

SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ONTARIO



Sault College

COURSE OUTLINE

COURSE TITLE: AUTOMATIC CONTROL SYSTEMS

CODE NO.: ELR 315 **SEMESTER:** Six

PROGRAM: ELECTRICAL TECHNOLOGY

AUTHOR: R. CHARTRAND

DATE: 4/2/2007 **PREVIOUS OUTLINE DATED:** 01/2006

APPROVED: _____
DEAN DATE

TOTAL CREDITS: 6

PREREQUISITE (S):

HOURS/WEEK: 6 hours per Week

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I. COURSE DESCRIPTION:

The student will develop an understanding of control system integration of equipment such as different PLCs, HMIs, analog / discrete cards, communication interfaces for instrumentation Process Control, Drive Control and Industrial Networks. Advanced PLC techniques using Allen Bradley PLC5&500 and the Contrologic 5000 family PLCs will be used to connect, commission and document individual sections and components of an automated control system. The student will program PLC 5 and Contrologic 5000 using advanced instruction, program files and utilize the trending and troubleshooting features of the software programs. The student will interface PLCs to control a level loop with a Master / Scanner PLC 5 and communicate calculated set points to Adaptor / Slave PLCs controlling flow loops and pressure loops. The student will interface PLCs to control drives & robotic equipment through analog and direct communication and using encoders or tach. feedback. The student will develop advance HMI programs to run each project including trending and troubleshooting screens. The student will be introduced to DeviceNet, ControlNet, & Ethernet IP networks and components. The student will also be introduced to functional block and SFC programming techniques.

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:

Assist in the design of a variety of control systems.

- Utilize block diagrams to model basic Networked control systems
- Identify different industrial network systems such as DeviceNet, ControlNet, DH+, and Industrial Ethernet etc.
- Basic Setup and installation of industrial networks
- Purpose and use of the above industrial networks
- Restrictions and imitations of the above industrial networks

2. Potential Elements of the Performance:

Develop and demonstrate animated graphic for HMI displays and advance programming of HMI screens

- The ability to program animated graphic screens for HMI
- The ability to program HMI to display various variables in both digital and animated forms
- The ability to set-up animated control functions on HMI graphic screens

3. Potential Elements of the Performance:

Develop advance PLC programs to control various electrical

equipment

- The ability to program PLCs and HMI to control Motor Drives, AC Variable Frequency Drives and Soft-starts
- The ability to program PLCs and HMI to retrieve and display motor control functions and operational data
- The ability to connect PLCs in Scanner mode (master) or adapter mode (slave) to transfer or retrieve information from smart equipment through either Peer to Peer or Remote I/O communications

4. **Potential Elements of the Performance:**

Assemble and connect a variety of automated equipment to perform process control and to develop Process Control PLC programs and HMI control and data acquisition

- The ability to program PLCs to control two and three loop processes (cascading)
- The ability to program HMI (RS View) to Control Two and Three Loop Process with PLCs

5. **Potential Elements of the Performance:**

Assemble and connect a variety of electrical automated equipment to perform as integrated systems utilizing task and control through HMI software and PLC Hardware and Smart equipment

- The ability to program PLCs, HMI, to perform selected tasks over different networks from local and remote locations
- The ability to program, connect PLCs, HMI, and control process control loops and smart equipment through Ethernet and DH+ Protocols from remote locations
- The ability to connect and implement basic safety circuits and requirements for control systems.
- Select and connect several different types of electrical equipment such as Motor Drives, PLCs, Process Control Equipment, HMIs along with sensing device and output power devices into a structured unified controlled system performing simulated tasks

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

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III. TOPICS:

1. Overview of Industrial Network control terminology and principles.
2. Overview of industrial controls and automation hardware/software.
3. Overview of Data Collection & Graphing software.
4. Overview of PLC/PC networking.
5. Advanced PLC programming Function Block, & Grafset.
6. Motor drive control with PLCs. And HMI software
7. Introduction to multiple process control and system integration control, interconnection and operation.
8. Overview of Tuning Software RSTune.
9. Overview of Excel and RSLogic software.

IV. REQUIRED RESOURCES/TEXTS/MATERIALS:

Instructor will indicate this in the first theory class

V. EVALUATION PROCESS/GRADING SYSTEM:

Test Theory & or practical	15 marks	15% overall
Assigned Projects & Lab demonstrations	50 marks	50% overall
Lab Write-ups	30 marks	30% overall
Class Participation & etc.	5 marks	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	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:Special Needs:

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.

Retention of course outlines:

It is the responsibility of the student to retain all course outlines for possible future use in acquiring advanced standing at other postsecondary institutions.

Plagiarism:

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.

Course outline amendments:

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, Projects & Project Write-ups and Demonstrations of Projects 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 throughout 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.

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 immediately 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 before the next class. Absence does not constitute a reason for missed work or late assignments.

ADDITIONAL:

Since all work must be performed on special network computer software located at the college, there will be little opportunity to work on the projects at home. The reading, review questions, and planning 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.

ELR 315

TABLE OF CONTENTS EQUIPMENT

6	SLC 500, 2–504, 3-503, 1–502
4	analog in and out
3	panel mates
5	input and output sets
1	scanner card
1	DMC card
6	Link couplers RS 485
3	1336
2	1336 plus
2	1305
4	G2 Interfacing Cards
5	Powerfex 70 AC Drives
3	smc with 2 interfaces discrete
1	smc remote I/O
1	SMC with built in discrete interface
10	AB 5 Family Processors and Rack with 24 VDC Discrete I/O
4	Analog In and also Out Cards for the AB 5 Processors
10	PLC 5000 and associated hardware and software

Review HMI software and other software that instructor will discuss in class

Programming Requirements For Both PLC and HMIs

- 1) PLC programs shall have all logic programming in other program files not in main. Only jumps and necessary programming will be done in the main file.
- 2) PLC programs will have a minimum of 1 sub program file for each project
- 3) HMI Projects shall have a cover display page naming project and student name and other necessary information / control, analog display page, a digital display page and a Trend page minimum for each project.
- 4) HMI's will include animation in all projects.

General Lab Requirement for Write Ups

ALL Projects require write ups as outline below

- 1) Projects shall have a ladder logic diagram print out including documentation for both the Emulation portion and actual PLC Running portion of the lab
- 2) Projects shall have a hardwire schematic diagram
- 3) Projects shall have an AutoCAD wiring diagram of the complete lab including all associated equipment, Racks. Lights, switches, and wires.
- 4) Projects shall have an I / O listing
- 5) Projects shall have a brief description of operation and function in the student own words, typed in a word processor.
- 6) All Projects 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) Projects must be computer generated and labs that require tables shall be done in a spreadsheet or in a word processor the can produce a table. Hand written reports will not be accepted.
- 8) Each Project may have specific requirement so read each Project 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**
 - **Project title and number**
 - **Date Completed**
 - **Names of group members**
 - **Instructor's name**
- 11) Project 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 Project 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 fonts, 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 Project reports submission per group. Maximum 2 per group.
- 14) Note: All project write-ups must contain a ms-project 2 Gantt Chart (one for projected time for all project elements & one for actual time taken for each project element). Also each project will contain a flow chart that shows project operation from start to finish and another flow chart for troubleshooting the project.

Methods of Evaluation

Demonstration of Labs, Lab write-ups and tests etc. will constitute a total of 100% of your ELR 315 course mark. The distribution of marks are 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 doctors slip without any marks being deducted for that missed lab class.
- Students missing more than 1 lab class must have a doctors 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 Projects 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 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. 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

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).

Student Lab Evaluation Sheet

Student's Name _____ Mark out of 200= 200

NOTE: Each student must turn in his/her own sheet with each Project demonstration verified by the instructor signature. If the student does not turn the sheet with all Projects signed by the instructor the write-up will not be marked.

Lab #	Description ALL labs Must have HMI control and screens associated with it	Demo Mark	Instructor's Signature	Write-up Mark
1	PLC Communications and control of a AB 1336 VFD through discrete and analog control use HMI control animated and operational data display ,ask instructor which processor your group will use before you start	10		10
2	PLC Communications and control of a AB 1336 or other AC drives through direct communication as a smart I/O using an interfacing or other adapter cards use HMI control animated and operational data display ,ask instructor which processor your group will use before you start	10		10
3	PLC 5 in master / slave config. Connect the three instrumentation loops (level, pressure, & flow) to simulate a process. Instructor will discuss this project in the class. Use HMI control animated and operational data display along with RSTUNE	20		20
4	PLC-5000 Communications and control of a AB powerflex 70 through direct communication as a Ethernet IP and controlnet adaptor interface cards and use HMI control animated and operational data display	20		20
5	PLC 5 in master / slave config. Connect the 16 Pushbutton ReadyPanel as a remote I/O. Use HMI control animated and operational data display .Repeat this project again using the SLC 504 and then with the Contollogix 5000	15		15
6	Instructor will assign a project that the student must, demonstrate to the instructor and write-up in step-by-step detail. You will also present this project explain and demonstrate it to the other members of the class	25		25
7				
8				
	Total Marks	100		100

Note: Instructor will assign the student (s) to project 6. Instructor will assign the student (s) to groups for projects (labs) 1,2,3,4& 5 as outlined above

STUDENT COURSE AGREEMENT (Please print)

I, _____ **student ID #** _____
with regards to the course known as ELR 315 Automation Control Systems
COURSE CODE # **ELR 315** 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 Projects 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, Project 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 Projects that are assigned by the instructor on or before the due date if requested by the instructor. Each student must be sure that he / she can duplicate the Project that they turned in on or before the due date. If the student cannot duplicate the Project to the satisfaction of the instructor, a grade of 0% will be assessed to that particular Project. 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, Projects & Project Write-ups and Demonstrations of Projects 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 requirements outlined above and in the course outline.

(Student's Signature)

(Date)