



CAMOSUN COLLEGE

Trades and Technology

ELECTRONICS & COMPUTER ENGINEERING DEPARTMENT

**ECET 234
PLC Control 1**

Fall 2022

COURSE OUTLINE

CREDIT:	3
IN-CLASS WORKLOAD:	3 hours lecture, 2.5 hours lab
OUT-OF-CLASS WORKLOAD:	8 hours
PREREQUISITES:	ECET 165

1. INSTRUCTOR INFORMATION

(a) Instructor	Dr. Raju Sapkota
(b) Office hours	Email for an appointment
(c) Location	TEC 206
(d) Phone	Alternative: _____
(e) E-mail	SapkotaR@camosun.bc.ca
(f) Website	_____

2. INTENDED LEARNING OUTCOMES

Upon successful completion of this course a student will be able to:

- Use knowledge of PLC systems and functions to design and execute PLC programs
- Draft a PLC ladder diagram for programming purposes
- Use a variety of basic and more advanced PLC instructions in order to implement more complex programs
- Explain interrupts and how to use them in a PLC program
- Operate a PLC's analog I/O module to convert analog signals to digital form.

OBJECTIVE

Upon completion of this course the student will have a working knowledge of ladder diagrams, PLC programming and applications.

3. REQUIRED MATERIALS

- Access to D2L (Course Notes, Labs, Assignments/Problem sets, Quizzes, Tests)
- Max Rabiee, **Programmable Logic Controllers: Hardware and Programming**, 3rd Edition, G-W Publisher, ISBN: 978-1-60525-945-1 (Optional)

4. COURSE CONTENT

1. Introduction to PLCs

- 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: PC, etc.
 - 1.3.3 Typical PLC Controller
- 1.4 PLC Applications
- 1.5 PLC Instruction
 - 1.5.1 Main part
 - 1.5.2 Extension parts
- 1.6 Typical PLC control unit and system
- 1.7 How PLCs function

2. Introduction to PLC Programming

- 2.1 File Structure
 - 2.1.1 Program Files
 - 2.1.2 Data Files
 - 2.1.3 Function Files
- 2.2 Addressing
 - 2.2.1 I/O Address
 - 2.2.2 Data file Address
- 2.3 Construction of Logix500 programming window
- 2.4 Basic ladder diagram edition
- 2.5 Project verification

3. Bit Instructions

- 3.1 What are bit instructions
- 3.2 Main applications of bit instructions
- 3.3 XIC bit instruction
- 3.4 XIO bit instruction
- 3.5 OTE bit instruction
- 3.6 OTL bit instruction
- 3.7 OUT bit instruction
- 3.8 OSR bit instruction

4. Software Usage

- 4.1 Overview on debugging
- 4.2 Force On and Force Off

5. Logical Operations

- 5.1 Main types of logic
- 5.2 Logic AND, Logic OR, Logic NOT
- 5.3 Realization of logics

6. Advanced PLC Instructions

- 6.1 Timer Instructions
 - 6.1.1 What are timer instructions?
 - 6.1.2 Structure of timer instructions
 - 6.1.3 How timer instructions work
 - 6.1.4 Application of timer instructions
- 6.2 Counter Instructions
 - 6.2.1 How counter instructions work
 - 6.2.2 CTU and CTD
 - 6.2.3 Usages of counter instructions
- 6.3 Compare Instructions
 - 6.3.1 What is a compare instruction?
 - 6.3.2 How compare instructions work
 - 6.3.3 Common compare instructions: EQU, NEQ, GRT, GEQ, LES, LEQ, MEQ, and LIM
 - 6.3.4 Usage of compare instructions
- 6.4 Subroutine Instructions
 - 6.4.1 What is a subroutine?
 - 6.4.2 Why use a subroutine?
 - 6.4.3 How subroutines work
 - 6.4.4 Usage of subroutine instructions
- 6.5 Sequencer Instructions
 - 6.5.1 Why sequencer instructions are popular?
 - 6.5.2 Sequencer instructions SQC, SQO, and SQL
 - 6.5.3 Mask and its effects
 - 6.5.4 Steps and sequencer operation
- 6.6 Move Instructions
 - 6.6.1 Move instructions MOV and MVM
 - 6.6.2 Move instructions' role in resetting and initializing PLC systems

7. Advanced PLC Instructions II

- 7.1 Math Instructions
 - 7.1.1 Structure of math instructions
 - 7.1.2 ADD, SUB, MUL, DIV, SQR, CLR, NEG
 - 7.1.3 How the PLC handles math instructions
 - 7.1.4 Math status bits
- 7.2 Shift Instructions
 - 7.2.1 Construction of shift instruction BSL
 - 7.2.2 How shift instructions work
 - 7.2.3 Other instructions: BSR, BSL FFL, FFU, LFL, LFU
- 7.3 Logic Instructions
 - 7.3.1 Logical functions
 - 7.3.2 Ways to use logical functions
 - 7.3.3 Logical instructions: AND, OR, XOR, and NOT

- 7.4 Data Conversion Instruction
 - 7.4.1 DCD, INC, TOD, FRD Instructions

8. Analog Control Modules

- 8.1 A typical Digital System
- 8.2 Introduction to ADC and DAC
- 8.3 Analog Input Module 1762-IF4
- 8.4 Analog Output Module 1762-OF4
- 8.5 Input/output Module Configuration

9. Interrupts

- 9.1 What is an interrupt?
- 9.2 How the Micrologix 1200 handles interrupts
- 9.3 When interrupts can be responded too
- 9.4 Interrupt priority
- 9.5 Interrupt instructions: INT, UIE, UID, and UIF
- 9.6 Interrupt configuration: EII

LAB EXERCISES: (Subject to change)

Various lab exercises will be performed to practice and reinforce the lecture material.

- 1. Week 1 – Boolean Refresher (Teaching to be done in the lab)
- 2. Week 2 – Review of Ladder Logic, the LogixPro PLC Simulator, and RSLogix
- 3. Week 3 – Garage Door Simulation-Exercise 1
- 4. Week 4 – Garage Door Simulation-Exercise 2&3
- 5. Week 5 – Silo System Simulation
- 6. Week 6 – Traffic Control Exercises utilizing TON (1)
- 7. Week 7 – Traffic Control Exercises utilizing TON (2)
- 8. Week 8 –Traffic Control utilizing Word Comparison
- 9. Week 9 – **Midterm (01-Nov-2022)**
- 10. Week 10 – Bit Shift Instructions-Bottle Line
- 11. Week 11 – Batch Mixing Utilizing Counters
- 12. Week 12 – Dual Compressor
- 13. Week 13 – Multi Floor Elevator or Allen-Bradley PLCs and RSLogix 500

Holidays:

- Fri- Sept 30- National day- college closed (Week 4)
- Mon.-Oct 10 - Thanksgiving - College closed (Week 6)
- Fri.-Nov 11 – Remembrance Day - College Closed (Week 10)

Weeks	Lesson plan
Week 1	(1) Information session: Brief about PLC start up
	(2) Lecture 1: Introduction to PLC
	(3) Lecture 2: PLC Application
	Lab0: Boolean Refresher (Teaching to be done in the lab time slot)
Week 2	(1) Tutorial-Lab start up
	(2) Lecture 3a: Karnaugh Map
	(3) Lecture 3: PLC Programming
	Lab1: Review of Ladder Logic, the LogixPro PLC Simulator, and RSLogix
Week 3	(1) Tutorial
	(2) Lecture 4: BIT Instruction
	(3) Lecture 5-6: Software Usage - Logical Operation
	Lab2: Garage Door Simulation-Exercise 1
Week 4	(1) Lecture 7: Timer Instruction
	(2) Quiz -1
	(3) Holiday
	Lab3: Garage Door Simulation-Exercise 2&3
Week 5	(1) Tutorial
	(2) Lecture 8: Counter Instruction
	(3) Lecture 8: Counter Instruction
	Lab4: Silo System Simulation
Week 6	(1) Lecture 9: Compare Instruction
	(2) Lecture 9: Compare Instruction
	(3) Quiz 2
	Lab5: Traffic Control Exercises utilizing TON (1)
Week 7	(1) Tutorial
	(2) Lecture 10: Subroutine Instruction
	(3) Lecture 10: Subroutine Instruction
	Lab6: Traffic Control Exercises utilizing TON (2)
Week 8	(1) Tutorial
	(2) Lecture 11- 12: MOV Instruction- Math Instruction
	(3) Lecture 11- 12: MOV Instruction- Math Instruction
	Lab7: Traffic Control utilizing Word Comparison
Week 9	(1) Tutorial
	(2) Lecture 13: Sequencer Instruction
	(3) Lecture 13: Sequencer Instruction
	Lab: Midterm (01-Nov-2022)
Week 10	(1) Tutorial
	(2) Lecture 14: Shift Instruction
	(3) Holiday
	Lab8: Bit Shift Instructions-Bottle Line
Week 11	(1) Tutorial
	(2) Lecture 15: Logic Instruction
	(3) Lecture 16-17: Data Conversion Instruction-Analog Control Module

	Lab9: Batch Mixing Utilizing Counters
Week 12	(1) Tutorials
	(2) Lecture 16-17: Data Conversion Instruction-Analog Control Module
	(3) Quiz
	Lab10: Dual compressor
Week 13	(1) Tutorials
	(2) Lecture 18: Interrupts
	(3) Lecture 18: Interrupts
	Lab11: Multi Floor Elevator or Allen-Bradley PLCs and RSLogix 500
Week 14 (Review)	(1) Course review
	(2) Course review
	(3) Course review
	Lab: Makeup Week

5. STUDENT ASSESSMENT (WEIGHTING)

Problem Sets	10%
Quizzes/Tests	15%
Midterm	15%
Final Exam	40%
Total theory	80%
Laboratory Evaluation	20%
Total	100%

*Students must achieve a passing grade in both the theory and lab portions of the course in order to pass the entire course. Lab attendance is compulsory and all labs must be completed satisfactorily to pass this course. 40% of the lab mark will be based on preparation, performance and successful completion of each lab.

*Students must obtain a minimum of 50% in both the theory and practical portions of the course and a minimum of 50% on the final exam.

Note:

- Lab and lecture portions MUST be passed individually.
- Late penalties of 30% per week will be applied at the instructor's discretion.
- Lab attendance is MANDATORY. Failure to attend sufficient labs will result in an F grade.
- Lab grades will not be awarded for missed labs without a valid reason for absence.

6. Grading System

Standard Grading System (GPA)

Competency Based Grading System

7. Recommended Materials or Services to Assist Students to Succeed Throughout the Course

LEARNING SUPPORT AND SERVICES FOR STUDENTS

There are a variety of services available for students to assist them throughout their learning. This information is available in the College Calendar, Student Services or the College web site at <http://www.camosun.bc.ca>

STUDENT CONDUCT POLICY

There is a Student Conduct Policy. It is the student's responsibility to become familiar with the content of this policy. The policy is available in each School Administration Office, Registration, and on the College web site in the Policy Section.

<http://www.camosun.bc.ca/policies/policies.html>

A. GRADING SYSTEMS <http://www.camosun.bc.ca/policies/policies.php>

The following two grading systems are used at Camosun College:

1. Standard Grading System (GPA)

Percentage	Grade	Description	Grade Point Equivalency
90-100	A+		9
85-89	A		8
80-84	A-		7
77-79	B+		6
73-76	B		5
70-72	B-		4
65-69	C+		3
60-64	C		2
50-59	D		1
0-49	F	Minimum level has not been achieved.	0

2. Competency Based Grading System (Non-GPA)

This grading system is based on satisfactory acquisition of defined skills or successful completion of the course learning outcomes

Grade	Description
COM	The student has met the goals, criteria, or competencies established for this course, practicum or field placement.
DST	The student has met and exceeded, above and beyond expectation, the goals, criteria, or competencies established for this course, practicum or field placement.
NC	The student has not met the goals, criteria or competencies established for this course, practicum or field placement.

B. TEMPORARY GRADES

Temporary grades are assigned for specific circumstances and will convert to a final grade according to the grading scheme being used in the course. See Grading Policy at <http://www.camosun.bc.ca/policies/E-1.5.pdf> for information on conversion to final grades, and for additional information on student record and transcript notations.

Temporary Grade	Description
I	<i>Incomplete:</i> A temporary grade assigned when the requirements of a course have not yet been completed due to hardship or extenuating circumstances, such as illness or death in the family.
IP	<i>In progress:</i> A temporary grade assigned for courses that are designed to have an anticipated enrollment that extends beyond one term. No more than two IP grades will be assigned for the same course.
CW	<i>Compulsory Withdrawal:</i> A temporary grade assigned by a Dean when an instructor, after documenting the prescriptive strategies applied and consulting with peers, deems that a student is unsafe to self or others and must be removed from the lab, practicum, worksite, or field placement.