

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 Basic Industrial Networks. Advanced PLC techniques using Allen Bradley PLC5 family and the SLC 500 family PLCs will be used to connect commission and document individual sections and components of an automated control systems and basic Industrial Network again using Allen Bradley equipment. The student will program PLCs using advanced instruction and utilize the trending and troubleshooting features of the software programs. The student will interface PLCs to form the bases to communicate to other PLCs and remote equipment such as industrial drives, ready panels, etc in master/slave(scanner/adaptor) configurations. and process control loops both The PLC controllogix 5000 will be introduced for basic discrete & analog control to prepare the student for advance use of the 5000 PLC in the sixth semester. The student will also set-up hardware, develop programs to enable PLCs to analog information and to configure and test PID instructions **This course will require the student to work independently and / or in groups (team) during lab times. The student will also be required to work independently or in a team structure 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. ***Understand various Basic Terminology, Concepts of a PLC Control and functions of AB PLC5, 500, and 5000***

Potential Elements of the Performance:

- Identify and list the equipment and components that make up a basic automated control system network
- Integrate a variety of PLC
- Use available recourses such as internet, manuals, help files, and handbooks to aid in selecting, installing commissioning, testing and troubleshooting appropriate equipment, components for projects assigned.
- Identify and state the function of components of the SLC 500/ 5000 Family PLCs
- State the function, operation and set-up of analog cards used on PLC 5, 5000 and SLC 500 series PLC
- Discuss the function, advantages, and limitations of PLCs in Industrial Process Control Loops.
- Discuss the basic communication functions of PLC 5, 5000 and 500

- Discuss the function of PID in the PLC software control blocks for the PLC 5, 5000 and SLC 500 series PLCs.
- State the difference between Remote I/O, Adaptor Mode, and Scanner Mode, Master/Slave operation of PLCs and their interfaced components
- Discuss the function of Message block commands used in Peer-to-Peer Communications for PLC 5, 5000 and Slick 500 series PLCs.

2. *Develop various Basic and advance programs to control PLC's functions through different programming structures such as address based structure and Tag based structure for AB PLC5, 500, and 5000*

Potential Elements of the Performance:

- Develop advance PLC 5 & 500 & 5000 programs to control various electrical equipment
- Analyze and troubleshoot PLC circuits that contain discrete logic, sequential logic and A to D and D to A conversion
- Apply logic family characteristics in PLC programming design
- Design and implement solutions to control problems using PLCs
- Program PLC 5, 500 & 5000 processors using RSLogix programming software
- Configure PLC Analog input and output interfacing modules
- Configure PLC, PID software advance instructions
- Program a PLC to control a single loop process
- Configure and program PLC for both scanner and adaptor mode operations
- Configure and program PLC peer to peer communications for data exchange

3. *Develop various Basic HMI programs to control PLC's functions for AB PLC5, 500, and 5000*

Potential Elements of the Performance:

- Program and simulate devices using graphical software
- Develop advance HMI programs for the PLC 5, 500, 5000 to control various electrical equipment
- Develop advance HMI programs for the PLC Analog input and output interfacing modules for both PLC 5, 500 & 5000 PLC
- Develop HMI for PLC peer to peer communications and Remote Master Slave communications

4. ***Develop various Basic skills to provide accurate meaningful information with respect to the projects (Labs) assigned so that they could be reproduced by and other group in the future.***

Potential Elements of the Performance:

- Communicate information effectively and accurately by producing electrical PLC related equipment drawings and other related documentation
- 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
- Plan, organize, and deliver presentations including technical documents and projects
- Use computer software and other technology to produce diagrams, charts, tables, graph and project timelines

III. TOPICS:

1. Introduction control terminology and principles.
2. Overview of industrial controls and automation hardware/software
3. Overview of AB PLC 5.500 and 5000 hardware.
4. Overview of AB PLC 5, 500 and 5000 software.
5. Overview of AB PLC 5, 500 and 5000 Analog.
6. Overview of AB PLC 5, 500 and 5000 PID.
7. Advanced PLC programming
8. Introduction to HIM Programming and Software
9. Introduction to PLC Networking Communications and Troubleshooting

IV. REQUIRED RESOURCES/TEXTS/MATERIALS:

Text and Material will be indicated by the instructor

The student will be informed of the material prior to requiring it for course study.

Student RSlogix Software package is required for this course

| V. EVALUATION PROCESS/GRADING SYSTEM: | | | |
|----------------------------------------------|-----------------|-----------------------------|--------------------|
| Written Test 1 | 15 marks | | 10% overall |
| Written Test 2 | 30 marks | | 30% overall |
| Practical Test | 30 marks | | 30% overall |
| Lab Write-ups | 15 marks | | 15% overall |
| Lab <u>Demonstration</u> | 10 marks | | 10% overall |
| Total 100 marks | | | 100 % |
| | Write-ups | Demonstration including HMI | |
| Lab # 1 | 0 marks | 0 marks | 0% overall |
| Lab # 2 | 1 marks | 1 marks | 2% overall |
| Lab # 3 | 1 marks | 1 marks | 2% overall |
| Lab # 4 | 1 marks | 1 marks | 2% overall |
| Lab # 5 | 2 marks | 1 marks | 3% overall |
| Lab # 6 | 2 marks | 1 marks | 3% overall |
| Lab # 7 | 2 marks | 1 marks | 3% overall |
| Lab # 8 | 2 marks | 1 marks | 3% overall |
| Lab # 9 | 2 marks | 1 marks | 3% overall |
| Lab #10 | 2 marks | 2 marks | 4% overall |
| Total | 15 marks | 10 marks | 25% overall |

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:

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.

Special Note:

All Students enrolled in ELR 320 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 320. 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!

VII. COURSE OUTLINE ADDENDUM:

The provisions contained in the addendum located on the portal form part of this course outline.

Course outline important points:

- In order to maintain a passing grade the student must obtain a minimum **50%** average in all subject sections listed here, such as, the theory Tests section, Practical Tests section, & Lab Write-ups. **ALL Labs must be 100% completed and demonstrated to the satisfaction of the Instructor in order to maintain a passing grade in this section. Failure to demonstrate any of the listed labs in this section of the course will result in a final grade of F for this course.**
- If a student misses a test he/she must have a valid reason (e.g. medical or family emergency). A Doctors Slip may be requested by the instructor if a test or deadline is missed due to a medical 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.

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:

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 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. 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.

POLICIES AND EXPECTATIONS FOR LEARNING ENVIRONMENT:**Assignments**

Any Chapter review questions (written in a Text) are designed to help the student review and consolidate the theory presented in each of the chapters. The chapters in an assigned text, computer programs demos, computer text files and the hand out material that the instructor may provide to the student, are designed as walk-through learning tools and must be read for understanding **ahead of class**. The hands-on projects are designed to allow the student to apply and practice the concepts introduced in ELR 320 while providing an opportunity to reinforce skills learned previously.

All assignments including Student Assignments, Lab Exercises, and Lab demonstrations are due on or before the due date specified in class. Assignments handed in on the due date must be in the instructor's hands **before** the specified time. **Late assignments will not be graded or checked.** Students **must** complete all assignment in the required time, no extensions will be permitted, therefore, the due date will be strictly enforced to provide time for the instructor to mark the lab write-up material and return it to the student. No photocopies or mass produced documents will be accepted.

Lab Write-ups Requirements:

Labs 0 require no write-ups

Lab # 1 through and including Lab #10 all require write-ups and demonstration as outlined 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 hardware **schematic** CAD diagram of PLC and related equipment.
- 3) Labs shall have an AutoCAD **wiring diagram** of the complete lab including all Associated network equipment, Racks, Lights, switches, and wires etc.
- 4) Labs shall have an I/O listing,
- 5) Labs shall have a description of operation and function described in the students own words and it shall be typed using a word processor program such as Microsoft Word, Word etc.
- 6) All lab assignments must be turned in on hard copy and on computer disk(s) (CD, DVD) before or no later than the last lab class of the semester. The media will contain all program drawings, word-processor write-ups HMI files and PLC programs files
- 7) Labs that require tables shall be done in a spreadsheet or a word processor the can produce a table.
- 8) Each lab may have specific requirements which the instructor will inform the students during the lab period. These requirements may include changes to the equipment, procedure, write-ups, demonstrations or any other requirement that the instructor deem as necessary. So all students must attend the labs to obtain any of the specific requirements. These will only be given out on the day of the particular lab is scheduled
- 9) If the student is not clear on any of the lab requirements, it is his/her's responsibility to ask the instructor for clarification
- 10) All projects must contain MS project proposed time line and actual time line and Flow charts for troubleshooting projects.

NOTE:

Each student must demonstrate the lab to the instructor and turn in a write-up as outline. The student must obtain a passing mark (grade) in each area of the course sections as described below.

- Written Tests, and Practical test student must obtain 50%
- Write-up, student must obtain 50% and turn in a write-up for all compulsory labs (1 to 10) to obtain a grade in this portion of the course
- Demonstration, student must obtain 50% marks and the student must have demonstrated all 9 compulsory labs (1 to 10), to obtain a grade in this portion of the course. Each student must demonstrate the assigned projects.

STUDENT COURSE AGREEMENT**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).

I, _____ student ID # _____

(Please print)
with regards to the course known as

COURSE CODE # **ELR 320** have read and understood the course content, outline and expectations which clearly state 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 (projects) must be handed in by the due date or a grade of 0 will be awarded.
- 3- Lab & lecture attendance are at the students discretion. 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 Demonstrations must be completed during assigned Lab times unless prior approval is obtained from the instructor. Demonstration times will be at the discretion of the Instructor.
- 6- Students will be able to demonstrate the assigned projects only once at which time the instructor will grade project as complete or incomplete. Complete will result in full marks for that project, while incomplete will result in a 0 mark for that particular project. So each student must be sure that the lab is ready for demonstration.
- 7- In order to maintain a passing grade and have all marks totaled for a final 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- Most important you understand all safety requirements that are required of you to function safely at all times in the automation labs , B1050,B1093. These requirements were explained to you by the instructor as outlined below in Lab 0 which was your first Lab class.

(Signature)

(Date)

Student Lab Evaluation Sheet ELR 320

Student's Name _____ Mark _____

NOTE: Each student must turn in his/her own sheet with each lab demonstration verified by the instructor signature. If the student does not turn the sheet with all labs signed by the instructor the write-up will not be accepted and the student will be assessed a mark of 0% resulting in an overall F (fail) grade for ELR 320.

| Lab # | Description NOTE: All labs are compulsory unless state other wise | Demo Mark | Instructor's Signature | Write-up Mark |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------------------|---------------|
| 0 | General Safety requirements In and during the Lab time and Safe LAB SET-UP & handling of HARDWARE for PLCs and related equipment in B1050 and B1093 | No mark | | No mark |
| 1a,b,c | PROGRAM PLC 5, PLC 500, & 5000 USING RS LOGIC CONTROL 3 MOTORS WITH HMI | | | |
| 2a,b | PROGRAM PLC 500 & 5000 USING RS LOGIC CONTROL TRAFFIC LIGHT USING TIMERS LIMIT TEST & SEQUENCERS WITH HMI | | | |
| 3 | SET-UP AB-5 ANALOG IN & OUT CARDS | | | |
| 4 | SET-UP ANALOG IN & OUT CARDS ALONG WITH THE PID BLOCK & PERFORM AN OPEN LAB ASSIGNMENT WITH HMI | | | |
| 5 a,b | PROGRAM PLC 500 & 5000 USING RS LOGIC CONFIGURE, SET-UP, OPERATE ANALOG IN / OUT CARDS | | | |
| 6a,b | PROGRAM PLC 500 and 5000 USING RS LOGIC WITH PID AND PERFORM AN OPEN LOOP LAB ASSINGNMENT WITH HMI | | | |
| 7 | PLC-5 SCANNER TO PLC 5 ADAPTER COMMUNICATIONS USING BLOCK TRANSFERS WITH SIMPLE START / STOP MMI CONTROL | | | |
| 8 | AB-5 SCANNER TO SLC 504 REMOTE PLC WITH HMI | | | |
| 9 | AB-5 SCANNER TO REMOTE I/O Ready Panel WITH HMI | | | |
| 10 | AB-500 SCANNER TO REMOTE I/O Ready Panel WITH HMI | | | |
| | Total Marks | | | |