CAMOSUN COLLEGE

ELEN 138 COURSE OUTLINE

ELEN 138 PLC Control

This course introduces students to Programmable Logic Controllers. Topics include: PLC ladder diagrams, basic and advanced instructions, interrupts, analog control modules, PID control, DC motor control, paralleling DC Generators. Instrumentation and troubleshooting concepts are also introduced.

OFFERED	Term 3
IN-CLASS WORKLOAD:	5 lecture, 2.5 lab for ***13 Weeks***
OUT-OF-CLASS WORKLOAD:	8 hours

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OBJECTIVES

Upon completion of this course the student will have a working knowledge of ladder diagrams, PLC programming and applications. PID control, DC Motor Control and control of DC generators topics will be included if time permits.

LEARNING OUTCOMES

Upon completion of this course, students will be able to:

- Describe a typical PLC system
- Explain how a PLC functions
- Draft and Analyze a PLC ladder diagram
- Design and Execute PLC programs
- Demonstrate and utilize a variety of basic and advanced PLC instructions
- Explain interrupts and their function in a PLC program
- Assemble and Operate the Allen Bradley PLC 1762 Analog I/O Module
- Demonstrate PID control using the PLC
- Utilize the PLC for DC Motor Control
- Construct a DC generator using the PLC

Course Material

1. Introduction — Estimated Time (1 hour)

    1.1 Description of a PLC
    1.2 History of the PLC
    1.3 Function of the PLC
        1.3.1 Compared to traditional relay control systems
        1.3.2 Compared to microprocessor based systems: FPGA, PC, etc.
        1.3.3 Typical PLC Controller

2 Introduction to PLCs

    2.1 PLC Applications
    2.2 PLC Instruction
        2.2.1 Main part
        2.2.2 Extension parts
    2.3 Typical PLC control unit and system
    2.4 How PLCs function (1 hour)

3. Introduction to PLC Programming

    3.1 File Structure
        3.1.1 Program Files
        3.1.2 Data Files
        3.1.3 Function Files
    3.2 Addressing
        3.2.1 I/O Address
        3.2.2 Data file Address
    3.3 Construction of RSLogix500 programming window
    3.4 Basic ladder diagram edition
    3.5 Project verification (2 hours)

4. Bit Instructions

    4.1 What are bit instructions
    4.2 Main applications of bit instructions
    4.3 XIC bit instruction
    4.4 XIO bit instruction
    4.5 OTE bit instruction
    4.6 OTL bit instruction
    4.7 OUT bit instruction (2 hours)

5. Software Usage

5.1 Overview on debugging
5.2 Force On and Force Off (1 hour)

6. Logical Operations

6.1 Main types of logic
6.2 Logic AND, Logic OR, Logic NOT
6.3 Realization of logics (2 hours)

7. Advanced PLC Instructions

7.1 Timer Instructions
- 7.1.1 What are timer instructions?
- 7.1.2 Structure of timer instructions
- 7.1.3 How timer instructions work
- 7.1.4 Application of timer instructions

7.2 Compare Instructions
- 7.2.1 What is a compare instruction?
- 7.2.2 How compare instructions work
- 7.2.3 Common compare instructions: EQU, NEQ, GRT, GEQ, LES, LEQ, MEQ, and LIM
- 7.2.4 Usage of compare instructions

7.3 Subroutine Instructions
- 7.3.1 What is a subroutine?
- 7.3.2 Why use a subroutine?
- 7.3.3 How subroutines work
- 7.3.4 Usage of subroutine instructions

7.4 Move Instructions
- 7.4.1 Move instructions MOV and MVM
- 7.4.2 Move instructions' role in resetting and initializing PLC systems

7.5 Sequencer Instructions
- 7.5.1 Why sequencer instructions are popular?
- 7.5.2 Sequencer instructions SQC, SQO, and SQL
- 7.5.3 Mask and its effects
- 7.5.4 Steps and sequencer operation

7.6 Counter Instructions
- 7.6.1 How counter instructions work
- 7.6.2 CTU and CTD
- 7.6.3 Usages of counter instructions (9 hours)

8. Interrupts

- 8.1 What is an interrupt?
- 8.2 How the Micrologix 1200 handles interrupts
- 8.3 When interrupts can be responded too
- 8.4 Interrupt priority
- 8.5 Interrupt instructions: INT, UIE, UID, and UIF
- 8.6 Interrupt configuration: EII (2 hours)

9. Advanced PLC Instructions II

- 9.1 Shift Instructions
  - 9.1.1 Construction of shift instruction BSL
  - 9.1.2 How shift instructions work
  - 9.1.3 Other instructions: BSR, FFL, FFU, LFL, LFU, and SWP
- 9.2 Math Instructions
  - 9.2.1 Structure of math instructions
  - 9.2.2 ADD, SUB, MUL, DIV, ABS, SQR, CLR, NEG, SCL, and SCP
  - 9.2.3 How the PLC handles math instructions
  - 9.2.4 Math status bits
- 9.3 Logic Instructions
  - 9.3.1 Logical functions
  - 9.3.2 Ways to use logical functions
  - 9.3.3 Logical instructions: AND, OR, XOR, and NOT (5 hours)

10. Analog Control Modules

- 10.1 A typical Digital System
- 10.2 Introduction to ADC and DAC
- 10.3 Analog Input Module 1762-IF4
- 10.4 Analog Output Module 1762-OF4
- 10.5 Input/Output Module Configuration (3 hours)

11. PID Control using a PLC

- 11.1 What is a PID controller and why use it
- 11.2 How PID controller works
- 11.3 PID Instructions
- 11.4 Tuning PID parameters (2 hours)

12. DC Motor Control using a PLC

- 12.1 Control System (review)
  - 12.1.1 Open-loop control vs. Closed-loop control
- 12.2 DC Motors (review)
  - 12.2.1 How DC Motors work
  - 12.2.2 Three ways to change DC motor speed
- 12.3 Control Units
  - 12.3.1 Signal Buffers
  - 12.3.2 Field Current Controllers
  - 12.3.3 Terminal Voltage Regulators
- 12.4 Pulse-Width Modulation Drives (2 hours)

13. DC Generators using a PLC

- 13.1 How DC Generators work
- 13.2 Three ways to adjust generated voltage
- 13.3 Parallel DC Generators
  - 13.3.2 Load sharing
  - 13.3.3 Generator PLC Control Systems
  - 13.3.4 Relative PLC Instructions
  - 13.3.5 Control Block Diagram (5 hours)

16. Troubleshooting (1 hour)

EVALUATION

Tests/Quizzes/Midterm	30%
Final Exam	30%
Assignments	15%
Lab Mark	25%
Total Course Mark	100%

Grading: in accordance with Camosun College Policy

A <u>minimum of 60%</u> must be achieved in both the theory and lab portions to pass the course. Less than 60% in either portion will result in a failure of the entire course.

Labs are to be completed within the assigned lab period and evaluated as satisfactory or unsatisfactory. Any unsatisfactory lab reports must be redone until a satisfactory level is achieved.

Quizzes may be given at any time without prior notice and will be based on the current class notes, example problems and any textbook reading assigned.

- ***Attendance is mandatory to complete the course.***

- ***All course material must be completed and handed in prior to writing the final exam***

<u>COURSE TEXT</u> - **Programmable Logic Controllers: Hardware and Programming**
- **Rabiee** - **ISBN** 9781566378734

- **Laboratory Exercises, Handouts and Course Outline**
- Provided as needed in class