuse-Base Assembly, 12 VDC Power Supply, 3¢ Phase (208 VAC) Squirrel Cage Induction Motor, 12 VDC DC Permanent Magnetic Motors, Push Button/Pilot Lamp Input/Output PLC Interface Test Station.

N. % GRADING METHOD: A-F

O. % SUGGESTED MEASUREMENT CRITERIA/METHODS: Reports, Laboratory Practicum's, Quizzes.

P. % DETAILED COURSE OUTLINE / LAB

1, 2.	Introduction to Industrial Motor Control - Standard Control Circuit The Full Voltage Across-the-Line Starter - Multiple Push Button Stations, Jogging Circuits
3.	Practicum Exam during Lab
4. %	AC Full Voltage Across-the-Line Reversing Starter - Multiple Push Button Stations, Interlock Techniques, Job Both Directions
5.	Practicum Exam during Lab
6.	Introduction to the Programmable Logic Controller
7.	Programming the PLC
8.	Interfacing the PLC with controlling the three phase motor
9.	Practical Exam in Lab
10.	Retentive and non-retentive timers
11.	Counters up and down
12.	Practicum exam in Lab
13, 14, 15	Programming advance control circuits

16.	Practicum Exam in Lab
17, 18, 19	Time Driven Sequencers using Timer, Counter and Limit Test Instruction
20.	Practicum exam in lab
21, 22	Subroutines, Memory Map/Move/Clear Procedures
23.	Practicum in Lab
24, 25	Comparison Instruction
26, 27	Logic and Arithmetic Operations
28.	Practicum in Lab

Q. LABORATORY OUTLINE: Included in above

DETAILED COURSE OUTLINE
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1. Introduction to Control Systems
   1.1 Basic Control System Block diagram
      1.1.1. Power Source
      1.1.2 Load
      1.1.3 Switch(s)

   1.2 Basic Control Devices
      1.2.1. Switches
      1.2.2. Push Buttons
      1.2.3. Electro-Mechanical Relay
      1.2.4. Solid-State Relay (SSR)
      1.2.5. Basic Symbols and Construction

   1.3 Remote Control
      1.3.1. Momentary Push Button and Relay
      1.3.2. Sealing Contact
      1.3.3. Reset/Stop
      1.3.4. Standard control Circuit
      1.3.5. Multiple Push Button Control
      1.3.6. Limit/Over-Ride/Overload Shutdown
      1.3.7. Low Voltage protection (LVP)
      1.3.8. Low Voltage Release (LVR)

2. Across-The-Line Magnetic Starter
   2.1. Construction
      2.1.1. Electro-Mechanical Relay
      2.1.2. Thermo-Overload Relay, Reset
      2.1.3. Take-Off Points
      2.1.4. Line/Load Terminal Designation
      2.1.5. Sample Assemblies
      2.1.6. Power/Control Circuits
      2.1.7. Internal/External Wiring Diagrams

   2.2 Basic Circuits and Concepts
      2.2.1. Standard Control with LVP
      2.2.2. 2-wire and 3-wire Control
      2.2.3. Overload Simulation
      2.2.4. Single Phasing
      2.2.5. Reversing Rotation
      2.2.6. Multiple Push Button Stations
      2.2.7. Trouble Shooting

   2.3 Jogging Circuits

2.3.1. Contact Race
2.3.2. Anti-Race Jog Circuits
A. Circuit #1 (Overload-Auto Restart)
B. Circuit #2 (Overload-Manual Restart)
2.3.3. Multiple Push Button Stations

3. Reversing Starter
3.1 Construction
3.1.1. Similarities to Non-reversing Starter-Reversing Mode
3.1.2. Mechanical Interlocks
3.1.3. Electrical Interlocks
3.1.4. Take-Off Points
3.1.5. Sample Assemblies
3.1.6. Power/Control Circuits
3.1.7. Internal/External Wiring Diagrams
3.1.8. Multiple Push-Button Stations
3.1.9. Jog Both Directions
3.1.10 Trouble Shooting

4. Programmable Logic Controller
4.1 History (Automation, Microcomputer)
4.2 Block Diagram
4.3 Input Module (Input Ladder Diagram)
4.4 Output Module (Output Ladder Diagram)
4.5 Processor Ladder Diagram
4.6 Addresses/Files/Documentation
4.7 System Setup
4.8 Program Commands/Syntax
4.9 Sample I/O Test Program
4.10 Internal/External Coils
4.11 Latch/Unlatch Coils
4.12 Practice Problems (Various)
4.13 Counter/Timers
4.14 Oscillator and Pulsess
4.15 Comparator Functions
4.16 Logic functions
4.17 Arithmetic Operations
4.18 Memory Map/Move/Clear
4.19 Subroutine/Return Feature
4.20 Limit-Test Sequencer
NOTE: The above PLC topics will use the Allen-Bradley Micrologix 1000 controller and RS Logix 500 software.

ELEC 141
Course Outline
SUPPLEMENTAL INFORMATION

The student is required to learn the action and the ability to construct and demonstrate traditional "HARD-WIRED" motor control circuits. At least two laboratory tests in this area will be required by the student. Grading will be 100% or 0%, no partial credit. Written test will involve control circuit theory, nomenclature and graphic symbols.

Programmable Logic Controller (PLC) section of the course will involve the use of the Allen-Bradley MICROLOGIX 1000 controller and the RS LOGIX 500 windows driven software. The student will program basic control circuits, logic operations, and more advance application, using UP/DOWN counter, RETENTIVE and NON-RETENTIVE [TON] Timers, Time Driven Sequencers using the Limit test instruction, Arithmetic Operations, Memory data transfer and Data Handling to control motor. At least two laboratory tests using the PC and PLC will be administered by the instructor. The student may use "boiler plate" programs as allowed by the instructor. Grading may allow partial credit depending on the instructor.

Of course, the student is urged to use the library, various reference sources, the internet, WINDOWS and RS Logix 500 HELP to enhance his/her understanding of using the PC, PLC and control circuit theory.

The student must be able to navigate through a PC using MY COMPUTER and/or WINDOWS EXPLORER, have good file management and use appropriate file folder(s) as mandated by the in-home set up the RSLOGIX500 software.