SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ONTARIO

Sault College

COURSE OUTLINE

COURSE TITLE:	**PLC CONTROL SYSTEMS**

CODE NO.:	**ELR 223**	**SEMESTER:**	Four

PROGRAM:	**ELECTRICAL TECHNOLOGY**

AUTHOR:	**R. CHARTRAND**

DATE:	**4/2/2007**	**PREVIOUS OUTLINE DATED:**	**08/2004**

APPROVED:

_____ _____
                                                          DEAN   **DATE**

TOTAL CREDITS:	4

PREREQUISITE (S):

HOURS/WEEK:	4 hours per Week

I.   COURSE DESCRIPTION:

The student will develop an understanding of PLC in general; understand the hardware and software associated will Allen Bradley 5 family PLCs. PLC programming techniques using RS logic 5 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.

II.   LEARNING OUTCOMES AND ELEMENTS OF THE PERFORMANCE:

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

1.   **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.   **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. **Potential Elements of the Performance:**
Develop and demonstrate basic programming techniques for AB 5 PLCs using RS Logic software
   - ❑ the ability to program basic PLC functions offline
   - ❑ the ability to program PLCs to control
   - ❑ the ability to hard-wire PLCs to field equipment and 110 cards
   - ❑ the ability to add documentation to a PLC program

4. **Potential Elements of the Performance:**
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
   - ❑ 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 down toad a program to a local PLC and run a program
   - ❑ the ability to down load 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. **Potential Elements of the Performance:**
Demonstrate the ability to connect PLCs to control various electrical equipment in the lab and run the programs in a PLC in the lab
   - ❑ the ability to hard-wire PLCs to field equipment and I/O cards
   - ❑ the ability to wire PLCs to control Motors, traffic lights, and robot

6. **Potential Elements of the Performance:**
   - •

III.   TOPICS:
1. Overview of PLC terminology and principles
2. Overview of industrial controls and automation hardware/software.
3. Overview of RS Logic 5 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

V. EVALUATION PROCESS/GRADING SYSTEM:

Test 1	15 marks	15% overall
Practical Test 1	15 marks	15% overall
Test 2	25 marks	25% overall
Practical Test 2	25 marks	25% overall
Lab demonstrations	5 marks	5% overall
Lab Write-ups and	10 marks	10% overall
Class Participation & Quizzes	5	5% overall
Total 100 marks		**100 %**

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

Grade	Definition	Grade Point Equivalent
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.	

VI.   SPECIAL NOTES:

<u>**Special Needs**</u>:
If you are a student with special needs (e.g. physical limitations, visual impairments, hearing impairments, or learning disabilities), you are encouraged to discuss required accommodations with your instructor and/or the Special Needs office. Visit Room E1204 or call Extension 493 so that support services can be arranged for you.

<u>**Retention of course outlines:**</u>
It is the responsibility of the student to retain all course outlines for possible future use in acquiring advanced standing at other postsecondary institutions.

<u>**Plagiarism:**</u>
Students should refer to the definition of "academic dishonesty" in *Student Rights and Responsibilities*. Students who engage in "academic dishonesty" will receive an automatic failure for that submission and/or such other penalty, up to and including expulsion from the course/program, as may be decided by the professor/dean. In order to protect students from inadvertent plagiarism, to protect the copyright of the material referenced, and to credit the author of the material, it is the policy of the department to employ a documentation format for referencing source material.

<u>**Course outline amendments:**</u>
The Professor reserves the right to change the information contained in this course outline depending on the needs of the learner and the availability of resources.

Substitute course information is available in the Registrar's office.

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.

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).

General Information to include in course outlines
Special Accommodations:
If you have a special learning need or issue, it works to your advantage to notify your instructor <u>immediately</u> if special devices or assistance will help you in this class.
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 **<u>before</u>** 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.

VII.   PRIOR LEARNING ASSESSMENT:

Students who wish to apply for advanced credit in the course should consult the professor. Credit for prior learning will be given upon successful completion of a challenge exam or portfolio.

VIII.   DIRECT CREDIT TRANSFERS:

Students who wish to apply for direct credit transfer (advanced standing) should obtain a direct credit transfer form from the Dean's secretary. Students will be required to provide a transcript and course outline related to the course in question.

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.

ELR 223
TABLE OF CONTENTS

COURSE NAME   COURSE NUMBER
PLC CONTROL SYSTEMS   ELR 223

LAB # 8 TRAFFIC LIGHTS WITH DELAYED REDS USING A TIMERS AND LIMIT TEST

1.   Familiarization with programming PLCS with RS logic 5 limit test& timer
         instructions
2.   Development PLCS Programs offline and online
3.   Connect through hardwiring PLCS hardware I/O

LAB # 9 TIME STARTING OF SIX (6) MOTORS USING SEQUENCERS

1.   Familiarization with programming PLCS with RS logic *5* sequencer instructions
2.   Development PLCS Programs offline and online
3.   Connect through hardwiring PLCS hardware 1/0

LAB # 10 TRAFFIC LIGHTS WITH DELAYED REDS, FLASHING GREEN LIGHTS USING A TIMERS AND SEQUENCERS

1.   Familiarization with programming PLCS with RS logic 5 advance sequencer
         instructions
2.   Development PLCS Programs offline and online
3.   Connect through hardwiring PLCS hardware 1/0

LAB # 11 A TANK FILLING PROCESS THOUGH LEVEL LIMIT SWITCH CONTROL USING INPUT AND OUTPUT SEQUENCERS

1.   Familiarization with programming PLCS with RS logic 5 sequencer input &
         output instructions
2.   Development PLCS Programs offline and online
3.   Connect through hardwiring PLCS hardware I/O

LAB # 12 HERCULES ROBOT USING INPUT AND OUTPUT SEQUENCERS

1.   Familiarization with programming PLCS with RS logic *5* advance sequencer
         input & output instructions
2.   Development PLCS Programs offline and online
3.   Connect through hardwiring PLCS hardware 1/0

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 3 through and including Lab 12 require write ups as outline below

1) Labs shall have a ladder logic diagram print out including documentation for both the Emulation portion and actual PLC running portion of the lab

2) Labs shall have a hardwire schematic diagram

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 1 page (double spaced, Arial size 12 founts, maximum 1 inch margins) in length and is to be an analysis of the results. 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.

You must pass all sections of the course, theory, the demonstration part of the course and the write up portion of the 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 demonstration marks will be added with the write up marks to arrive at a final student average for this course. If the student fails any one 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
 - ➢ 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 a the material that was stated in previous pages
 - ➢ All labs must be turned in, in a binder, in order, the second last week of the course up to Friday noon for marking. The labs turned in after this time will be deducted 2% per day late. No labs will be accepted for marking after the last lab class of the semester. 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 has read all martial 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**.**

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

Lab #	_Description_	_Demo Mark_	_Instructors Signature_	_Write-up mark_
1	**Intro**	0mk		NA 0mk
2	**Start-Stop Light**	0mk		NA 0mk
3	**3 Motors**	3mk		4mk
4	**F & R A Motors**	6mk		4mk
5	**Time Starting 6 Motors**	10mk		10mk
6	**Traffic Lights Using Timers**	8mk		7mk
7	**Starting 6 Motors Using Limit Test**	8mk		10mk
8	**Traffic Lights Limit Test**	7mk		10mk
9	**Starting 6 Motors Using Sequencers**	12mk		10mk
10	**Traffic Lights Sequencers**	12mk		10mk
11	**Tank Filling Process Using I/P & O/P Sequencers**	15mk		15mk
12	**Robot using I/P & O/P Sequencers**	15mk		20mk
	Total Marks	100 Mk		100 Mk

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 form 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 safety glasses and the student must wear
        the safety glasses 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 requires outlined above and in the course outline.

_____   _____
              (Student's Signature)   (Date)