Microcontroller Interfacing and Programming

Mechanical and Transportation Technology

Course Number: ELN9204	**Contribution to Program:** Vocational	**Normative Hours:** 75
Applicable Program(s): 0550X01FWO EME Technician - Robotics	**AAL:** 4	**Core/Elective:** Core	**Approval Date:** 21/06/2013
Prepared by: Stephen Ryan Coordinator		**Approved by:** Misheck Mwaba, PhD., P.Eng. Chair, Mechanical and Transportation Technology
Co-Requisites N/A		**Approved for Academic Year:** 2013-2014
Pre-Requisites ELN8303 and ELN9203		

COURSE DESCRIPTION

Interfacing the PIC microcontroller to an assortment of electronic components demonstrates many of the various ways these components can be used in industry. Topics include Temperature Sensors, EEPROM Programming, Analog to Digital Conversion, Clocking Data in and out, Interfacing Displays, Real-Time Interfacing and Programming the PIC using C. Different methods of circuit analysis and troubleshooting skills are examined through experimentation with the PIC and its associated components.

RELATIONSHIP TO VOCATIONAL LEARNING OUTCOMES

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

EME Technician - Robotics 0550X01FWO

2	Interpret and produce electrical, electronic, and mechanical drawings and other related documents and graphics to appropriate engineering standards.(T,A,CP)
3	Select and use a variety of troubleshooting techniques and test equipment to assess electromechanical circuits, equipment, processes, systems, and subsystems.(T,A)
4	Modify, maintain, and repair electrical, electronic, and mechanical components, equipment, and systems to ensure that they function according to specifications.(T,A)
5	Apply the principles of engineering, mathematics, and science to analyze and solve routine technical problems and to complete work related to electromechanical engineering.(T,A,CP)
7	Analyze, build, and troubleshoot logic and digital circuits, passive AC and DC circuits, and active circuits.(T,A,CP)
9	Install and troubleshoot basic computer hardware and programming to support the electromechanical engineering environment. (T,A,CP)
14	Perform all work in accordance with relevant law, policies, codes, regulations, safety procedures, and standard shop practices. (T,A,CP)
15	Develop personal and professional strategies and plans to improve job performance and work relationships with clients, coworkers, and supervisors.(T,A,CP)

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:

3	Execute mathematical operations accurately.(T,A,CP)
4	Apply a systematic approach to solve problems.(T,A,CP)
5	Use a variety of thinking skills to anticipate and solve problems.(T,A,CP)
9	Interact with others in groups or teams in ways that contribute to effective working relationships and the achievement of goals. (T,A)
10	Manage the use of time and other resources to complete projects.(T,A,CP)
11	Take responsibility for one's own actions, decisions and consequences.(T,A,CP)

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

COURSE LEARNING REQUIREMENTS/EMBEDDED KNOWLEDGE AND SKILLS

COURSE LEARNING REQUIREMENTS **When you have earned credit for this course, you will have demonstrated the ability to:**	EMBEDDED KNOWLEDGE AND SKILLS
1. Define basic concepts	 ○ Define the term "computer" and discuss hardware and software components ○ Discuss the hierarchical organization of data ○ Understand the program development process ○ Distinguish between syntax and logical errors ○ Describe the process that C and Assembly Language perform to create executables from source statements ○ Design and write simple programming applications in C
2. Discuss the structure of a C program	 ○ Discuss the basic structure of a C program and the purpose of the *main()* function ○ Define constants and variables ○ Declare and assign data to integer and floating point data types ○ Declare and assign data to character and string data types ○ Code standard input and output operations ○ Write programs to accept input from keyboard
3. Write modular programs	 ○ Discuss the concepts and benefits of modular structured programming ○ Divide a program into a series of self-contained modules ○ Explain the purpose of logic structures - sequence, selection and iteration ○ Explain why programming guidelines are necessary ○ Write C programs using top-down design and modular structured programming techniques
4. Explain string functions and loops	 ○ Manipulate string data using various string functions ○ Understand the concepts of iteration and loop processing ○ Use relational and logic operators to write conditional statements ○ set up loops using the WHILE, DO-WHILE and FOR statements ○ format printer output and accumulate report totals ○ Code nested loops
5. Control program flow using branching	 ○ Distinguish between conditional and unconditional branching ○ Use IF and ELSE/IF statements to select alternate processing paths ○ Code nested decisions using the IF and IF/ELSE statements ○ Use the SWITCH and BREAK statements to code multipath decisions ○ Understand why programmers avoid the GOTO statement
6. Store data into sorted arrays	 ○ Understand the purpose of arrays and the use of subscripts ○ Define and load numeric and character arrays ○ Manipulate and print data stored in arrays ○ Define and load data into parallel arrays ○ Sort the elements in an array in ascending and descending order
7. Allocate the PIC microcontroller hardware	 ○ Apply interrupts to C programs ○ Write C programs to complete I/O tasks

8. Define standard I/O and Preprocessor directives	l ○ Apply the *#define, #include, #pragma* and *#use* statements ○ Use standard input and output functions to gather and output data from a program ○ Use the device specification directives to correctly select a device for a program
9. Select the appropriate C compiler for programming the PIC	l ○ Create and compile a project ○ Apply the C compiler to program a target device ○ Apply a serial port monitor to send and receive RS232 communications
10. Develop a project plan	l ○ Define the problem ○ Design a solution for the stated problem ○ Program and debug using a C compiler ○ Test and evaluate the solution
11. Integrate Software & Hardware	l ○ Choose the appropriate method for choosing proper hardware and software components

LEARNING RESOURCES

Text: **Embedded C Programming and the Microchip PIC, Barnett, Cox, O'Cull**
ISBN: **140183748-4, Thomson Delmar Learning**

Check Blackboard's external links and course documents for further helpful resources

LEARNING ACTIVITIES

During this course, you are likely to experience the following learning activities:
THEORY: Lectures are conducted to help explain course material. Students write tests and quizzes.

PRACTICAL: Experiments are conducted in a laboratory environment.

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:

3 Unit Tests:
 	
 Test 1: --20%
   -CLR 1,2,3,4
 Test 2: --20%
   -CLR 5,6,7,8
 Test 3: --20%
   -CLR 9,10,11,12
	l Define basic concepts
	   - [CLR 1]
	
	 l Write modular programs
	   - [CLR 3]
	
	 l Select the appropriate C compiler for programming the PIC
	   - [CLR 9]
	
	 l Develop a project plan
	   - [CLR 10]
	
	 l Store data into sorted arrays
	   - [CLR 6]
	
	 l Define standard I/O and Preprocessor directives
	   - [CLR 8]
	
	 l Control program flow using branching
	   - [CLR 5]
	
	 l Allocate the PIC microcontroller hardware
	   - [CLR 7]
	
	 l Explain string functions and loops
	   - [CLR 4]
	
	 l Discuss the structure of a C program

	l - [CLR 2]
	l Integrate Software & Hardware - [CLR 11]
	l Execute mathematical operations accurately. - [EES 3]
	l Apply a systematic approach to solve problems. - [EES 4]
	l Use a variety of thinking skills to anticipate and solve problems. - [EES 5]
	l Interact with others in groups or teams in ways that contribute to effective working relationships and the achievement of goals. - [EES 9]
	l Manage the use of time and other resources to complete projects. - [EES 10]
	l Take responsibility for one's own actions, decisions and consequences. - [EES 11]

3 Quizzes:
 	
Quiz 1 ---3%
  -CLR 1,2,3,4
Quiz 2 ---3%
  -CLR 5,6,7,8
Quiz 4 ---4%
  -CLR 9,10,11,12
	l Discuss the structure of a C program - [CLR 2]
	
	l Define standard I/O and Preprocessor directives - [CLR 8]
	
	l Select the appropriate C compiler for programming the PIC - [CLR 9]
	
	l Develop a project plan - [CLR 10]
	
	l Integrate Software & Hardware - [CLR 11]
	
	l Control program flow using branching - [CLR 5]
	
	l Allocate the PIC microcontroller hardware - [CLR 7]
	
	l Store data into sorted arrays - [CLR 6]
	
	l Define basic concepts - [CLR 1]
	
	l Write modular programs - [CLR 3]
	
	l Explain string functions and loops - [CLR 4]
	
	l Execute mathematical operations accurately. - [EES 3]
	
	l Apply a systematic approach to solve problems. - [EES 4]
	
	l Use a variety of thinking skills to anticipate and solve problems. - [EES 5]
	
	l Interact with others in groups or teams in ways that contribute to effective working relationships and the achievement of goals. - [EES 9]
	
	l Manage the use of time and other resources to complete projects. - [EES 10]
	
	l Take responsibility for one's own actions, decisions and consequences. - [EES 11]

1 Project : Project 1--24% -CLR 1,2,3,4,5,6, 7,8,9,10,11,and 12	l Apply a systematic approach to solve problems. - [EES 4] l Use a variety of thinking skills to anticipate and solve problems. - [EES 5] l Manage the use of time and other resources to complete projects. - [EES 10] l Take responsibility for one's own actions, decisions and consequences. - [EES 11]
Labs	l Control program flow using branching

All labs completed (lab sign off sheet submitted)------------6%

- [CLR 5]

l Allocate the PIC microcontroller hardware
  - [CLR 7]

l Discuss the structure of a C program
  - [CLR 2]

l Define standard I/O and Preprocessor directives
  - [CLR 8]

l Store data into sorted arrays
  - [CLR 6]

l Explain string functions and loops
  - [CLR 4]

l Define basic concepts
  - [CLR 1]

l Write modular programs
  - [CLR 3]

l Select the appropriate C compiler for programming the PIC
  - [CLR 9]

l Develop a project plan
  - [CLR 10]

l Integrate Software & Hardware - [CLR 11]

l Apply a systematic approach to solve problems. - [EES 4]

l Use a variety of thinking skills to anticipate and solve problems. - [EES 5]

l Interact with others in groups or teams in ways that contribute to effective working relationships and the achievement of goals. - [EES 9]

l Manage the use of time and other resources to complete projects. - [EES 10]

l Take responsibility for one's own actions, decisions and consequences. - [EES 11]

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:

l Portfolio

l Challenge Exam
l Performance Test
l Project/Assignment

RELATED INFORMATION

The following information is course-specific:

Required Equipment:

PIC Programmer
Safety Glasses
Closed-toed shoes
Electronics toolkit consisting of cutters, wire strippers, needle-nose pliers, protoboard, small electronic screwdriver kit, 2 oscilloscope leads, 2 BNC to alligator leads and 3 sets of meter leads.

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

No extensions or exceptions will be permitted except for valid medical reasons approved by the Program Coordinator

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 AlgonquinCollege 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 very 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/)**