

SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ONTARIO



COURSE OUTLINE

COURSE TITLE: PLC CONTROL SYSTEMS
CODE NO.: ELR223 **SEMESTER:** FOUR
PROGRAM: ELECTRICAL TECHNOLOGY
AUTHOR: R. CHARTRAND
DATE: JAN 2014 **PREVIOUS OUTLINE DATED:** JAN 2013
APPROVED: *“Corey Meunier”*
CHAIR _____
DATE _____
TOTAL CREDITS: FOUR
PREREQUISITE (S):
HOURS/WEEK: FOUR

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I. COURSE DESCRIPTION:

The student will develop an understanding of PLC in general; understand the hardware and software associated with Allen Bradley 5000 family PLCs. PLC programming techniques using RS logic 5000 software will be used to design, document and commission basic to intermediate PLC lab assignments. The student will learn how to interface a PLC to control a Robot as the final Lab Assignment. Basic control theory associated with PLCs will be introduced to assist with lab assignment implementation. This course will require the student to work independently and / or in groups during lab times. The student will also be required to work independently on assigned work outside of class time and access information from help files, manuals, and internet as necessary to solve PLC related work problems. This is to prepare the student for PLC job related tasks.

II. LEARNING OUTCOMES AND ELEMENTS OF THE PERFORMANCE:

Upon successful completion of this course, the student will demonstrate the ability to:

1. *Identify basic PLC hardware and software required for AB 5 PLCs.*

Potential Elements of the Performance:

- State the major advantages of a typical logic controller (PLC) over conventional hardware relay systems
- Identify the four major components of a typical PLC and describe the function of each
- Define the term discrete
- Define the term analog
- Identify different types of programming devices
- Describe the I/O section of a PLC
- Define the term interposing relay
- Define the term optical isolation
- Describe how basic AC and DC input and output modules work

2. *Develop an understanding of basic PLC ladder logic instructions, numbering systems and Demonstrate hardwiring techniques for AB 5000 PLCs.*

Potential Elements of the Performance:

- Describe the proper wiring connections for input devices and their corresponding modules
- Explain why a hard-wire emergency-stop function is desirable
- Describe the function of the PLC's processor
- Identify the two distinct types of memory

- Explain the term on-line programming
- Understand decimal, binary, hexadecimal, binary coded decimal (BCD) numbering systems
- Identify a hard-wiring diagram
- Understand the Examine ON, OFF, timers, counters move, limits test, sequencers and Internal Storage instructions
- Describe basic programming techniques
- Describe the Force On and Off features and hazards that could be associated with both

3. *Develop and demonstrate basic programming techniques for AB 5000 PLCs using RS Logic software.*

Potential Elements of the Performance:

- the ability to program basic PLC functions offline
- the ability to program PLCs to control
- the ability to hard-wire PLCs to field equipment
- the ability to add documentation to a PLC program

4. *Demonstrate the ability to write basic PLC programs to control various electrical equipment in the lab and run the programs in a PLC in the lab.*

Potential Elements of the Performance:

- the ability to download a program to a PLC attached to a PC
- the ability to download a program to a PLC from a remote PC over Ethernet through a gateway server to Data Highway then to a particular PLC in the Lab
- the ability to online edit programs
- the ability to upload a program to a PC from a PLC
- the ability to program basic PLC functions online
- the ability to program PLCs to control Motors, traffic lights, and robot
- the ability to download a program to a local PLC and run a program
- the ability to download a program to a remotely located PLC from room B 1035 to room B 1060 over the Ethernet network to a gateway server to the AB data Highway to a particular PLC and run a program

5. *Demonstrate the ability to connect PLCs to control various electrical equipment in the lab and run the programs in a PLC in the lab.*

Potential Elements of the Performance:

- the ability to hard-wire PLCs to field equipment and I/O cards
- Use available resources such as internet, manuals, help

- files, and handbooks to aid in project troubleshooting
- Apply problem-solving techniques and use the knowledge of computer systems and application software to resolve technical problems associated with PLC assigned projects.
- Use appropriate application software for programming, communication and troubleshooting projects
- Wire, test and configure automation and control systems that maybe required by the assigned projects to be connected to a PLC such as Lights, Motors Control, traffic lights, and robot
- Apply, install, test and troubleshoot PLC project related equipment, systems and tasks

6. *Communicate information effectively and accurately by producing electrical PLC related equipment drawings and other related documentation.*

Potential Elements of the Performance:

- apply standards and standard symbols in the production of drawings
- Use computers and selected tools and equipment to produce or reproduce drawings on CAD
- Use and produce graphics such as single line drawings, schematics etc. as necessary to convey technical information for the associated projects assigned.
- Use available recourses such as internet, manuals, help files and handbooks to aid in accurate project documentation.
- Establish and document procedures required to successfully complete assigned projects
- Document all work and produce a complete project manual

III. TOPICS:

1. Overview of PLC terminology and principles
2. Overview of industrial controls and automation hardware/software.
3. Overview of RS Logic 5000 software
4. Overview of PLC/PC networking.
5. Basic PLC programming.
6. PLC Hardware

IV. REQUIRED RESOURCES/TEXTS/MATERIALS:

Instructor will indicate this in the first theory class

Student RSLogix Software package is required for this course

V. EVALUATION PROCESS/GRADING SYSTEM:**(1) Theory Portion of ELR 223 total 35 marks**

Test 1	15 marks	15% overall
Test 2	20 marks	25% overall

(2) Lab Practical Portion of ELR 223 total 35 marks

Practical Test 1	15 marks	15% overall
Practical Test 2	20 marks	20% overall

(3) Demonstration and Write-up Portion 25 marks

Lab demonstrations	15 marks	15% overall
Lab Write-ups and	10 marks	10% overall
Class Attendance & Participation & Quizzes	5	5% overall

Total 100 marks **100 %**

The following semester grades will be assigned to students in postsecondary courses:

<u>Grade</u>	<u>Definition</u>	<u>Grade Point Equivalent</u>
A+	90 - 100%	4.00
A	80 - 89%	4.00
B	70 - 79%	3.00
C	60 - 69%	2.00
D (Fail)	50 - 59%	1.00
F (Fail)	49% and below	0.00
CR (Credit)	Credit for diploma requirements has been awarded.	
S	Satisfactory achievement in field /clinical placement or non-graded subject area.	
U	Unsatisfactory achievement in field/clinical placement or non-graded subject area.	
X	A temporary grade limited to situations with extenuating circumstances giving a student additional time to complete the requirements for a course.	
NR	Grade not reported to Registrar's office.	
W	Student has withdrawn from the course without academic penalty.	

In order to maintain a passing grade the student must obtain a minimum 50% average in all subject sections that the course may have, such as, the (1) theory Tests section, (2) Practical Tests section, Lab & (3) Lab Write-ups and (4) Demonstrations of Labs section. All labs must function safely and correctly to be evaluated. The student must demonstrate all labs regardless of mark value to pass the course. Failure to demonstrate all correctly functioning labs will result in student being assessed F grade for ELR 223.

VI. SPECIAL NOTES:

Attendance

Sault College is committed to student success.

There is a direct correlation between academic performance and class attendance; therefore, for the benefit of all its constituents, all students are encouraged to attend all of their scheduled learning and evaluation sessions. This implies arriving on time and remaining for the duration of the scheduled session. **It is the departmental policy that once the classroom door has been closed, the learning process has begun. Late arrivers will not be granted admission to the room.**

General Information to include in course outlines**Classroom Etiquette:**

Pagers and cell phones should be either turned off or set to vibrate mode during class. Please show courtesy to the class by restricting conversation to in-class topics, and raise your hand to gain attention when asking a question or raising a point of discussion.

Class Room Safety:

Safety is the most important aspect in this course and any compromise in student safety by any other student will not be tolerated. Students that observe any unsafe lab condition and/or act must report it to the instructor immediately. Student safety in the Labs is the number one priority. Students are to contact the instructor before working on any live equipment that they are not familiar with or have not been instructed in the safety procedures of that particular equipment.

Turning in Work :

Be sure to include your name and the course name and section on all work to be turned in.

Late Coursework :

All assignments are to be turned in on the due date. Students may be allowed to make up any late work at the instructor's discretion.

Term tests/quizzes

With the expectation that the student will attend all classes, there will be no make up tests for missed tests. There will be no rewrites for low-test scores.

Attendance

Students' attendance and participation are required in all activities. If a student is absent from class, it is her/his responsibility to find out what was missed prior to the next class and complete any assigned work **before** the next class.

Absence does not constitute a reason for missed work or late assignments.

ADDITIONAL:

Since all final work must be performed on special network PLCs located at the college, there is limited time to run tested and demonstrated labs at the college, therefore reading, review questions, planning and offline programming must be done outside of class time. All student assignment materials that are not picked up by the student will be held for a maximum of two weeks after grading. After this time materials may be discarded or used at the professor's discretion.

Attendance may be monitored. Regular absentia may be reported to OSAP at the college's discretion.

Special Note:

All Students enrolled in ELR 223 will be required to purchase Notes and Labs package from the Sault College Book Store and also purchase a special RSLogix Student Software package from Westburne Ruddy Electric located on 64 White Oak Dr. Sault Ste. Marie before the first lab period for ELR 223. Instructor will inform the students in the first class about costs and other information about the above items.

Note: Student RSLogix Software package is required for this course!

In order to maintain a passing grade the student must obtain a minimum 50% average in all subject sections that the course may have, such as, the (1) theory Tests section, (2) Practical Tests section, Lab & (3) Lab Write-ups and Demonstrations of Labs section.

In order to have a mark assigned to the write-ups the student must produce attach the lab demonstration sign off sheet with all labs assigned off by the instructor as completed to the write-up book.

If a student misses a test he/she must have a valid reason (e.g. medical or family emergency). In addition, the school must be notified before the scheduled test sitting.

The student should contact the instructor involved. If the instructor cannot be reached leave a message with the Dean's office or the College switchboard. If this procedure is not followed the student will receive a mark of zero on the test with no rewrite option.

The Instructor, if time permits, will summarize the main points of this course outline in the first Lecture. Student's questions related to the course outline will be addressed at that time. The Instructor through out the course may also expand on particular items related to the course outline and the course requirements.

It is the responsibility of the student to read the course outlines and be aware of the course requirements.

Sault College email account:

Students are expected to maintain an active Sault College email account. They are further required to check this email account daily. The instructor may announce details of lab and test requirements and scheduling through the Sault College email system (as well as sharing other important information).

ELR 223 TABLE OF CONTENTS

LAB # 1 to 7 INTRODUCTION TO RS LOGIC 5000 & programming

1. Familiarization to B 1050 Lab Environment and Equipment
2. Familiarization with RS LOGIC 5000.
3. Familiarization with programming PLCS with RS logic 5000
4. Development Contrologix 5000 Programs offline and online
5. Connect through hardwiring Contrologix 5000 hardware I / O

LAB# 8a & 8b THREE (3) MOTORS

1. Familiarization with programming RS logic 5000 basic instructions
2. Development Contrologix 5000 Programs offline and online
3. Connect through hardwiring Contrologix 5000 hardware I/O

LAB # 9a & 9b FORWARD & REVERSING A MOTOR

1. Familiarization with programming Contrologix 5000 with RS logic 5000 basic instructions
2. Development Contrologix 5000 Programs offline and online
3. Connect through hardwiring Contrologix 5000 hardware I/O

LAB # 10, 11a, 11b TIME STARTING OF Three (3) MOTORS

1. Familiarization with programming Contrologix 5000 with RS logic 5000 timer instruction,
2. Development Contrologix 5000 Programs offline and online
3. Connect through hardwiring Contrologix 5000 hardware I/O

LAB # 12a,b,c,d TIME STARTING OF SIX (6) MOTORS

1. Familiarization with programming PLCS with RS logic 5000 timer & counter instruction,
2. Development Contrologix 5000 Programs offline and online
3. Connect through hardwiring Contrologix 5000 hardware I/O

LAB # 13a TIME STARTING OF SIX (6) MOTORS USING LIMIT TEST AND A TIMER

1. Familiarization with programming Contrologix 5000 with RS logic 5000 limit test instructions
2. Development Contrologix 5000 Programs offline and online
3. Connect through hardwiring Contrologix 5000 hardware I/O

LAB # 13b TIME STARTING OF SIX (6) MOTORS USING SEQUENCER AND A TIMER

1. Familiarization with programming PLCS with RS logic 5000 sequencer output instructions
2. Development Contrologix 5000 Programs offline and online
3. Connect through hardwiring Contrologix 5000 hardware I/O

LAB # 14A TRAFFIC LIGHTS WITH DELAYED REDS USING TIMERS

1. Familiarization with programming Contrologix 5000 with RS logic 5000 Advance timer instructions
2. Development Contrologix 5000 Programs offline and online
3. Connect through hardwiring Contrologix 5000 hardware I/O

LAB # 14B TRAFFIC LIGHTS WITH DELAYED REDS USING A TIMERS AND LIMIT TEST

1. Familiarization with programming Contrologix 5000 with RS logic 5000 limit test& timer instructions
2. Development Contrologix 5000 Programs offline and online
3. Connect through hardwiring Contrologix 5000 hardware I/O

LAB # 14C TRAFFIC LIGHTS WITH DELAYED REDS, FLASHING GREEN LIGHTS USING A TIMERS AND SEQUENCERS

1. Familiarization with programming Contrologix 5000 with RS logic 5000 advance sequencer instructions
2. Development Contrologix 5000 Programs offline and online
3. Connect through hardwiring Contrologix 5000 hardware I/O

LAB # 15 A HMI FOR 1 MOTOR START/STOP

1. Familiarization with programming Contrologix 5000 with RS logic 5000 and RSView 32 & output instructions
2. Development Contrologix 5000 Programs offline and online
3. Connect through hardwiring Contrologix 5000 hardware I/O & HMI

LAB # 15 B HMI FOR 3 MOTOR START/STOP

1. Familiarization with programming Contrologix 5000 with RS logic 5000 and RSView 32 & output instructions
2. Development PLCS Programs offline and online
3. Connect through hardwiring PLCS hardware I/O

LAB # 15 C Creating a Trend Graph in RSLogix 5000 Software

1. Familiarization with programming PLCS with RS logic 5000 trending
2. Development PLCS Programs offline and online
3. Connect through hardwiring PLCS hardware I/O

LAB # 16 HERCULES ROBOT USING INPUT AND OUTPUT SEQUENCERS

1. Familiarization with programming PLCS with RS logic 5000 advance sequencer input & output instructions
2. Development PLCS Programs offline and online
3. Connect through hardwiring PLCS hardware I/O

General Lab Requirement for Write Ups

Lab 1 and Lab 2 require no write ups, the student only has to demonstrate these labs to the instructor and have them signed complete on their sheet.

Lab 1 through and including Lab 15 require write ups as outline below

- 1) Labs shall have a ladder logic diagram print out including all necessary rung by rung documentation such as addressing, instruction name and rung functions etc.
- 2) Labs shall have a hardwire **schematic** CAD diagram of PLC and related equipment.
- 3) Labs shall have an AutoCAD **wiring diagram** of the complete lab including all Associated equipment Racks. Lights, switches, and wires.
- 4) Labs shall have an I / O listing
- 5) Labs shall have a brief description of operation and function in the student own words, typed in a word processor.
- 6) All labs assignments must be turned in on hard copy and on computer disk before or no later than the last lab class of the semester. The disk will contain all programs, drawing in AutoCAD and word processor work.
- 7) Labs must be computer generated and labs that require tables shall be done in a spread sheet or in a word processor the can produce a table. **Hand written reports will not be accepted.**
- 8) Each lab may have specific requirement so read each lab carefully.
- 9) If the student is not clear on any of the requirements, it is his/her's responsibility to ask the instructor for clarification.
- 10) **All lab reports are to include a title page with the following information**
 - **Lab title and number**
 - **Date Completed**
 - **Names of group members**
 - **Instructor's name**
- 11) Lab reports are to include all procedures, diagrams and observation etc required in this course outline for the lab write-up to be complete. The labs are to be in the order they were performed / demonstrated and numbered to match the lab handouts.
- 12) Every lab report is to conclude with a summary (whether requested in the lab document or not.) The summary is to be up to 1 page maximum (double spaced, Arial size 12 founts, maximum 1 inch margins) in length and is to be an analysis of the results that will include quantifying basic technical problems that may have

occurred during the project (assigned lab), formulating alternative solution to these technical problems and suggesting possible optimal solutions. The summary is not to be a regurgitation of the results, it is expected that the student will use course notes, library resources and the internet research to assist in writing lab summaries.

Labs submitted with a substandard summary will receive a grade of 0 (zero).

13) One lab report submission per group. Maximum 2 per group.

NOTE:

You must pass all sections of the course, theory, and the Lab portions of ELR 223 course to obtain a passing grade in this course. If the student passes all sections, the final mark will be the mark as state for each section added together for the final mark. That is the theory mark, and lab (Practical tests, Demos & Write-ups)marks will be added with the 5% Class Participation / quiz mark to arrive at a final student average for this course. If the student fails theory or lab section of this course he/she will receive an F grade (failing grade).

Methods of Evaluation

Demonstration of Labs, Lab write-ups and tests etc. will constitute a total of 100% of your ELR 223 course mark. The distribution of marks is as stated in the previous pages.

NOTES:

- Attendance is compulsory and may be taken each and every lab class or at random.
- Two percent per lab class will be deducted for each schedule lab class missed without permission by a student from his final grade up to a maximum of 30%.
- Every student will be allowed to miss only one lab class without a doctor's slip without any marks being deducted for that missed lab class.
- Students missing more than 1 lab class must have a doctor's slip or the 2% per missed lab class will be deducted from his/her's final lab mark.
- Example the second miss lab class will result in the student having 2% deducted from his/her's final lab grade, e.g. Final mark of 100 % - 2% = 98% or 65% - 2%= 63%
- Students missing any lab classes will still be responsible to have the particular lab completed, not simply copied from other student. You must indicate to the instructor when you plan to do the lab, you will be responsible for making arrangements to complete the lab and demonstrate it to the instructor.
- All drawings or diagrams must be done in AutoCAD or instructor approved drawing program.
- All labs will contain the material that was stated in previous pages
- All labs must be demonstrated and signed off by instructor before any of the labs write up can be marked.
- The Lab completion sign off sheet must be in the front of the lab write-up book. When write-up are turned in for marking
- All labs must be turned in, in a binder, in order, by the last lab class of the course for marking. The labs turned in after this time will be deducted 5% per day late. No labs will be accepted for marking after the Friday noon of the last week of classes. No labs turned in will result in the student obtaining an F (fail) grade
- All labs must be signed by the instructor at the completion of each and every lab shop portion during the schedule lab class. Therefore when you have completed the lab steps and demonstrated the lab to the instructor, he/she will sign the lab and you may proceed with the next lab assignment. Auto Cad drawings, and all other lab requirements must be met before the labs can be handed in for marking.
- The student must demonstrate all lab projects assigned to the instructor to his/her satisfaction before the student can have the lab project signed by the instructor as being complete.
- The instructor may alter or give particular instructions, or additional instructions on a per lab bases

REMEMBER:

Read all labs completely and any additional material that is included or handed out by the instructor that pertains to the labs. The student is responsible to make sure that he / she have read all material pertaining to a lab before starting the lab.

ALL students must **Demonstrate all labs** to the instructor and have the instructor sign your sheet that each lab was completed successfully. The sheet will be given to you by the instructor during the first lab period.

Note: the sheet discussed above must be turned in with the lab write ups during the last lab class of the semester with all labs signed on the sheet and demonstrated to the instructor.

Again : All labs must function safely and correctly to be evaluated. The student must demonstrate all labs regardless of mark value to pass the course. Failure to demonstrate all labs will result in student being assessed F grade for ELR 223.

If the sheet is not with the lab write ups. The write ups will not be accepted for marking until the student re-demonstrates selected labs which the instructor will select as proof that the student has successfully completed the practical parts of the labs. The student will have to make arrangements with the instructor for a time to demonstrate his/her practical skill. If the student is successful in the practical demonstration his/her labs will be evacuated as if the student had turned in their signed sheet.

**YOU ARE RESPONSIBLE FOR YOUR SHEET
NO EXCUSES WILL BE ACCEPTED**

Student Evaluation Sheet

Student's name

<u>Due Date</u>	<u>Lab #</u>	<u>Description</u>	<u>Demo Mark</u>	<u>Instructors Signature</u>	<u>Write-up mark</u>
Jan 17	1-7	Intro Labs 1 to 7	7mk	1,2,3,4,5,6,7	7mk
Jan 24	8a -8b	3 Motors	4mk	8a, 8b	4mk
Jan 31	9a -9b	F & R A Motors	4mk	9a, 9b	4mk
Feb 7	10,11a-b	Both Push On / Push Off , 3 Motor Time Start and	6mk	10, 11a, 11b	6mk
Fe 14	12a, 12b	Time Starting 6 Motors	6mk	12a, 12b	6mk
Fe 21	12c 12d	Time Starting 6 Motors	8mk	12c, 12d	8mk
Feb 28	13a	Starting 6 Motors Using Limit Test etc	5mk	13a	10mk
Final Dealine For the These labs	1,2,3,4,5, 6,7,,8ab 9ab,10, 11ab, 12abcd,13a	All labs 1 through 13a must be demo by Mar 7 to receive the demo mark associated with the above labs.		Failure to demo working labs will result in a grad of zero for labs not demonstrated	
	Mar 7	Practical test	xxxxxx	XXXXXXXXXXXXXXXXXXXX	xxxxxx
	Mar 10	Break	xxxxxx	XXXXXXXXXXXXXXXXXXXX	xxxxxx
Mar 21	13b	Starting 6 Motors Using Sequencer Output etc	15mk	13b	15mk
Mar 28	14a	Traffic Lights with timers	10mk	14a	10mk
Apr 4	14b	Traffic Lights Limit Test	10mk	14b	10mk
Apr 11	14c	Traffic Lights Sequencers	10mk	14c	10mk
Apr 18	15 a,b,c	HMI for 1 Motor Start/Stop & HMI 3 Motor Start & Creating Trend	15mk	15a,15b,15c	10mk
Final Dealine For the These labs	13b,14abc 15abc	All labs 13a through 15c must be demo by April 25 to receive the demo mark associated with the above labs.		Failure to demo working labs will result in a grad of zero for labs not demonstrated	xxxxxx
		Total Marks	100mk		100 Mk

Note All Labs must be demonstrated to instructor on or before the last lab class of the semester . All labs must operate safely and correctly and too the satisfaction of the instructor. Any labs not demonstrated or deemed incomplete or not correctly functioning by final due date will result in the student receiving an F grade for this course. Again ALL LABS MUST BE COMPLETE AND DEMONSTRATED.

STUDENT COURSE AGREEMENT (Please print)

I, _____ student ID # _____
with regards to the course known as ELR 223 PLC CONTROL SYSTEMS
COURSE CODE # **ELR 223** have read and understood the course content,
outline and expectations which clearly states the following:

- 1- Absolutely no make up tests or exams will be administered with the exceptions of personal illness or death of an immediate family member both requiring written verification.
- 2- All labs must be handed in by the due date or a grade of **0** will be awarded.
- 3- Lab & lecture attendance are compulsory. Any lecture notes, lab assignments etc. missed will become the student's responsibility to retrieve from another student.
- 4- Lab or lecture quizzes can be presented at anytime without prior notification.
- 5- All Labs must be completed during assigned Lab times unless prior approval is obtained from the instructor.
- 6- Students must be able to demonstrate labs that are assigned by the instructor after the due date if requested by the instructor. Each student must be sure that he / she can duplicate the lab that they turned in on or before the due date. If the student cannot duplicate the lab to the satisfaction of the instructor, a grade of **0%** will be assessed to that particular lab. Demonstration request will be at the discretion of the instructor.
- 7- In order to maintain a passing grade the student must obtain a minimum 50% average in all subject sections that the course may have, such as, the theory Tests section, Practical Tests section, Lab & Lab Write-ups and Demonstrations of Labs to Instructor section
- 8- Students are not permitted to work on live equipment outside of regular class time.
- 9- Students must supply their own hand tools, meters and safety glasses. Students will not be permitted in the lab without PPE and the student must wear the PPE whenever working on live equipment. Students must never work alone in the lab. Unsafe work habits, improper behavior will not be tolerated.
- 10- I have read and understand the requirements outlined above and in the course outline.

(Student's Signature)

(Date)