

## Programmable Logic Controllers

### Mechanical and Transportation Technology

<b>Course Number:</b> ELN9207	<b>Contribution to Program:</b> Vocational	<b>Normative Hours:</b> 60
<b>Applicable Program(s):</b> 0550X01FWO EME Technician - Robotics	<b>AAL:</b> 4	<b>Core/Elective:</b> Core
<b>Prepared by:</b> Stephen Ryan Coordinator		<b>Approval Date:</b> 21/06/2013
<b>Co-Requisites</b> N/A		<b>Approved by:</b> Misheck Mwaba, PhD., P.Eng. Chair, Mechanical and Transportation Technology
<b>Pre-Requisites</b> ELN9211		<b>Approved for Academic Year:</b> 2013-2014

### COURSE DESCRIPTION

The programmable logic controller has become the most powerful change to occur in the electronics world for factory automation. The ability to replace large banks of mechanical timers and relays with a software alternative has provided large cost savings in terms of equipment and upgrades. As an electro-mechanical technician, you run into the PLC in a wide variety of applications. Practical experience in interfacing the PLC to conveyor belts, motors, sensors, pneumatic circuits, level sensors, robots and more is provided. Knowledge gained demonstrates that the PLC is as important to the industrial automation world as the personal computer is to the business world.

### RELATIONSHIP TO VOCATIONAL LEARNING OUTCOMES

**This course contributes to your program by helping you achieve the following Vocational Learning Outcomes:**

#### EME Technician - Robotics 0550X01FWO

10 Maintain and troubleshoot automated equipment including robotic systems.(T,A)

**T:** Teach **A:** Assess **CP:** Culminating Performance

### ESSENTIAL EMPLOYABILITY SKILLS

**The course contributes to your program by helping you achieve the following Essential Employability Skills:**

- 1 Communicate clearly, concisely and correctly in the written, spoken and visual form that fulfills the purpose and meets the needs of the audience.(T,A,CP)
- 7 Analyze, evaluate and apply relevant information from a variety of sources.(T,A,CP)
- 8 Show respect for diverse opinions, values, belief systems and contributions of others. (T,A,CP)
- 10 Manage the use of time and other resources to complete projects.(A,CP)

**T:** Teach **A:** Assess **CP:** Culminating Performance

### COURSE LEARNING REQUIREMENTS/EMBEDDED KNOWLEDGE AND SKILLS

<b>COURSE LEARNING REQUIREMENTS</b> When you have earned credit for this course, you will have demonstrated the ability to:	<b>EMBEDDED KNOWLEDGE AND SKILLS</b>
1. Explain the function of a Programmable Logic Controller (PLC)  Identify the physical components that make up our PLC  Identify each part of the PLC Trainer  Identify the main sections of the PLC Programmer Software  Explain the various combinations of logic when used in PLC ladder diagrams.	<ul style="list-style-type: none"> <li>1 be able to define the term PLC and how it is used</li> <li>1 be able to identify and explain each of the physical components of the PLC</li> <li>1 be able to identify and explain each part of the PLC trainer.</li> <li>1 be able to identify and explain the main sections and headings of the PLC Programmer Software</li> <li>1 be able to demonstrate working knowledge of the software</li> <li>1 be able to identify and explain the basic logic functions in a PLC</li> </ul>
2. Explain the mnemonics of the PLC programming software and how to	<ul style="list-style-type: none"> <li>1 be able to convert programs written in mnemonics to ladder and</li> </ul>

convert back and forth to ladder programming  Explain Latching and the various ways to achieve this with a PLC	<ul style="list-style-type: none"> <li>vice versa</li> <li>be able to explain the parameters of a logical block</li> <li>demonstrate the various forms of latching available including Set, Reset, Keep</li> <li>explain the function of the internal inputs and outputs, demonstrate their use</li> <li>demonstrate external inputs and outputs including lights, sensors and forward and reverse relays for a DC motor</li> </ul>
3. Explain the use of Timers and latching Timers and how they are used  Explain Counters and the types used with your PLC	<ul style="list-style-type: none"> <li>demonstrate the various timers provided in the Programmer software including high speed and multi-output</li> <li>demonstrate how to create a latched timer and explain the importance</li> <li>demonstrate how to reset your timer and how this can be done</li> <li>demonstrate all of the counters available with this PLC including straight counters, reversible counters and resets</li> <li>explain how you can use a counter as a timer</li> </ul>
4. Explain Shift Registers and their various applications  Explain Function Blocks and their various uses and applications	<ul style="list-style-type: none"> <li>demonstrate the basic shift register as well as the reversible shift register</li> </ul>
5. Explain Sequencers and the use of Indexed Addressing  Explain Subroutines and how to use them properly in a program  Identify Analog Inputs and how they are received by the PLC	<ul style="list-style-type: none"> <li>Create a table for sequence programming using indexed addressing</li> <li>Explain all of the instruction blocks required for a sequencer and the function of each</li> <li>Create a subroutine using the SBS, SBN and END instructions</li> <li>Create an analog input and incorporate it into a running program</li> </ul>

## LEARNING RESOURCES

Text/Workbook: Programmable Logic Controllers: OMRON CJ1M – CPU 12 and CX -One Educational Version Workbook Rev F2010 Lana Michele, 2010

OMRON Programming, Operation, and Instructions Manuals

## LEARNING ACTIVITIES

**During this course, you are likely to experience the following learning activities:**

A large portion of this course is achieved by hands on practical experience. Some peer teaching and collaborated learning may be involved. A complete list of required labs is available on blackboard

## EVALUATION/EARNING CREDIT

The following will provide evidence of your learning achievements:	This activity validates the following Course Learning Requirements and/or Essential Employability Skills:
Quizzes ..... 10%  1 Quiz for each of the 5 CLR's worth 2% each	<ul style="list-style-type: none"> <li>Explain the mnemonics of the PLC programming software and how to convert back and forth to ladder programming  Explain Latching and the various ways to achieve this with a PLC - [CLR 2]</li> <li>Explain the use of Timers and latching Timers and how they are used  Explain Counters and the types used with your PLC - [CLR 3]</li> <li>Explain Shift Registers and their various applications  Explain Function Blocks and their various uses and applications - [CLR 4]</li> <li>Explain Sequencers and the use of Indexed Addressing  Explain Subroutines and how to use them properly in a program</li> </ul>

	<p>Identify Analog Inputs and how they are received by the PLC - [CLR 5]</p> <p>1 Explain the function of a Programmable Logic Controller (PLC)</p> <p>Identify the physical components that make up our PLC</p> <p>Identify each part of the PLC Trainer</p> <p>Identify the main sections of the PLC Programmer Software</p> <p>Explain the various combinations of logic when used in PLC ladder diagrams. - [CLR 1]</p> <p>1 Communicate clearly, concisely and correctly in the written, spoken and visual form that fulfills the purpose and meets the needs of the audience. - [EES 1]</p> <p>1 Analyze, evaluate and apply relevant information from a variety of sources. - [EES 7]</p> <p>1 Manage the use of time and other resources to complete projects. - [EES 10]</p>
<p>Tests ..... 60%</p> <p>1 Test for each of the 5 CLRs worth 12% each</p>	<p>1 Explain the function of a Programmable Logic Controller (PLC)</p> <p>Identify the physical components that make up our PLC</p> <p>Identify each part of the PLC Trainer</p> <p>Identify the main sections of the PLC Programmer Software</p> <p>Explain the various combinations of logic when used in PLC ladder diagrams. - [CLR 1]</p> <p>1 Explain Shift Registers and their various applications</p> <p>Explain Function Blocks and their various uses and applications - [CLR 4]</p> <p>1 Explain the mnemonics of the PLC programming software and how to convert back and forth to ladder programming</p> <p>Explain Latching and the various ways to achieve this with a PLC - [CLR 2]</p> <p>1 Explain the use of Timers and latching Timers and how they are used</p> <p>Explain Counters and the types used with your PLC - [CLR 3]</p> <p>1 Explain Sequencers and the use of Indexed Addressing</p> <p>Explain Subroutines and how to use them properly in a program</p> <p>Identify Analog Inputs and how they are received by the PLC - [CLR 5]</p>
<p>Labs ..... 10%</p> <p>1 <b>Completed</b> Lab Sign off sheet 10%</p>	<p>1 Explain Shift Registers and their various applications</p> <p>Explain Function Blocks and their various uses and applications - [CLR 4]</p> <p>1 Explain the function of a Programmable Logic Controller (PLC)</p> <p>Identify the physical components that make up our PLC</p> <p>Identify each part of the PLC Trainer</p> <p>Identify the main sections of the PLC Programmer Software</p> <p>Explain the various combinations of logic when used in PLC ladder diagrams. - [CLR 1]</p> <p>1 Explain the mnemonics of the PLC programming software and how to convert back and forth to ladder programming</p>

	<p>Explain Latching and the various ways to achieve this with a PLC - [CLR 2]</p> <p>1 Explain the use of Timers and latching Timers and how they are used</p> <p>Explain Counters and the types used with your PLC - [CLR 3]</p> <p>1 Explain Sequencers and the use of Indexed Addressing</p> <p>Explain Subroutines and how to use them properly in a program</p> <p>Identify Analog Inputs and how they are received by the PLC - [CLR 5]</p>
<p>Group Projects ..... 20%</p> <p>Two Projects, Culminating worth 13%</p> <p>Other project worth 7%</p>	<p>1 Communicate clearly, concisely and correctly in the written, spoken and visual form that fulfills the purpose and meets the needs of the audience. - [EES 1]</p> <p>1 Analyze, evaluate and apply relevant information from a variety of sources. - [EES 7]</p> <p>1 Manage the use of time and other resources to complete projects. - [EES 10]</p> <p>1 Show respect for diverse opinions, values, belief systems and contributions of others. - [EES 8]</p>

## COLLEGE GRADING NUMERICAL EQUIVALENT TABLE

Final Grade	Mark Equivalent	Numeric Value	Final Grade	Mark Equivalent	Numeric Value
A+	90-100%	4.0	C+	67-69%	2.3
A	85-89%	3.8	C	63-66%	2.0
A-	80-84%	3.6	C-	60-62%	1.7
B+	77-79%	3.3	D+	57-59%	1.4
B	73-76%	3.0	D	53-56%	1.2
B-	70-72%	2.7	D-	50-52%	1.0
			F	0-49%	0
			FSP	0	0

## OTHER COURSE INFORMATION

Students are required to respect the confidentiality of employer, client and/or patient information, interactions, and practices that occur either on Algonquin College premises, or at an affiliated clinical/field/co-op placement site. Concerns regarding clients, patients, and/or employer practices are to be brought to the attention of the program coordinator, or designated field/clinical/co-op placement supervisor so that they may be resolved collaboratively. Such concerns are not to be raised publically either verbally, in writing, or in electronic forums. These matters are to be addressed through established program communication pathways.

## PRIOR LEARNING ASSESSMENT AND RECOGNITION

Students who wish to apply for prior learning assessment and recognition (PLAR) need to demonstrate competency at a post-secondary level in all of the course learning requirements outlined above. Evidence of learning achievement for PLAR candidates includes:

- 1 Portfolio
- 1 Challenge Exam
- 1 Performance Test
- 1 Project/Assignment

## RELATED INFORMATION

The following information is course-specific:

Required Equipment:

Safety Glasses

Closed-toed shoes

Electronics toolkit consisting of cutters, wire strippers, needlenose pliers, protoboard, small electronic screwdriver kit, 2 oscilloscope leads, 2 BNC

to alligator leads and 3 sets of metre leads.

Refer to your CSI under Course Information on Blackboard for the updated Lab and Testing Policy.

If you are a student with a disability please identify your needs to the professor and/or the Centre for Students with Disabilities (CSD) so that support services can be arranged for you. You can do this by making an appointment at the CSD, Room C142, Ottawa, 727-4723, Ext 7683 or arranging a personal interview with the professor to discuss your needs.

#### Respect for Confidentiality

Students are required to respect the confidentiality of employer, client and/or patient information, interactions, and practices that occur either on Algonquin College premises, or at an affiliated clinical/field/co-op placement site. Concerns regarding clients, patients, and/or employer practices are to be brought to the attention of the program coordinator, or designated field/clinical/co-op placement supervisor so that they may be resolved collaboratively. Such concerns are not to be raised publically either verbally, in writing, or in electronic forums. These matters are to be addressed through established program communication pathways.

**The following information is school/department-specific:**

#### **GENERAL CLAUSES - School of Advanced Technology**

**Harassment/Discrimination/Violence will not be tolerated.** Any form of harassment (sexual, racial, gender or disability-related), discrimination (direct or indirect), or violence, whether towards a professor or amongst students, will not be tolerated on the college premises. Action taken will start with a formal warning and proceed to the full disciplinary actions as outlined in Algonquin College Policy - HR22.

Harassment means one or a series of vexatious comment(s) or conduct related to one or more of the prohibited grounds that is known or ought reasonably to be known to be unwelcome/ unwanted, offensive, intimidating, derogatory or hostile.

This may include, but is not limited to: gestures, remarks, jokes, taunting, innuendo, display of offensive materials, offensive graffiti, threats, verbal or physical assault, academic penalties, stalking, slurs, shunning or exclusion related to the prohibited grounds.

For further information, a copy of the official policy statement can be obtained from the Student Association.

**The Use of Electronic Devices**, with the sound turned on, during classes is strictly prohibited. In particular, cell phones are not to be used to communicate during a class. The use of any electronic devices during exams and mid-term tests, other than those sanctioned by the faculty in charge of the examination, is strictly prohibited.

Anyone caught using a prohibited device will be considered to have plagiarized, and will be treated as such in accordance with College Plagiarism Policy. For further details on this directive, consult the Algonquin College Policy AA32 on the use of Electronic Devices in Class and Exams.

**The School of Advanced Technology's Standard Operating Procedure on Plagiarism and Academic Honesty** defines plagiarism as an attempt to use or pass off as one's own idea or product, work of another without giving credit. Plagiarism has occurred in instances where a student either directly copies another person's work without acknowledgement; or, closely paraphrases the equivalent of a short paragraph or more without acknowledgement; or, borrows, without acknowledgement, any ideas in a clear and recognizable form in such a way as to present them as one's own thought, where such ideas, if they were the student's own would contribute to the merit of his or her own work.

Plagiarism is one of the most serious academic offenses a student can commit. Anyone found guilty will, on the first offense, be given a written warning and an F on the plagiarized work. If the student commits a second offense, an F will be given for the course along with a written warning. A third offense will result in suspension from the program and/or the college.

For further details on this directive, consult the Algonquin College Policy - AA20 and the School of Advanced Technology's Standard Operating Procedure on Plagiarism and Academic Dishonesty.

#### **Respect for Confidentiality**

Students are required to respect the confidentiality of employer, client and/or patient information, interactions, and practices that occur either on Algonquin College premises, or at an affiliated clinical/field/co-op placement site. Concerns regarding clients, patients, and/or employer practices are to be brought to the attention of the program coordinator, or designated field/clinical/co-op placement supervisor so that they may be resolved collaboratively. Such concerns are not to be raised publically either verbally, in writing, or in electronic forums. These matters are to be addressed through established program communication pathways.

**Disruptive Behaviour** is any conduct, or threatened conduct, that is disruptive to the learning process or that interferes with the well-being of other members of the College community. It will not be tolerated.

Members of the College community, both students and staff, have the right to learn and work in a secure and productive environment. The College will make every effort to protect that right.

Incidents of disruptive behaviour must be reported in writing to the departmental Chair as quickly as possible. The Chair will hold hearings to review available information and determine any sanctions that will be imposed. Disciplinary hearings can result in penalties ranging from a written warning to expulsion.

For further details consult the Algonquin College Policy - SA07.

June 15, 2012

**The following information is College-wide:**

**Email**

Algonquin College provides all full-time students with an e-mail account. This is the address that will be used when the College, your professors, or your fellow students communicate important information about your program or course events. It is your responsibility to ensure that you know how to send and receive e-mail using your Algonquin account and to check it regularly.

**Centre for Students with Disabilities (CSD)**

If you are a student with a disability, it is strongly recommended that you identify your needs to the professor and the Centre for Students with Disabilities (CSD) by the end of the first month of the semester in order that any necessary support services can be arranged for you.

**Academic Integrity\* & Plagiarism\***

Adherence to acceptable standards of academic honesty is an important aspect of the learning process at Algonquin College. Academic work submitted by a student is evaluated on the assumption that the work presented by the student is his or her own, unless designated otherwise. For further details consult Algonquin College Policies AA18 <http://www2.algonquincollege.com/directives/files/2012/04/AA18.pdf> and AA20 <http://www2.algonquincollege.com/directives/files/2011/08/AA20.pdf>

**Student Course Feedback\***

It is Algonquin College's policy to give students the opportunity to complete a course assessment survey in each course that they take which solicits their views regarding the curriculum, the professor and the facilities. For further details consult Algonquin College Policy AA25 <http://www2.algonquincollege.com/directives/files/2011/10/AA25.pdf>

**Use of Electronic Devices in Class\***

With the proliferation of small, personal electronic devices used for communications and data storage, Algonquin College believes there is a need to address their use during classes and examinations. During classes, the use of such devices is disruptive and disrespectful to others. During examinations, the use of such devices may facilitate cheating. For further details consult Algonquin College Policy AA32 <http://www2.algonquincollege.com/directives/files/2011/11/AA32.pdf>

**Transfer of Credit**

Students, it is your responsibility to retain course outlines for possible future use to support applications for transfer of credit to other educational institutions.

\* College policies (previously called directives) are under review and redesign. The term *directives* is being retired. As such, the policy classification nomenclature is in transition. Students, it is your responsibility to refer to the Algonquin College Directives/Policies website for the most current information available at: (<http://www2.algonquincollege.com/directives/>)