COURSE ELT1010: ELECTRO-ASSEMBLY 1

Level: Introductory

Prerequisite: None

Description: Students apply basic fabricating and servicing techniques to construct and test electronic and electromagnetic devices and cables.

Parameters: Access to basic hand tools, soldering equipment, voltmeter, ohmmeter/test light and related resources.

Outcomes: The student will:

1. **create a health and safety plan with special emphasis on conditions and factors related to the specific pathway or series of courses**
   - 1.1 research and identify the following eight common elements of a health and safety management system:
     - 1.1.1 management, leadership and organizational commitment including policies, guidelines and responsibilities
     - 1.1.2 hazard identification and assessment
     - 1.1.3 hazard control
     - 1.1.4 worker competency and training including: technical competence, safe work practices and procedures, personal protective equipment
     - 1.1.5 work site inspection
     - 1.1.6 incident investigation
     - 1.1.7 emergency response
     - 1.1.8 management system administration including: evaluation, records and statistics, maintenance of system
   - 1.2 explain each of the elements reflecting on occupational health and safety implications
   - 1.3 define health and safety elements relevant to the world-of-work
   - 1.4 present a health and safety plan clarifying its relevance to the work world and society in general
2. **research common processes and methods of hazard identification, assessment and control specific to the pathway or series of courses**
   - 2.1 research and identify common job site hazard identification processes
   - 2.2 research and identify common methods for assessment and control of hazards
   - 2.3 explain and demonstrate appropriate health and safety effective practices
   - 2.4 demonstrate a proactive personal commitment toward improvement of workplace health and safety including concern for others and following instructions, rules and guidelines
3. **apply the appropriate fabrication techniques, including proper soldering and component assembly procedures, to construct and test a simple electronic circuit**
   - 3.1 construct and analyze a simple control circuit
   - 3.2 use various breadboarding techniques to be able to understand methods used; e.g., nail and board sector and spring clip, wire wrap, point-to-point and solderless breadboard
   - 3.3 identify components
   - 3.4 measure voltage and continuity to appraise condition of circuit using appropriate instrumentation; e.g., simple alarm, simple automobile circuit, multimeter (digital and analog)

4. **apply the appropriate fabrication techniques to construct and test an electromagnetic device**
   - 4.1 define AC/DC voltage and polarity
   - 4.2 use proper solder and soldering techniques to gain an understanding of their value
   - 4.3 analyze several magnetic devices to formulate an understanding of their function; e.g., speakers, electromagnetic crane, tape heads, moving magnetic pick-ups, relays, magnetic strip, levitation trains, magnetic device in hard drive
5. **identify and assemble common electrical/electronic cables and connectors used in power, audio and video connections**
   - 5.1 install specialty connectors and cables to acquire knowledge and skills
   - 5.2 demonstrate an understanding of specialty cables that link systems with special functions including fibre optics, coaxial and telephone
6. **demonstrate established laboratory procedures and safe work practices**
   - 6.1 demonstrate safe home/laboratory procedures with respect to electrical hazards and use of solder and flux
   - 6.2 identify and explain the importance of electrical protection devices
7. **demonstrate basic competencies**
   - 7.1 demonstrate fundamental skills to:
     - 7.1.1 communicate
     - 7.1.2 manage information
     - 7.1.3 use numbers
     - 7.1.4 think and solve problems
   - 7.2 demonstrate personal management skills to:
     - 7.2.1 demonstrate positive attitudes and behaviours
     - 7.2.2 be responsible
     - 7.2.3 be adaptable
     - 7.2.4 learn continuously
     - 7.2.5 work safely
   - 7.3 demonstrate teamwork skills to:
     - 7.3.1 work with others
     - 7.3.2 participate in projects and tasks
8. **make personal connections to the cluster content and processes to inform possible pathway choices**
   - 8.1 complete/update a personal inventory; e.g., interests, values, beliefs, resources, prior learning and experiences
   - 8.2 create a connection between a personal inventory and occupational choices

COURSE ELT1030: CONVERSION & DISTRIBUTION

Level: Introductory

Prerequisite: None

Description: Students experiment and work with principles of electrical energy conversion and distribution.

Parameters: Access to basic hand tools, a multimeter and related resources.

Outcomes: The student will:

1. **identify and describe methods of converting nonrenewable and renewable sources of energy into electricity**
   - 1.1 build and/or operate one energy conversion system that produces electricity using chemical, light, heat and/or mechanical energy forms
2. **construct an electrical distribution system**
   - 2.1 describe electrical power distribution systems from source to consumer
   - 2.2 wire common lighting and communication circuits
     - 2.2.1 breadboarding (low voltage)
     - 2.2.2 switches, lights, plugs, bells, buzzers, etc.
   - 2.3 test circuits for continuity and function
3. **demonstrate how mechanical, chemical, light and heat energy can be converted into electrical energy**
   - 3.1 identify and describe how energy is converted into electricity in a:
     - 3.1.1 wet/dry cell
     - 3.1.2 photovoltaic cell
     - 3.1.3 thermocouple
     - 3.1.4 generator/alternator
     - 3.1.5 piezoelectric crystal
4. **determine the cost efficiency, practicality and environmental impact of producing electricity from various sources of energy**
   - 4.1 research issues related to electrical generation, transmission and distribution systems including:
     - 4.1.1 cost efficiencies
     - 4.1.2 environmental impact of fossil fuel, hydro-electric and nuclear power plants
     - 4.1.3 conventional (fossil fuel) versus nonconventional (tidal, solar, wind) sources
   - 4.2 report on issues related to energy efficiency and conservation
   - 4.3 identify specific applications of energy conversion used in personal life
5. **demonstrate established laboratory procedures and safe work practices**
   - 5.1 identify and follow safety procedures in a home/laboratory
6. **demonstrate basic competencies**
   - 6.1 demonstrate fundamental skills to:
     - 6.1.1 communicate
     - 6.1.2 manage information
     - 6.1.3 use numbers
     - 6.1.4 think and solve problems

6.2 demonstrate personal management skills to:
    6.2.1 demonstrate positive attitudes and behaviours
    6.2.2 be responsible
    6.2.3 be adaptable
    6.2.4 learn continuously
    6.2.5 work safely
6.3 demonstrate teamwork skills to:
    6.3.1 work with others
    6.3.2 participate in projects and tasks

7. make personal connections to the cluster content and processes to inform possible pathway choices

7.1 complete/update a personal inventory; e.g., interests, values, beliefs, resources, prior learning and experiences
7.2 create a connection between a personal inventory and occupational choices

COURSE ELT1050: ELECTRONIC POWER SUPPLY 1

Level: Introductory

Prerequisite: ELT1010: Electro-assembly 1

Description: Students construct different types of alternating and direct current power supplies and demonstrate their application in electrical/electronic systems.

Parameters: Access to basic hand tools, a multimeter and related resources. Direct teacher supervision for line voltage connections.

Outcomes: The student will:

1. **identify and describe various types of alternating and direct current power supplies**
   - 1.1 distinguish and describe voltage, current and power ratings on a power supply
   - 1.2 describe AC/DC power supplies
   - 1.3 distinguish between the following various power supplies:
     - 1.3.1 transformers
     - 1.3.2 inverters
     - 1.3.3 converters
     - 1.3.4 eliminators
     - 1.3.5 battery
     - 1.3.6 solar
     - 1.3.7 voltage doubler/tripler
   - 1.4 appraise the merits and deficiencies of half-wave bridge, full-wave bridge and centre-tap rectifiers
   - 1.5 identify stages of a power supply in transformer, rectifier, filter and regulator
2. **construct a simple power supply**
   - 2.1 construct simple power supplies, using perforated circuit boards
3. **test a regulated, filtered power supply for output characteristics**
   - 3.1 measure power supply output using a multimeter
4. **demonstrate established laboratory procedures and safe work practices**
   - 4.1 demonstrate a positive attitude of personal safety
   - 4.2 identify, locate and use proper personal protective equipment
5. **demonstrate basic competencies**
   - 5.1 demonstrate fundamental skills to:
     - 5.1.1 communicate
     - 5.1.2 manage information
     - 5.1.3 use numbers
     - 5.1.4 think and solve problems
   - 5.2 demonstrate personal management skills to:
     - 5.2.1 demonstrate positive attitudes and behaviours
     - 5.2.2 be responsible
     - 5.2.3 be adaptable
     - 5.2.4 learn continuously
     - 5.2.5 work safely

5.3 demonstrate teamwork skills to:
    5.3.1 work with others
    5.3.2 participate in projects and tasks

6. make personal connections to the cluster content and processes to inform possible pathway choices

6.1 complete/update a personal inventory; e.g., interests, values, beliefs, resources, prior learning and experiences

6.2 create a connection between a personal inventory and occupational choices

COURSE ELT1080: CONTROL SYSTEMS 1

Level: Introductory

Prerequisite: ELT1010: Electro-assembly 1

Description: Students construct process control systems, demonstrate their basic operation and demonstrate procedures for testing them.

Parameters: Access to digital/analog multimeters, pressure devices and related resources.

Outcomes: The student will:

1. **identify how control systems are used in residential and commercial applications**
   - 1.1 draw and explain a process control system using block diagrams depicting each functional component and the flow of signals through the systems
2. **identify basic process control systems and explain how they function**
   - 2.1 explain the difference between open-loop and closed-loop control systems
3. **construct basic process control circuits, using passive devices**
   - 3.1 construct a basic process control system using passive devices including:
     - 3.1.1 thermistor
     - 3.1.2 pressure sensor
     - 3.1.3 proximity switch
     - 3.1.4 light control resistor
     - 3.1.5 float switch
     - 3.1.6 reed switch
     - 3.1.7 photocell
   - 3.2 explain process control terms including:
     - 3.2.1 precision
     - 3.2.2 standard
     - 3.2.3 calibration
     - 3.2.4 accuracy
     - 3.2.5 sensor
     - 3.2.6 transducers
     - 3.2.7 distortion
     - 3.2.8 transients
     - 3.2.9 sampling
     - 3.2.10 interrupt
     - 3.2.11 frequency
   - 3.3 demonstrate knowledge in measuring voltage, current and resistance in any control system using analog and digital instruments
   - 3.4 explain how to test process control circuit(s), voltage, current, continuity, opens and shorts
4. **demonstrate established laboratory procedures and safe work practices**
   - 4.1 demonstrate safe and correct procedures in measuring voltage, current and resistance using digital and analog meters

5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:
- 5.1.1 communicate
- 5.1.2 manage information
- 5.1.3 use numbers
- 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:
- 5.2.1 demonstrate positive attitudes and behaviours
- 5.2.2 be responsible
- 5.2.3 be adaptable
- 5.2.4 learn continuously
- 5.2.5 work safely

5.3 demonstrate teamwork skills to:
- 5.3.1 work with others
- 5.3.2 participate in projects and tasks

6. make personal connections to the cluster content and processes to inform possible pathway choices

6.1 complete/update a personal inventory; e.g., interests, values, beliefs, resources, prior learning and experiences

6.2 create a connection between a personal inventory and occupational choices

COURSE ELT1090: ANALOG COMMUNICATION 1

Level: Introductory

Prerequisite: ELT1010: Electro-assembly 1

Description: Students install and demonstrate the fundamentals of various consumer audio integrated systems.

Parameters: Access to consumer audio or automobile systems, multimeters and related resources.

Outcomes: The student will:

1. **distinguish the difference between terms and specifications used in analog audio systems**
   - 1.1 define audio terms and specifications; e.g., wattage, peak value, sine waves, distortion, impedance matching
   - 1.2 identify various subsystems of an audio system including:
     - 1.2.1 amplifier
     - 1.2.2 preamplifier
     - 1.2.3 equalizer
     - 1.2.4 speakers
     - 1.2.5 compact disc player
     - 1.2.6 tape
     - 1.2.7 crossover
   - 1.3 identify major components of an amplifier through the use of a block diagram, identifying power supply, preamplifier and amplifier
2. **install a functional audio system according to a given set of specifications**
   - 2.1 follow correct wiring procedures
   - 2.2 read and interpret an audio system flow connection chart
   - 2.3 install a complete audio system
   - 2.4 lay out and connect the wiring for an audio system
   - 2.5 explain and demonstrate how to test an audio device for intended function
   - 2.6 construct a simple audio device; e.g., amplifier, crossover network, fader, equalizer, distribution network, mixers or light organ
3. **service and maintain a consumer audio system**
   - 3.1 explain and demonstrate how to troubleshoot an audio system
   - 3.2 maintain an audio system by identifying and correcting problems
4. **demonstrate established laboratory procedures and safe work practices**
   - 4.1 identify causes of high current and high heat in systems
5. **demonstrate basic competencies**
   - 5.1 demonstrate fundamental skills to:
     - 5.1.1 communicate
     - 5.1.2 manage information
     - 5.1.3 use numbers
     - 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:
    5.2.1 demonstrate positive attitudes and behaviours
    5.2.2 be responsible
    5.2.3 be adaptable
    5.2.4 learn continuously
    5.2.5 work safely
5.3 demonstrate teamwork skills to:
    5.3.1 work with others
    5.3.2 participate in projects and tasks

6. make personal connections to the cluster content and processes to inform possible pathway choices

6.1 complete/update a personal inventory; e.g., interests, values, beliefs, resources, prior learning and experiences
6.2 create a connection between a personal inventory and occupational choices

COURSE ELT1110: SECURITY SYSTEMS 1

Level: Introductory

Prerequisite: ELT1010: Electro-assembly 1

Description: Students install and demonstrate the fundamentals of sensors, control units and warning devices used in security systems.

Parameters: Access to specialized equipment.

Outcomes: The student will:

1. **identify and compare different electronic systems used to secure people, property and information**
   - 1.1 distinguish between different types of security systems; e.g., monitored, stand-alone, closed-circuit, automobile, personal
   - 1.2 distinguish between various security devices; e.g., computer systems, hardwire, remote frequency systems
2. **describe and compare hardwired sensors**
   - 2.1 demonstrate how to inspect various sensors; e.g., contact closure, motion, thermal, moisture detectors
   - 2.2 demonstrate how to inspect various warning devices; e.g., dialler, siren, lights
3. **install and test a security system, evaluate circuit performance and identify possible maintenance requirements**
   - 3.1 explain and demonstrate how to install a security system
   - 3.2 demonstrate how to test and validate circuit performance using voltmeter or continuity tester
   - 3.3 explain/maintain various security systems
4. **demonstrate established laboratory procedures and safe work practices**
   - 4.1 demonstrate appropriate attitudes of personal safety
   - 4.2 identify ethical points of view in using personal security systems
5. **demonstrate basic competencies**
   - 5.1 demonstrate fundamental skills to:
     - 5.1.1 communicate
     - 5.1.2 manage information
     - 5.1.3 use numbers
     - 5.1.4 think and solve problems
   - 5.2 demonstrate personal management skills to:
     - 5.2.1 demonstrate positive attitudes and behaviours
     - 5.2.2 be responsible
     - 5.2.3 be adaptable
     - 5.2.4 learn continuously
     - 5.2.5 work safely
   - 5.3 demonstrate teamwork skills to:
     - 5.3.1 work with others
     - 5.3.2 participate in projects and tasks

6. make personal connections to the cluster content and processes to inform possible pathway choices

6.1 complete/update a personal inventory; e.g., interests, values, beliefs, resources, prior learning and experiences

6.2 create a connection between a personal inventory and occupational choices

COURSE ELT1130: ROBOTICS 1

Level: Introductory

Prerequisite: None

Description: Students apply the fundamentals of robotics systems and basic robotics functions.

Parameters: No specialized equipment or facilities.

Outcomes: The student will:

1. **describe the evolution and applications of robotics systems**
   - 1.1 distinguish between various robotics geometric systems
   - 1.2 distinguish between subsystems and their applications
2. **identify and classify programmable robotics systems and subsystems**
   - 2.1 demonstrate an understanding of AC/DC motor controls to include switching motor states
   - 2.2 identify problem/task for robotics systems
3. **identify and describe various alternative types of power sources**
   - 3.1 prototype a direct control robotics unit to illustrate the:
     - 3.1.1 use of computer-aided design
     - 3.1.2 hydraulic, pneumatic and electromechanical interfacing
     - 3.1.3 cumulative serial and parallel operations
   - 3.2 demonstrate operation of a robot through its predetermined set of functions
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems
   - 4.2 demonstrate personal management skills to:
     - 4.2.1 demonstrate positive attitudes and behaviours
     - 4.2.2 be responsible
     - 4.2.3 be adaptable
     - 4.2.4 learn continuously
     - 4.2.5 work safely
   - 4.3 demonstrate teamwork skills to:
     - 4.3.1 work with others
     - 4.3.2 participate in projects and tasks
5. **make personal connections to the cluster content and processes to inform possible pathway choices**
   - 5.1 complete/update a personal inventory; e.g., interests, values, beliefs, resources, prior learning and experiences
   - 5.2 create a connection between a personal inventory and occupational choices

COURSE ELT1140: ROBOTICS APPLICATIONS

Level: Introductory

Prerequisite: ELT1010: Electro-assembly 1

Description: Students apply the fundamentals of robotics systems and basic robotics functions.

Parameters: Access to a programmable robotics system.

Outcomes: The student will:

1. **describe the evolution and applications of programmable robotics systems**
   - 1.1 research the evolution and trends of programmable robotics systems
   - 1.2 distinguish between various programmable robotics designs
   - 1.3 explore areas where programmable robotics systems are used including outer space, medicine, manufacturing and military
2. **identify and classify programmable robotics systems and subsystems**
   - 2.1 distinguish between subsystems and their applications
   - 2.2 identify and distinguish between teach pendant and software programming
3. **identify and describe various alternative types of power sources**
   - 3.1 identify and describe the following power sources:
     - 3.1.1 electrochemical
     - 3.1.2 pneumatic
     - 3.1.3 solar (traditional and fuel cell)
     - 3.1.4 wind
     - 3.1.5 hydraulic
     - 3.1.6 biological
     - 3.1.7 electromagnetic
4. **build and program a programmable robotics system**
   - 4.1 identify program download strategies including:
     - 4.1.1 teach pendant
     - 4.1.2 hardwire
     - 4.1.3 wireless
5. **design and build a direct control robotics system**
   - 5.1 prototype a robot by:
     - 5.1.1 identifying a problem/task for a robotics system
     - 5.1.2 constructing using an engineered system
     - 5.1.3 performing serial and/or parallel operations
     - 5.1.4 demonstrating operation of a robot through its predetermined set of functions
   - 5.2 demonstrate an understanding of DC motor controls to include:
     - 5.2.1 switching motor states using a program
6. **demonstrate established laboratory procedures and safe work practices**
   - 6.1 follow laboratory safety procedures
   - 6.2 adhere to safe equipment practices and personal protection

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:
- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:
- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:
- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. make personal connections to the cluster content and processes to inform possible pathway choices

8.1 complete/update a personal inventory; e.g., interests, values, beliefs, resources, prior learning and experiences

8.2 create a connection between a personal inventory and occupational choices

COURSE ELT1910: ELT PROJECT A

Level: Introductory

Prerequisite: None

Description: Students develop project design and management skills to extend and enhance competencies and skills in other CTS courses through contexts that are personally relevant.

Parameters: Introductory project courses must connect with a minimum of two CTS courses, one of which must be at the introductory level and be in the same occupational area as the project course. The other CTS course(s) can be either at the same level or at the intermediate level from any occupational area.

Project courses cannot be connected to other project courses or practicum courses.

All projects and/or performances, whether teacher- or student-led, must include a course outline or student proposal.

Outcomes:

The teacher/student will:

1. **identify the connection between this project course and two or more CTS courses**
   - 1.1 identify the outcome(s) from each identified CTS course that support the project and/or performance deliverables
   - 1.2 explain how these outcomes are being connected to the project and/or performance deliverables
2. **propose the project and/or performance**
   - 2.1 identify the project and/or performance by:
     - 2.1.1 preparing a plan
     - 2.1.2 clarifying the purposes
     - 2.1.3 defining the deliverables
     - 2.1.4 specifying time lines
     - 2.1.5 explaining terminology, tools and processes
     - 2.1.6 defining resources; e.g., materials, costs, staffing
   - 2.2 identify and comply with all related health and safety standards
   - 2.3 define assessment standards (indicators for success)
   - 2.4 present the proposal and obtain necessary approvals

The student will:

3. **meet goals as defined within the plan**
   - 3.1 complete the project and/or performance as outlined
   - 3.2 monitor the project and/or performance and make necessary adjustments
   - 3.3 present the project and/or performance, indicating the:
     - 3.3.1 outcomes attained
     - 3.3.2 relationship of outcomes to goals originally set

3.4 evaluate the project and/or performance, indicating the:
    3.4.1 processes and strategies used
    3.4.2 recommendations on how the project and/or performance could have been improved

4. demonstrate basic competencies

4.1 demonstrate fundamental skills to:
    4.1.1 communicate
    4.1.2 manage information
    4.1.3 use numbers
    4.1.4 think and solve problems
4.2 demonstrate personal management skills to:
    4.2.1 demonstrate positive attitudes and behaviours
    4.2.2 be responsible
    4.2.3 be adaptable
    4.2.4 learn continuously
    4.2.5 work safely
4.3 demonstrate teamwork skills to:
    4.3.1 work with others
    4.3.2 participate in projects and tasks

5. make personal connections to the cluster content and processes to inform possible pathway choices

5.1 complete/update a personal inventory; e.g., interests, values, beliefs, resources, prior learning and experiences
5.2 create a connection between a personal inventory and occupational choices

COURSE ELT2010: ELECTRO-ASSEMBLY 2

Level: Intermediate

Prerequisite: ELT1010: Electro-assembly 1

Description: Students apply electro-assembly technology to manufacture circuit boards.

Parameters: Access to a printed circuit fabrication kit and related resources.

Outcomes: The student will:

1. **identify appropriate construction methods to fabricate a circuit board**
   - 1.1 research the benefits and drawbacks of prototype construction assembly methods
2. **lay out and construct a simple electronic circuit board, using approved construction techniques**
   - 2.1 use schematic symbols to represent electronic components
   - 2.2 draw and/or modify schematic diagrams for a simple electronic circuit
   - 2.3 match actual components to schematic symbols
   - 2.4 use an etch-resistant pen or photographic method to make a circuit board project
3. **use a printed circuit board and proper fabrication techniques to assemble a project**
   - 3.1 prototype an electronic circuit on a breadboard
   - 3.2 create the artwork circuit layout drawing for a printed circuit board
   - 3.3 practise printed circuit board building and component installation
   - 3.4 demonstrate appropriate safety techniques when using solder and chemicals for prototype construction
   - 3.5 evaluate the circuit using electronic instruments
   - 3.6 demonstrate how to troubleshoot an electronic circuit board
4. **demonstrate established laboratory procedures and safe work practices**
   - 4.1 research illnesses caused by chemicals, solder and flux used in prototype construction
   - 4.2 identify and follow safe home/laboratory procedures while using solder, flux, photochemicals, cleaning chemicals and etching chemicals
5. **demonstrate basic competencies**
   - 5.1 demonstrate fundamental skills to:
     - 5.1.1 communicate
     - 5.1.2 manage information
     - 5.1.3 use numbers
     - 5.1.4 think and solve problems
   - 5.2 demonstrate personal management skills to:
     - 5.2.1 demonstrate positive attitudes and behaviours
     - 5.2.2 be responsible
     - 5.2.3 be adaptable
     - 5.2.4 learn continuously
     - 5.2.5 work safely
   - 5.3 demonstrate teamwork skills to:
     - 5.3.1 work with others
     - 5.3.2 participate in projects and tasks
6. **identify possible life roles related to the skills and content of this cluster**
   - 6.1 recognize and then analyze the opportunities and barriers in the immediate environment
   - 6.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2020: ELECTRICAL SERVICING

Level: Intermediate

Prerequisite: ELT1010: Electro-assembly 1

Description: Students demonstrate the fundamental concepts of repairing, servicing and maintaining electrical and electronic equipment.

Parameters: Access to basic hand tools, testing equipment and related resources.

Supporting Course: ELT2010: Electro-assembly 2

Outcomes: The student will:

1. **develop a basic repair and maintenance schedule for an electrical or electronic device**
   - 1.1 define current, resistance, magnetic field, voltage rating, temperature and wattage
   - 1.2 identify the types of data found on a name plate
   - 1.3 explain why the Canadian Standards Association (CSA) standards are applied to appliances
   - 1.4 create a service schedule including:
     - 1.4.1 nameplate data
     - 1.4.2 stages of operation
     - 1.4.3 charts and wiring schematics
     - 1.4.4 grounding techniques
     - 1.4.5 protection devices
     - 1.4.6 function of the unit
     - 1.4.7 frequency of use
     - 1.4.8 subjected conditions
     - 1.4.9 age
     - 1.4.10 cost of service
     - 1.4.11 cost of replacement service and cost to maintain and repair electrical or electronic devices by identifying potential problems and correcting
2. **identify faults in an electrical or electronic device and propose solutions for repair**
   - 2.1 identify stages of operation of various types of electrical or electronic systems
   - 2.2 interpret a flow connection chart or wiring schematic of the system
   - 2.3 troubleshoot an electrical or electronic device
   - 2.4 explain and demonstrate how to repair electronic printed circuit boards
   - 2.5 measure the voltage, current and wattage of repaired items and compare the values with the nameplate ratings
3. **use appropriate testing procedures to assess/repair an electrical or electronic device**
   - 3.1 describe standard procedures to locate circuit/component faults
   - 3.2 identify the problem and propose a solution to affect the repair
   - 3.3 use measurement techniques related to voltage, current, resistance, wattage and continuity to appraise the condition of the circuit
4. **demonstrate established laboratory procedures and safe work practices**
   - 4.1 demonstrate a professional attitude of personal safety
   - 4.2 use proper grounding techniques, current protection and static protection when testing electronic circuits

5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:
- 5.1.1 communicate
- 5.1.2 manage information
- 5.1.3 use numbers
- 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:
- 5.2.1 demonstrate positive attitudes and behaviours
- 5.2.2 be responsible
- 5.2.3 be adaptable
- 5.2.4 learn continuously
- 5.2.5 work safely

5.3 demonstrate teamwork skills to:
- 5.3.1 work with others
- 5.3.2 participate in projects and tasks

6. identify possible life roles related to the skills and content of this cluster

6.1 recognize and then analyze the opportunities and barriers in the immediate environment

6.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2030: BRANCH CIRCUIT WIRING

Level: Intermediate

Prerequisite: ELT1030: Conversion & Distribution

Description: Students demonstrate the fundamentals of branch circuit wiring used in residential/commercial buildings.

Parameters: Access to basic hand tools, a multimeter and related resources.

Note: The student must have access to instruction from an individual with journeyman qualifications when projects are hardwired to main power supply and for permanent usage.

Outcomes: The student will:

1. **identify and describe various branch wiring systems used in residential and commercial applications**
   - 1.1 draw schematic and pictorial diagrams of branch circuit wiring
   - 1.2 interpret architectural drawings regarding branch circuit wiring
   - 1.3 identify various wiring systems, methods and materials including:
     - 1.3.1 nonmetallic shielded cable (NMSC)
     - 1.3.2 armoured cable (BX)
     - 1.3.3 conduit and conductors
     - 1.3.4 teck cable
     - 1.3.5 raceway systems
     - 1.3.6 mineral insulated cable (Pyrotenex)
     - 1.3.7 wire mould
2. **apply Canadian Electrical Code (CEC) standards to various branch wiring system designs**
   - 2.1 compare series and parallel branch wiring circuits
   - 2.2 identify live, grounding and grounded branch circuit conductors
   - 2.3 measure voltage, current and continuity
   - 2.4 research requirements for obtaining an electrical permit
   - 2.5 identify CEC standards in branch circuit design and installation
3. **wire a branch circuit for a residential application**
   - 3.1 demonstrate how to connect wiring to comply with CEC, local and Alberta standards
   - 3.2 demonstrate safe practices regarding grounding and overload protection of circuits and devices, such as case/receptacle grounding
   - 3.3 construct, according to CEC standards, the following branch circuits in NMSC:
     - 3.3.1 standard receptacle
     - 3.3.2 single location lamp switching
     - 3.3.3 switch receptacle
     - 3.3.4 range and/or dryer receptacle
     - 3.3.5 split receptacle
     - 3.3.6 multiple locations lamp switching
     - 3.3.7 ground fault interrupter (GFI) receptacle

3.4 construct, according to CEC standards, one of the above branch circuits using:
    3.4.1 armoured cable
    3.4.2 conduit raceway
3.5 install breakers and terminate branch circuit wiring in a single phase panelboard

4. demonstrate established laboratory procedures and safe work practices

4.1 describe the danger of electrical shocks and burns
4.2 describe lockout/tagout practices

5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:
    5.1.1 communicate
    5.1.2 manage information
    5.1.3 use numbers
    5.1.4 think and solve problems
5.2 demonstrate personal management skills to:
    5.2.1 demonstrate positive attitudes and behaviours
    5.2.2 be responsible
    5.2.3 be adaptable
    5.2.4 learn continuously
    5.2.5 work safely
5.3 demonstrate teamwork skills to:
    5.3.1 work with others
    5.3.2 participate in projects and tasks

6. identify possible life roles related to the skills and content of this cluster

6.1 recognize and then analyze the opportunities and barriers in the immediate environment
6.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2050: ELECTRONIC POWER SUPPLY 2

Level: Intermediate

Prerequisite: ELT1050: Electronic Power Supply 1

Description: Students construct and demonstrate the fundamentals of electronic power supply technology.

Parameters: Access to an oscilloscope, a multimeter, an isolation transformer and related resources.

Supporting Course: ELT2010: Electro-assembly 2

Outcomes: The student will:

1. **construct, analyze and evaluate single-phase rectifiers**
   - 1.1 identify components responsible for improved output of a regulated filtered power supply
   - 1.2 explain the fundamentals of diodes, zeners, transistors and operational amplifiers
2. **observe and test the voltage and waveform of a switching power supply**
   - 2.1 diagram half-wave bridge, full-wave bridge and centre-tap rectifiers
   - 2.2 identify current path in half-wave bridge, full-wave bridge and centre-tap rectifiers
3. **build and analyze the characteristics of a power supply regulated by a zener transistor**
   - 3.1 construct, energize, measure and graph the input and output of half-wave bridge, full-wave bridge and centre-tap rectifiers, and regulated power supply
4. **build, test and analyze filtering circuits used in electronic power supplies**
   - 4.1 mathematically analyze output voltage, ripple frequency and required peak inverse voltage of a half-wave bridge, full-wave bridge and centre-tap rectifier
   - 4.2 mathematically determine component values for the construction of a regulated power supply
   - 4.3 set-up, test and analyze a switching power supply
   - 4.4 construct a full-wave, filtered and regulated power supply
   - 4.5 test regulated power supply
5. **demonstrate established laboratory procedures and safe work practices**
   - 5.1 use an isolation transformer
   - 5.2 demonstrate safe practices, especially regarding grounding and using an oscilloscope
6. **demonstrate basic competencies**
   - 6.1 demonstrate fundamental skills to:
     - 6.1.1 communicate
     - 6.1.2 manage information
     - 6.1.3 use numbers
     - 6.1.4 think and solve problems
   - 6.2 demonstrate personal management skills to:
     - 6.2.1 demonstrate positive attitudes and behaviours
     - 6.2.2 be responsible
     - 6.2.3 be adaptable
     - 6.2.4 learn continuously
     - 6.2.5 work safely

6.3 demonstrate teamwork skills to:
    6.3.1 work with others
    6.3.2 participate in projects and tasks

7. identify possible life roles related to the skills and content of this cluster

7.1 recognize and then analyze the opportunities and barriers in the immediate environment
7.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2080: CONTROL SYSTEMS 2

Level: Intermediate

Prerequisite: ELT1080: Control Systems 1

Description: Students demonstrate how process control technology is used in real-world applications.

Parameters: Access to a power supply, an oscilloscope, a transistor checker, breadboards, a frequency counter, a digital multimeter and related resources.

Outcomes: The student will:

1. **identify discrete components used in process control**
   - 1.1 relate schematic diagrams and connection symbols to real-world devices
   - 1.2 explain differences between alternating current (AC) and direct current (DC) as they relate to semiconductor components
   - 1.3 explain the differences among the following circuit conditions:
     - 1.3.1 grounded system
     - 1.3.2 floating system
     - 1.3.3 isolated system
   - 1.4 explain the voltage, current and resistance differences among series, parallel and series parallel circuits, using Ohm's law
2. **identify and describe analog and sensor components used in process control**
   - 2.1 describe an analog signal through both open- and closed-loop control systems
   - 2.2 research applications of solid-state control circuits in automotive, home and industrial application systems
3. **construct a process control device, using analog and sensor components**
   - 3.1 explain, experiment with and demonstrate knowledge of various semiconductor components by prototyping mini control circuits in various applications including:
     - 3.1.1 rectifiers
     - 3.1.2 silicon controlled rectifier transistors
     - 3.1.3 unijunction transistors
     - 3.1.4 triac
     - 3.1.5 diac
     - 3.1.6 field-effect transistors
     - 3.1.7 junction field-effect transistors
     - 3.1.8 metal-oxide-semiconductor field-effect transistors
     - 3.1.9 timers; e.g., 555s
     - 3.1.10 operational amplifiers
     - 3.1.11 solid-state relays
   - 3.2 explain, experiment with and demonstrate various semiconductor transducers and sensors including:
     - 3.2.1 thermistor
     - 3.2.2 pressure sensor
     - 3.2.3 photoelectric transducers
     - 3.2.4 hall effect
     - 3.2.5 optocouplers

3.2.6 bar codes
3.2.7 light controller resistors
3.2.8 light-emitting diode
3.2.9 photodiode
3.2.10 phototransistor
3.2.11 proximity switches

3.3 construct an electronic project(s) to control home environment or vehicle function by:
3.3.1 troubleshooting the project
3.3.2 writing a technical report describing the control system operation
3.3.3 developing a flow chart and block diagram to show process control in project(s)

3.4 demonstrate correct use and procedure in operating an oscilloscope

3.5 demonstrate knowledge of testing semiconductor components including transducers and sensors, multimeters, oscilloscopes, solid-state testers

4. demonstrate established laboratory procedures and safe work practices

4.1 describe hazards associated with voltage, including capacitor discharge, currents, grounded systems, floating systems and isolated systems

5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:
5.1.1 communicate
5.1.2 manage information
5.1.3 use numbers
5.1.4 think and solve problems

5.2 demonstrate personal management skills to:
5.2.1 demonstrate positive attitudes and behaviours
5.2.2 be responsible
5.2.3 be adaptable
5.2.4 learn continuously
5.2.5 work safely

5.3 demonstrate teamwork skills to:
5.3.1 work with others
5.3.2 participate in projects and tasks

6. identify possible life roles related to the skills and content of this cluster

6.1 recognize and then analyze the opportunities and barriers in the immediate environment

6.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2090: ANALOG COMMUNICATION 2

Level: Intermediate

Prerequisite: ELT1090: Analog Communication 1

Description: Students demonstrate the fundamental concepts of electronic analog communication systems.

Parameters: Access to an oscilloscope, a signal generator, a transistor checker, a multimeter, a decibel (dB) meter and related resources.

Outcomes: The student will:

1. **identify characteristics of analog communication systems**
   - 1.1 research the history of the beginnings of electrical communication
   - 1.2 describe what is meant by an analog signal
   - 1.3 identify various devices used to convert sound into electrical signals
   - 1.4 explain how an electrical signal is turned into sound
   - 1.5 mathematically determine component values for crossover/band pass filters
   - 1.6 describe how an FM or AM radio station, a television station or a theatre uses communication equipment
2. **explain analog communication technology through project design, construction, experimentation, circuit analysis and electronic component identification**
   - 2.1 draw and explain the block diagram of a simple communication model
   - 2.2 identify the differences between wire and wireless telephone systems' technology and networking
   - 2.3 using a block diagram, explain the operation of the following forms of analog electronic communication systems:
     - 2.3.1 telephones
     - 2.3.2 audio amplifiers
     - 2.3.3 intercom systems
     - 2.3.4 light and sound boards
     - 2.3.5 automotive sensors (analog)
   - 2.4 build a small audio amplifier and/or intercom for personal use
   - 2.5 construct a speaker system with low-, mid- and high-range speakers with appropriate crossover networks such as an intercom system
   - 2.6 test the project using analog test instruments such as an analog multimeter and an oscilloscope
3. **demonstrate established laboratory procedures and safe work practices**
   - 3.1 identify and describe the difference between a dB meter and dB ratings of communications systems and the effects on human hearing
   - 3.2 troubleshoot, repair and maintain analog communication systems used in the home including:
     - 3.2.1 portable stereo systems
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems

4.2 demonstrate personal management skills to:
    4.2.1 demonstrate positive attitudes and behaviours
    4.2.2 be responsible
    4.2.3 be adaptable
    4.2.4 learn continuously
    4.2.5 work safely
4.3 demonstrate teamwork skills to:
    4.3.1 work with others
    4.3.2 participate in projects and tasks

5. identify possible life roles related to the skills and content of this cluster

5.1 recognize and then analyze the opportunities and barriers in the immediate environment
5.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2110: SECURITY SYSTEMS 2

Level: Intermediate

Prerequisite: ELT1110: Security Systems 1

Description: Students demonstrate the fundamentals of security technology used in homes, businesses and transportation systems.

Parameters: Access to a digital multimeter, a soldering station, a breadboard, a power supply, hand tools and related resources.

Supporting Course: ELT2080: Control Systems 2

Outcomes: The student will:

1. **identify and describe elements of a security system**
   - 1.1 explain terms including:
     - 1.1.1 transceivers
     - 1.1.2 frequency
     - 1.1.3 microwave
     - 1.1.4 infrared radiation
     - 1.1.5 relays
     - 1.1.6 open and closed contact switches
   - 1.2 research long-range security monitoring
2. **identify detection and notification devices**
   - 2.1 identify and describe the following detection devices:
     - 2.1.1 proximity switches
     - 2.1.2 contact switches
     - 2.1.3 vibration detector
     - 2.1.4 glass breakage detector (foil strip)
     - 2.1.5 photoelectric beam
     - 2.1.6 ultrasonic motion detector
     - 2.1.7 microwave motion detector
     - 2.1.8 passive infrared motion detector
     - 2.1.9 dual technology detectors
     - 2.1.10 audio switch or sound discriminators
   - 2.2 explain, experiment with or connect various notification devices
3. **fabricate and operate a detection and notification alarm system for home or car use**
   - 3.1 identify the following three basic elements of a security system:
     - 3.1.1 control panel
     - 3.1.2 detection devices
     - 3.1.3 means of notification (alarm)
   - 3.2 research the differences between two different security systems
   - 3.3 install, test and demonstrate an advanced security system incorporating a control panel, detectors and notification devices
   - 3.4 explain the operation of various notification alarms by:
     - 3.4.1 identifying who is notified by each type of alarm
   - 3.5 design or construct an electronic security system for personal use

3.6 create a flowchart and block diagram to show detection, monitoring and alarm signals
3.7 write a technical report describing the security system

4. demonstrate established laboratory procedures and safe work practices

4.1 describe voltage and current hazards of security systems
4.2 demonstrate correct handling of batteries used in security systems
4.3 demonstrate how to recharge a battery safely

5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:
- 5.1.1 communicate
- 5.1.2 manage information
- 5.1.3 use numbers
- 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:
- 5.2.1 demonstrate positive attitudes and behaviours
- 5.2.2 be responsible
- 5.2.3 be adaptable
- 5.2.4 learn continuously
- 5.2.5 work safely

5.3 demonstrate teamwork skills to:
- 5.3.1 work with others
- 5.3.2 participate in projects and tasks

6. identify possible life roles related to the skills and content of this cluster

6.1 recognize and then analyze the opportunities and barriers in the immediate environment
6.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2120: ELECTRO-OPTICS

Level: Intermediate

Prerequisite: None

Description: Students demonstrate basic knowledge of lasers and other light wave communication applications in various electronic systems.

Parameters: Access to a laser experimental kit and related resources.

Outcomes: The student will:

1. identify common types and classes of lasers
- 1.1 define the word laser
- 1.2 research Canadian Standards Association (CSA) standards/guidelines for lasers
- 1.3 define lasers in terms of power
- 1.4 draw a block diagram of a laser
- 1.5 explain four unique properties of laser light
- 1.6 describe how light can be used as a modulation medium
- 1.7 research laser technology applications

2. explain the operation of laser, fibre optic, infrared and hologram light wave technology
- 2.1 define fibre optics, infrared and hologram
- 2.2 explain the following terms as related to fibre optics:
  - 2.2.1 reflection
  - 2.2.2 refraction
  - 2.2.3 lenses
  - 2.2.4 focal length
  - 2.2.5 absorption
  - 2.2.6 angle of incidence
  - 2.2.7 bar code
  - 2.2.8 cladding
  - 2.2.9 core
  - 2.2.10 attenuation
- 2.3 explain the operation of infrared communication systems
- 2.4 explain the process of producing a hologram
- 2.5 explain the six major types of lenses
- 2.6 explain the effect prisms have on light
- 2.7 explain beam splitters
- 2.8 describe the effects the following filters have on light:
  - 2.8.1 coloured gel
  - 2.8.2 interference
  - 2.8.3 dichroic
- 2.9 explain diffraction gratings
- 2.10 explain terms used in laser technology including:
  - 2.10.1 photon
  - 2.10.2 ground state
  - 2.10.3 excited state
  - 2.10.4 spontaneous emission

2.10.5 stimulated emission of radiation
2.10.6 pumping
2.10.7 population inversion
2.10.8 light amplification
2.10.9 lenses
2.10.10 multiwatt lasers

2.11 identify and explain the operation of the following laser components:
2.11.1 power supply
2.11.2 pumping device
2.11.3 lazing medium
2.11.4 optical resonant cavity

2.12 define the following types of lasers:
2.12.1 crystal and glass
2.12.2 excimer
2.12.3 chemical
2.12.4 semiconductor
2.12.5 gas lasers including:
2.12.5.1 helium–neon (HeNe)
2.12.5.2 argon
2.12.5.3 carbon dioxide
2.12.5.4 krypton

2.13 draw a diagram of a HeNe-neon laser

3. construct an electro-optical project

3.1 prototype, experiment with and analyze the following light wave communication devices:
3.1.1 a visible light-emitting diode transmitter
3.1.2 an alarm circuit using a phototransistor or optocoupler
3.1.3 a simple infrared remote control device
3.1.4 using a fibre optic cable to route light to a remote location
3.1.5 transmitting analog data through a fibre using a diode laser
3.1.6 constructing a simple alarm using high intensity visible light-emitting diode

3.2 prototype, analyze and construct an advanced laser, fibre optical, infrared or hologram project including:
3.2.1 a HeNe laser experimenters system
3.2.2 a pocket laser diode
3.2.3 an infrared push-button remote control
3.2.4 an infrared wireless speaker system
3.2.5 retro-fitted old equipment using a remote control
3.2.6 a laser light show
3.2.7 a fibre optical communication system
3.2.8 a fibre optic vibration detection
3.2.9 a system for the home
3.2.10 a split-beam transmission hologram

4. demonstrate established laboratory procedures and safe work practices

4.1 follow safe practices when:
4.1.1 using potentially hazardous materials in project construction
4.1.2 laser light radiation is present
4.1.3 exposed to high voltages around lasers
4.1.4 using laser classes I, II, III, IV
4.1.5 working with high voltage capacitors

5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:

- 5.1.1 communicate
- 5.1.2 manage information
- 5.1.3 use numbers
- 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:

- 5.2.1 demonstrate positive attitudes and behaviours
- 5.2.2 be responsible
- 5.2.3 be adaptable
- 5.2.4 learn continuously
- 5.2.5 work safely

5.3 demonstrate teamwork skills to:

- 5.3.1 work with others
- 5.3.2 participate in projects and tasks

6. identify possible life roles related to the skills and content of this cluster

6.1 recognize and then analyze the opportunities and barriers in the immediate environment

6.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2130: MAGNETIC CONTROL DEVICES

Level: Intermediate

Prerequisite: ELT1010: Electro-assembly 1

Description: Students demonstrate the fundamentals of electromagnetic control devices.

Parameters: Access to a multimeter, a clamp-on ammeter, a power supply, hand tools and related resources.

Outcomes: The student will:

1. **identify and state the function of electromagnetic control devices**
   - 1.1 research the benefits and drawbacks of electromagnetic and solid-state relays
   - 1.2 identify coil voltage and frequency ratings
   - 1.3 identify contact voltage and current ratings
   - 1.4 compare and contrast the use of relays, solenoids and actuators in electrical circuits
   - 1.5 demonstrate knowledge of electromagnetism
2. **explain the operation of electromagnetically controlled systems**
   - 2.1 demonstrate knowledge of activation principles
3. **design and construct electromagnetic circuits, using ladder logic systems and wiring diagrams**
   - 3.1 draw a schematic and wiring diagram and construct the following electromagnetic circuits:
     - 3.1.1 toggle switch controls load
     - 3.1.2 stop/start button controls load
     - 3.1.3 toggle switch controls
     - 3.1.4 limit switches
     - 3.1.5 stop/start from two locations
     - 3.1.6 jogging
     - 3.1.7 reversing
     - 3.1.8 annuciator and indicators
   - 3.2 create a flowchart of various magnetic control systems
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems
   - 4.2 demonstrate personal management skills to:
     - 4.2.1 demonstrate positive attitudes and behaviours
     - 4.2.2 be responsible
     - 4.2.3 be adaptable
     - 4.2.4 learn continuously
     - 4.2.5 work safely
   - 4.3 demonstrate teamwork skills to:
     - 4.3.1 work with others
     - 4.3.2 participate in projects and tasks
5. **identify possible life roles related to the skills and content of this cluster**
   - 5.1 recognize and then analyze the opportunities and barriers in the immediate environment
   - 5.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2140: ROBOTICS 2

Level: Intermediate

Prerequisite: ELT1130: Robotics 1
OR
ELT1140: Robotics Applications

Description: Students demonstrate the fundamental concepts of sensor devices and control systems by building an electronic circuit to control a direct wire or mobile robot.

Parameters: Access to a multimeter, a power supply, soldering stations, hand tools and related resources.

Outcomes: The student will:

1. **design and build a sensor device and control system for the robotic system**
   - 1.1 demonstrate the principles of photoelectric, sound, tactile, proximity and thermal sensors
   - 1.2 explain the operation of the electronic components and circuits used to build sensor controls
   - 1.3 explain how sensor control systems are used to control the drive circuit
   - 1.4 assemble electronic components to build a sensor
2. **identify sensor control systems and subsystems used in robotic systems**
   - 2.1 draw and explain the various blocks in a sensor control system
   - 2.2 describe and explain sight, sound and tactile sensor devices
   - 2.3 explain the fundamentals of the control system operating the motor drives in the robotic system
   - 2.4 identify the differences among drive systems, sensor control systems and processing systems
3. **explain sensory control circuits and components used in the robotic control system**
   - 3.1 research the benefits and drawbacks of various sensory devices that are used to control the robot
   - 3.2 describe where industry is making use of sensory control robots
4. **operate and demonstrate the capabilities of a robotic system equipped with sensor controls**
   - 4.1 demonstrate a knowledge of sensory control systems by building a sensor control for the robot system selecting from the following:
     - 4.1.1 photoelectric
     - 4.1.2 sound
     - 4.1.3 tactile
     - 4.1.4 proximity
     - 4.1.5 thermal
   - 4.2 prototype a sensory control system and construct the circuit so that the sensor controls the motors on the robot
   - 4.3 build a sensory control and mount the sensory control on the control robot
   - 4.4 draw the schematic diagram of the sensor control circuit
5. **demonstrate established laboratory procedures and safe work practices**
   - 5.1 demonstrate safe wiring practices when building a sensory control system
   - 5.2 use protection devices for all circuits including fusing and temperature cutoff
   - 5.3 operate robotic systems within design tolerances

6. demonstrate basic competencies

- 6.1 demonstrate fundamental skills to:
  - 6.1.1 communicate
  - 6.1.2 manage information
  - 6.1.3 use numbers
  - 6.1.4 think and solve problems
- 6.2 demonstrate personal management skills to:
  - 6.2.1 demonstrate positive attitudes and behaviours
  - 6.2.2 be responsible
  - 6.2.3 be adaptable
  - 6.2.4 learn continuously
  - 6.2.5 work safely
- 6.3 demonstrate teamwork skills to:
  - 6.3.1 work with others
  - 6.3.2 participate in projects and tasks

7. identify possible life roles related to the skills and content of this cluster

- 7.1 recognize and then analyze the opportunities and barriers in the immediate environment
- 7.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2150: ELECTRONIC CONTROLS

Level: Intermediate

Prerequisite: ELT2130: Magnetic Control Devices

Description: Students demonstrate the fundamentals of ladder/relay logic programming and how the programmable logic controller (PLC) system operates.

Parameters: Access to a programmable logic controller, a soldering station, hand tools and related resources.

Note: The student must have access to instruction from an individual with journeyman qualifications when projects are hardwired to main power supply and intended for permanent usage.

Outcomes: The student will:

1. **explain basic input and output hardware and fundamentals of basic programming in PLC systems**
   - 1.1 research the benefits and drawbacks of using PLC systems
   - 1.2 research where, how and why PLCs are used in industry
2. **write a basic programming logic code, through real or programmed inputs on a PLC system to operate and control electromagnetic devices**
   - 2.1 draw and identify the various blocks of a PLC system
   - 2.2 draw PLC ladder programs complete with wiring diagrams of inputs and outputs systems
   - 2.3 describe and explain numbering systems and codes
   - 2.4 plan PLC ladder programs and wiring diagrams of the PLC system
   - 2.5 demonstrate the fundamentals of logic
   - 2.6 compare relay logic control and PLC programming
   - 2.7 convert relay ladder diagrams into PLC ladder programs
   - 2.8 identify the differences between a wired relay motor control panel and a PLC motor control panel
3. **wire, operate and test a programmable electromagnetic device**
   - 3.1 build and program a multi-input/output PLC control installation
   - 3.2 demonstrate principles of electromagnetic relay output devices to control motors
   - 3.3 demonstrate the action of switch devices as an input sensor device
   - 3.4 design the relay logic program and construct the input and output devices so that the PLC can control electromagnetic and indicator lamps
   - 3.5 demonstrate a knowledge of PLC function by writing basic programs to operate a simple relay logic control of AC motors
   - 3.6 explain how an AC motor is operated by a PLC
4. **demonstrate established laboratory procedures and safe work practices**
   - 4.1 demonstrate safe wiring practices when wiring the input and output circuits
   - 4.2 use protection devices for all circuits

5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:
- 5.1.1 communicate
- 5.1.2 manage information
- 5.1.3 use numbers
- 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:
- 5.2.1 demonstrate positive attitudes and behaviours
- 5.2.2 be responsible
- 5.2.3 be adaptable
- 5.2.4 learn continuously
- 5.2.5 work safely

5.3 demonstrate teamwork skills to:
- 5.3.1 work with others
- 5.3.2 participate in projects and tasks

6. identify possible life roles related to the skills and content of this cluster

6.1 recognize and then analyze the opportunities and barriers in the immediate environment

6.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2160: ROBOTICS SENSOR 1

Level: Intermediate

Prerequisite: ELT1140: Robotics Applications

Description: Students demonstrate how basic sensors are used in a robotic system.

Parameters: Access to a programmable robotic system with basic sensors and a digital multimeter.

Outcomes: The student will:

1. **describe the difference between active and passive sensors**
   - 1.1 describe active and passive sensors and compare when each would be used
2. **identify and describe basic sensors used in programmable robotics systems**
   - 2.1 describe how a basic sensor signal is produced and "read" by the programmable robotics system
   - 2.2 identify and describe the uses of the following sensors:
     - 2.2.1 touch
     - 2.2.2 imaging
     - 2.2.3 light
     - 2.2.4 speech
     - 2.2.5 sound
     - 2.2.6 smell
     - 2.2.7 temperature
     - 2.2.8 ultrasonic
     - 2.2.9 rotation
3. **verify sensory input conversion, interpretation and reaction in programmable robotics systems**
   - 3.1 identify programmable robotics system sensor signal input requirements
4. **devise a programmable robotics system using at least three sensors to complete a task**
   - 4.1 develop a design solution including sensor specifications for robotics function to meet design drive criteria
   - 4.2 solve a design problem incorporating at least three sensors with a minimum of one active and one passive sensor
   - 4.3 construct a programmable robotics system to meet design criteria
   - 4.4 program a programmable robotics system to accomplish design criteria
5. **demonstrate established laboratory procedures and safe work practices**
   - 5.1 explain motor loading and safe sensor operating ranges
   - 5.2 identify and follow laboratory safety procedures
6. **demonstrate basic competencies**
   - 6.1 demonstrate fundamental skills to:
     - 6.1.1 communicate
     - 6.1.2 manage information
     - 6.1.3 use numbers
     - 6.1.4 think and solve problems
   - 6.2 demonstrate personal management skills to:
     - 6.2.1 demonstrate positive attitudes and behaviours
     - 6.2.2 be responsible
     - 6.2.3 be adaptable
     - 6.2.4 learn continuously
     - 6.2.5 work safely

6.3 demonstrate teamwork skills to:
    6.3.1 work with others
    6.3.2 participate in projects and tasks

7. identify possible life roles related to the skills and content of this cluster

7.1 recognize and then analyze the opportunities and barriers in the immediate environment
7.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2170: ROBOTICS SENSOR 2

Level: Intermediate

Prerequisite: ELT2160: Robotics Sensor 1

Description: Students demonstrate how specialized sensors are used in a robotic system.

Parameters: Access to programmable robotic system with specialized sensors.

Outcomes: The student will:

1. **identify and describe specialized sensors used in programmable robotic system**
   - 1.1 describe what a digital input is
   - 1.2 describe what an analog input is
   - 1.3 identify and describe the following sensors and their uses:
     - 1.3.1 colour
     - 1.3.2 speed
     - 1.3.3 balance (gyro)
     - 1.3.4 hall effect
     - 1.3.5 pressure
     - 1.3.6 angle sensor
     - 1.3.7 current
     - 1.3.8 compass
     - 1.3.9 voltage
     - 1.3.10 humidity
     - 1.3.11 position
     - 1.3.12 air pressure
     - 1.3.13 pH sensor
     - 1.3.14 accelerometer
     - 1.3.15 infrared
     - 1.3.16 global positioning system
2. **describe sensory input conversion, interpretation and reaction in robotics systems**
   - 2.1 using design requirements select sensor type and source technical data and manufacturer
3. **identify and specify interface between processor and sensor**
   - 3.1 identify processor and sensor compatibility with respect to voltage and current requirements
   - 3.2 specify interface components required for processor and sensor compatibility
4. **develop a robotic system using at least three specialized sensors to complete a specific task**
   - 4.1 develop a design solution including specialized sensor specifications for programmable robotic functions to meet design criteria
   - 4.2 solve a design problem incorporating three specialized sensors
   - 4.3 construct a programmable robotics system to meet design criteria
   - 4.4 program a programmable robotic system to accomplish design criteria
   - 4.5 test the robotic system to verify that fabrication and programming meet design criteria
5. **demonstrate established laboratory procedures and safe work practices**
   - 5.1 identify and follow laboratory safety procedures
   - 5.2 identify processor protection devices
   - 5.3 identify ancillary circuit protection devices

6. demonstrate basic competencies

6.1 demonstrate fundamental skills to:
- 6.1.1 communicate
- 6.1.2 manage information
- 6.1.3 use numbers
- 6.1.4 think and solve problems

6.2 demonstrate personal management skills to:
- 6.2.1 demonstrate positive attitudes and behaviours
- 6.2.2 be responsible
- 6.2.3 be adaptable
- 6.2.4 learn continuously
- 6.2.5 work safely

6.3 demonstrate teamwork skills to:
- 6.3.1 work with others
- 6.3.2 participate in projects and tasks

7. identify possible life roles related to the skills and content of this cluster

7.1 recognize and then analyze the opportunities and barriers in the immediate environment

7.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2180: PROCESS CONTROL

Level: Intermediate

Prerequisite: None

Description: Students develop skills in robotics/simulation software control by creating, modifying and using programs that incorporate computer-controlled movements and events in robotics/simulation activities and applications.

Parameters: Access to appropriate computer equipment, software and support materials.

Outcomes: The student will:

1. **demonstrate basic electronic process control software competence**
2. **explain the theory and processes used to control a robot and/or other simulation**
   - 2.1 describe the types of tasks robots perform
   - 2.2 diagram a basic robot, labelling components including the controller
   - 2.3 describe the functions of labelled components
   - 2.4 explain the processes used to control robots
   - 2.5 give examples of the types of software used to instruct the controller
   - 2.6 give an example of when it would be feasible to use a robot over a human to perform a task
   - 2.7 give an example of when it would be feasible to use a human over a robot to perform a task
   - 2.8 explain how robotics affect society now and will affect society in the future
3. **construct a robot or cause a robot to function, as intended, through computer control**
   - 3.1 design and implement a robotics and/or other computer simulation by following a procedure to:
     - 3.1.1 identify software and application(s)
     - 3.1.2 determine and design algorithm parameters
     - 3.1.3 collect required support resources
     - 3.1.4 input data
     - 3.1.5 apply animation or robotics software commands
     - 3.1.6 load, create, customize and modify robotics or a simulation files(s)
   - 3.2 demonstrate animation/robotic capability by:
     - 3.2.1 displaying, printing and/or exporting animation or a robotics file(s)
   - 3.3 use commands and functions to control a robot(s) in teacher-specified exercises
4. **apply appropriate work station routines consistently**
   - 4.1 apply efficient work station positions and routines that encourage:
     - 4.1.1 good health and safety; e.g., posture, positioning of hardware and furniture
     - 4.1.2 security for hardware, software, supplies and personal work
5. **demonstrate basic competencies**
   - 5.1 demonstrate fundamental skills to:
     - 5.1.1 communicate
     - 5.1.2 manage information
     - 5.1.3 use numbers
     - 5.1.4 think and solve problems
   - 5.2 demonstrate personal management skills to:
     - 5.2.1 demonstrate positive attitudes and behaviours
     - 5.2.2 be responsible
     - 5.2.3 be adaptable

5.2.4 learn continuously
5.2.5 work safely

5.3 demonstrate teamwork skills to:
5.3.1 work with others
5.3.2 participate in projects and tasks

6. identify possible life roles related to the skills and content of this cluster

6.1 recognize and then analyze the opportunities and barriers in the immediate environment
6.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2910: ELT PROJECT B

Level: Intermediate

Prerequisite: None

Description: Students develop project design and management skills to extend and enhance competencies and skills in other CTS courses through contexts that are personally relevant.

Parameters: Intermediate project courses must connect with a minimum of two CTS courses, one of which must be at the intermediate level and be in the same occupational area as the project course. The other CTS course(s) can be at any level from any occupational area.

Project courses cannot be connected to other project courses or practicum courses.

All projects and/or performances, whether teacher- or student-led, must include a course outline or student proposal.

Outcomes:

The teacher/student will:

1. **identify the connection between this project course and two or more CTS courses**
   - 1.1 identify the outcome(s) from each identified CTS course that support the project and/or performance deliverables
   - 1.2 explain how these outcomes are being connected to the project and/or performance deliverables
2. **propose the project and/or performance**
   - 2.1 identify the project and/or performance by:
     - 2.1.1 preparing a plan
     - 2.1.2 clarifying the purposes
     - 2.1.3 defining the deliverables
     - 2.1.4 specifying time lines
     - 2.1.5 explaining terminology, tools and processes
     - 2.1.6 defining resources; e.g., materials, costs, staffing
   - 2.2 identify and comply with all related health and safety standards
   - 2.3 define assessment standards (indicators for success)
   - 2.4 present the proposal and obtain necessary approvals

The student will:

3. **meet goals as defined within the plan**
   - 3.1 complete the project and/or performance as outlined
   - 3.2 monitor the project and/or performance and make necessary adjustments
   - 3.3 present the project and/or performance, indicating the:
     - 3.3.1 outcomes attained
     - 3.3.2 relationship of outcomes to goals originally set

3.4 evaluate the project and/or performance, indicating the:
    3.4.1 processes and strategies used
    3.4.2 recommendations on how the project and/or performance could have been improved

4. demonstrate basic competencies

4.1 demonstrate fundamental skills to:
    4.1.1 communicate
    4.1.2 manage information
    4.1.3 use numbers
    4.1.4 think and solve problems
4.2 demonstrate personal management skills to:
    4.2.1 demonstrate positive attitudes and behaviours
    4.2.2 be responsible
    4.2.3 be adaptable
    4.2.4 learn continuously
    4.2.5 work safely
4.3 demonstrate teamwork skills to:
    4.3.1 work with others
    4.3.2 participate in projects and tasks

5. identify possible life roles related to the skills and content of this cluster

5.1 recognize and then analyze the opportunities and barriers in the immediate environment
5.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2920: ELT PROJECT C

Level: Intermediate

Prerequisite: None

Description: Students develop project design and management skills to extend and enhance competencies and skills in other CTS courses through contexts that are personally relevant.

Parameters: Intermediate project courses must connect with a minimum of two CTS courses, one of which must be at the intermediate level and be in the same occupational area as the project course. The other CTS course(s) can be at any level from any occupational area.

Project courses cannot be connected to other project courses or practicum courses.

All projects and/or performances, whether teacher- or student-led, must include a course outline or student proposal.

Outcomes:

The teacher/student will:

1. **identify the connection between this project course and two or more CTS courses**
   - 1.1 identify the outcome(s) from each identified CTS course that support the project and/or performance deliverables
   - 1.2 explain how these outcomes are being connected to the project and/or performance deliverables
2. **propose the project and/or performance**
   - 2.1 identify the project and/or performance by:
     - 2.1.1 preparing a plan
     - 2.1.2 clarifying the purposes
     - 2.1.3 defining the deliverables
     - 2.1.4 specifying time lines
     - 2.1.5 explaining terminology, tools and processes
     - 2.1.6 defining resources; e.g., materials, costs, staffing
   - 2.2 identify and comply with all related health and safety standards
   - 2.3 define assessment standards (indicators for success)
   - 2.4 present the proposal and obtain necessary approvals

The student will:

3. **meet goals as defined within the plan**
   - 3.1 complete the project and/or performance as outlined
   - 3.2 monitor the project and/or performance and make necessary adjustments
   - 3.3 present the project and/or performance, indicating the:
     - 3.3.1 outcomes attained
     - 3.3.2 relationship of outcomes to goals originally set

3.4 evaluate the project and/or performance, indicating the:
    3.4.1 processes and strategies used
    3.4.2 recommendations on how the project and/or performance could have been improved

4. demonstrate basic competencies

4.1 demonstrate fundamental skills to:
    4.1.1 communicate
    4.1.2 manage information
    4.1.3 use numbers
    4.1.4 think and solve problems
4.2 demonstrate personal management skills to:
    4.2.1 demonstrate positive attitudes and behaviours
    4.2.2 be responsible
    4.2.3 be adaptable
    4.2.4 learn continuously
    4.2.5 work safely
4.3 demonstrate teamwork skills to:
    4.3.1 work with others
    4.3.2 participate in projects and tasks

5. identify possible life roles related to the skills and content of this cluster

5.1 recognize and then analyze the opportunities and barriers in the immediate environment
5.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT2950: ELT INTERMEDIATE PRACTICUM

Level: Intermediate

Prerequisite: None

Description: Students apply prior learning and demonstrate the attitudes, skills and knowledge required by an external organization to achieve a credential/credentials or an articulation.

Parameters: This practicum course, which may be delivered on- or off-campus, should be accessed only by students continuing to work toward attaining a recognized credential/credentials or an articulation offered by an external organization. This course must be connected to at least one CTS course from the same occupational area and cannot be used in conjunction with any advanced (3XXX) level course. A practicum course cannot be delivered as a stand-alone course, cannot be combined with a CTS project course and cannot be used in conjunction with the Registered Apprenticeship Program or the Green Certificate Program.

Outcomes: The student will:

1. **perform assigned tasks and responsibilities, as required by the organization granting the credential(s) or articulation**
   - 1.1 identify regulations and regulatory bodies related to the credential(s) or articulation
   - 1.2 describe personal roles and responsibilities, including:
     - 1.2.1 key responsibilities
     - 1.2.2 support functions/responsibilities/expectations
     - 1.2.3 code of ethics and/or conduct
   - 1.3 describe personal work responsibilities and categorize them as:
     - 1.3.1 routine tasks; e.g., daily, weekly, monthly, yearly
     - 1.3.2 non-routine tasks; e.g., emergencies
     - 1.3.3 tasks requiring personal judgement
     - 1.3.4 tasks requiring approval of a supervisor
   - 1.4 demonstrate basic employability skills and perform assigned tasks and responsibilities related to the credential(s) or articulation
2. **analyze personal performance in relation to established standards**
   - 2.1 evaluate application of the attitudes, skills and knowledge developed in related CTS courses
   - 2.2 evaluate standards of performance in terms of:
     - 2.2.1 quality of work
     - 2.2.2 quantity of work
   - 2.3 evaluate adherence to workplace legislation related to health and safety
   - 2.4 evaluate the performance requirements of an individual who is trained, experienced and employed in a related occupation in terms of:
     - 2.4.1 training and certification
     - 2.4.2 interpersonal skills
     - 2.4.3 technical skills
     - 2.4.4 ethics

3. demonstrate basic competencies

3.1 demonstrate fundamental skills to:

- 3.1.1 communicate
- 3.1.2 manage information
- 3.1.3 use numbers
- 3.1.4 think and solve problems

3.2 demonstrate personal management skills to:

- 3.2.1 demonstrate positive attitudes and behaviours
- 3.2.2 be responsible
- 3.2.3 be adaptable
- 3.2.4 learn continuously
- 3.2.5 work safely

3.3 demonstrate teamwork skills to:

- 3.3.1 work with others
- 3.3.2 participate in projects and tasks

4. identify possible life roles related to the skills and content of this cluster

4.1 recognize and then analyze the opportunities and barriers in the immediate environment

4.2 identify potential resources to minimize barriers and maximize opportunities

COURSE ELT3010: ELECTRO-ASSEMBLY 3

Level: Advanced

Prerequisite: ELT2010: Electro-assembly 2

Description: Students apply photographic processes to construct a printed circuit for an electronic project.

Parameters: Access to photographic printed circuit board supplies, image product equipment and related resources.

Outcomes: The student will:

1. **identify three photographic printed circuit (PC) board construction methods**
   - 1.1 research the benefits and drawbacks of various photographic construction methods
2. **design or modify a board layout to be used for photographic PC board construction**
   - 2.1 draw and/or modify schematic diagrams for an advanced electronic circuit
   - 2.2 use schematic symbols to represent electronic components
   - 2.3 match actual components to schematic symbols
3. **construct a PC board, using a photographic method**
   - 3.1 use the circuit layout with one of the photographic methods to make a circuit board
   - 3.2 demonstrate how to troubleshoot the fabricated electronic circuit board
   - 3.3 use multimeter for voltage, current and resistance checks
4. **assemble a project, using a PC board**
   - 4.1 create the photographic artwork circuit layout for a PC board
5. **demonstrate established laboratory procedures and safe work practices**
   - 5.1 describe illness caused by chemicals, solder and flux materials used in prototype construction
   - 5.2 demonstrate appropriate safety techniques when using solder and chemicals for prototype construction
   - 5.3 identify and follow safety procedures in home/laboratory while using solder, flux, photochemicals, cleaning chemicals and etching chemicals
   - 5.4 use Workplace Hazardous Materials Information System (WHMIS) data sheets
6. **demonstrate basic competencies**
   - 6.1 demonstrate fundamental skills to:
     - 6.1.1 communicate
     - 6.1.2 manage information
     - 6.1.3 use numbers
     - 6.1.4 think and solve problems
   - 6.2 demonstrate personal management skills to:
     - 6.2.1 demonstrate positive attitudes and behaviours
     - 6.2.2 be responsible
     - 6.2.3 be adaptable
     - 6.2.4 learn continuously
     - 6.2.5 work safely
   - 6.3 demonstrate teamwork skills to:
     - 6.3.1 work with others
     - 6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

7.1 identify short-term and long-term goals

7.2 identify steps to achieve goals

COURSE ELT3020: ELECTRONIC SERVICING

Level: Advanced

Prerequisite: ELT2020: Electrical Servicing

Description: Students develop and apply basic processes and skills to service and repair consumer-based electronic products.

Parameters: Access to a Dynamic Measuring Machine (DMM), an isolation transformer, an oscilloscope, a soldering iron, chemical cleaners, chamois cleaning sticks, foam swabs, a transistor tester, a capacitance meter and related resources. Access to optional equipment; e.g., colour pattern generator, Cathode Ray Tube (CRT) tester/restorer, high voltage test probe, alignment tools.

Supporting Course: ELT2090: Analog Communication 2

Outcomes: The student will:

1. **use a block diagram to show the function and stages of operation of an electronic device**
   - 1.1 identify the stages of operation of various consumer systems
   - 1.2 interpret a flow diagram and schematic of various consumer systems
2. **identify system faults and propose solutions to service and repair various digital and analog consumer products**
   - 2.1 identify problems associated with various consumer products and propose a solution to affect the repair
   - 2.2 use an oscilloscope to determine period in seconds and frequency in hertz
   - 2.3 identify measurements in engineering notation
   - 2.4 identify and test components in faulty section(s)
   - 2.5 demonstrate how to:
     - 2.5.1 service a faulty section
     - 2.5.2 clean user controls
     - 2.5.3 adjust colour balance, vertical height/linearity of a television or monitor
     - 2.5.4 clean a video cassette recorder (VCR) head and tape running system
     - 2.5.5 adjust a VCR tape tracking system
     - 2.5.6 clean belts and lubricate a VCR
     - 2.5.7 repair or replace printed circuit boards
3. **use standard, safe practices to service/repair an electronic component or device**
   - 3.1 demonstrate a safe attitude
   - 3.2 use proper grounding techniques when testing consumer electronic devices
   - 3.3 use proper handling techniques when working on cathode ray tubes and high voltages
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems

4.2 demonstrate personal management skills to:
    4.2.1 demonstrate positive attitudes and behaviours
    4.2.2 be responsible
    4.2.3 be adaptable
    4.2.4 learn continuously
    4.2.5 work safely
4.3 demonstrate teamwork skills to:
    4.3.1 work with others
    4.3.2 participate in projects and tasks

5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals
5.2 identify steps to achieve goals

COURSE ELT3030: POWER SYSTEMS & SERVICES

Level: Advanced

Prerequisite: ELT2030: Branch Circuit Wiring

Description: Students construct, operate, analyze and evaluate various single-phase and three-phase power systems and services.

Parameters: Access to a three-phase power supply, three-phase panel transformers, a wattmeter, a multimeter, an AC current meter, knife switches, a fused safety disconnect switch, a volt-amp clamp or probe and related resources.

Note: The student must have access to instruction from an individual with electrical technologist or journeyperson status when he or she is performing practical components using anything other than low voltages.

Outcomes: The student will:

1. **follow established, safe laboratory procedures and practices when working with three-phase systems**
   - 1.1 demonstrate safe practices in all activities, observing lockout and tagout procedures
2. **construct and analyze a three-wire, single-phase electrical system**
   - 2.1 analyze single-phase, three-wire systems for voltages and currents
   - 2.2 identify and diagram wye and delta systems
   - 2.3 energize various three-phase wye and delta circuits; measure line, phase voltages and currents
   - 2.4 diagram and construct a mock-up of a house service, according to the Canadian Electrical Code (CEC)
3. **analyze common reluctance inductance vector diagrams**
   - 3.1 diagram two-meter and three-meter wattmeter connections to measure three-phase power
   - 3.2 diagram current transformer connections
   - 3.3 solve phasor diagrams using trigonometry
4. **construct and analyze three-wire, three-phase and four-wire, three-phase wye systems**
   - 4.1 energize various three-phase wye and delta circuits; calculate and measure three-phase power consumed
   - 4.2 develop and use a three-phase power formula
   - 4.3 mathematically analyze three-phase, four-wire wye systems for neutral currents
5. **construct and analyze three-wire, three-phase delta systems**
   - 5.1 evaluate three-phase, three- and four-wire delta systems
   - 5.2 diagram and construct a mock-up of a three-phase service, according to the CEC
   - 5.3 mathematically analyze three-phase, three-wire delta and three-phase, three-wire wye systems for line and phase voltage and currents
6. **demonstrate basic competencies**
   - 6.1 demonstrate fundamental skills to:
     - 6.1.1 communicate
     - 6.1.2 manage information
     - 6.1.3 use numbers
     - 6.1.4 think and solve problems

6.2 demonstrate personal management skills to:
    6.2.1 demonstrate positive attitudes and behaviours
    6.2.2 be responsible
    6.2.3 be adaptable
    6.2.4 learn continuously
    6.2.5 work safely
6.3 demonstrate teamwork skills to:
    6.3.1 work with others
    6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

7.1 identify short-term and long-term goals
7.2 identify steps to achieve goals

COURSE ELT3040: GENERATION/TRANSFORMATION

Level: Advanced

Prerequisite: ELT1030: Conversion & Distribution

Description: Students operate, experiment with and analyze alternators and transformers used in power generation and distribution.

Parameters: Access to an AC/DC motor generator set, a transformer kit, AC/DC volt ampmeters, a multimeter and related resources.

Note: The student must have access to instruction from an individual with electrical technologist or journeyperson status when students are operating low voltage alternators.

Outcomes: The student will:

1. **explain the principles of operation of electrical components used in safety devices**
   - 1.1 differentiate between overload and overcurrent protection
2. **set up and operate three-phase low voltage alternators in no load and load conditions**
   - 2.1 demonstrate a knowledge of alternator function by operating a three-phase alternator for various voltages, frequencies and phase sequences
3. **explain the operational and loading parameters for alternators**
   - 3.1 build a working model of a three-phase alternator
4. **operate a low voltage alternator in parallel with another alternator(s)**
   - 4.1 set up and operate or report on the operation of alternators in parallel
   - 4.2 compare alternators and generators
   - 4.3 inspect transformer installations used to produce the correct voltage for consumer's equipment
5. **describe the operating principles of single-phase transformers**
   - 5.1 construct, operate and analyze step-up, step-down, 1:1, and isolation and variable transformers including:
     - 5.1.1 Jacob's ladder
     - 5.1.2 Tesla coil
     - 5.1.3 mutual induction coil
6. **identify fundamental loading characteristics of single-phase transformers**
   - 6.1 explain principles of transformer action including:
     - 6.1.1 apparent power
     - 6.1.2 voltage ratio
     - 6.1.3 turns ratio
     - 6.1.4 power transfer
     - 6.1.5 voltage, amperage rating
   - 6.2 explain schematic symbols and nameplate ratings
7. **demonstrate established laboratory procedures and safe work practices**
   - 7.1 demonstrate safe practices regarding high voltage system application and use of isolation transformers
   - 7.2 use various electrical tests to ensure the safety of equipment/projects
   - 7.3 describe dangers related to rotating shafts

8. demonstrate basic competencies

8.1 demonstrate fundamental skills to:

- 8.1.1 communicate
- 8.1.2 manage information
- 8.1.3 use numbers
- 8.1.4 think and solve problems

8.2 demonstrate personal management skills to:

- 8.2.1 demonstrate positive attitudes and behaviours
- 8.2.2 be responsible
- 8.2.3 be adaptable
- 8.2.4 learn continuously
- 8.2.5 work safely

8.3 demonstrate teamwork skills to:

- 8.3.1 work with others
- 8.3.2 participate in projects and tasks

9. create a transitional strategy to accommodate personal changes and build personal values

9.1 identify short-term and long-term goals

9.2 identify steps to achieve goals

COURSE ELT3110: AMPLIFIERS

Level: Advanced

Prerequisite: None

Description: Students demonstrate knowledge of various types and classes of amplifiers.

Parameters: Access to assorted types of amplifiers and related resources.

Supporting Course: ELT2050: Electronic Power Supply 2

Outcomes: The student will:

1. explain the differences among various types and classes of amplifiers

1.1 define terms including:
- 1.1.1 biasing
- 1.1.2 class A, AB, B, C amplifiers
- 1.1.3 common emitter amplifier
- 1.1.4 common collector circuit configuration
- 1.1.5 common base circuit configuration
- 1.1.6 impedance matching
- 1.1.7 capacitor coupling
- 1.1.8 multistages
- 1.1.9 bypass capacitors
- 1.1.10 inverting and non-inverting amplifiers
- 1.1.11 operational amplifiers
- 1.1.12 metal-oxides-semiconductor field-effect transistors (MOSFETs)
- 1.1.13 junction gate field-effect transistors (JFETs)

1.2 explain the function and operation of direct current (DC), audio, video, power, radio frequency (RF) and intermediate frequency (IF) amplifiers

1.3 describe a Darlington-pair arrangement

1.4 explain how a differential amplifier operates

1.5 identify three different types of power amplifiers

1.6 explain how volume and tone can be controlled in an audio amplifier

1.7 explain the basic differences between RF and IF amplifiers

1.8 list three ways of increasing the bandwidth in RF and IF amplifiers

1.9 draw a block diagram of a multistage audio amplifier

1.10 describe the operation of operational amplifiers using inverting and non-inverting circuits

1.11 choose the appropriate amplifier configuration for an application

1.12 calculate voltage gain and power gain in decibels

2. construct, analyze and test amplifier circuits and components

2.1 construct a 25-watt amplifier project (audio or video)

2.2 evaluate completed project

2.3 construct and experiment with amplification circuits including:
- 2.3.1 DC amplifier
- 2.3.2 class A amplifier
- 2.3.3 complementary class B Amplifier
- 2.3.4 class B push-pull circuit

2.3.5 class AB amplifier
2.3.6 two-stage, RC-coupled audio amplifier
2.3.7 basic audio power amplifier
2.3.8 push-pull power amplifier
2.3.9 IC amplifiers used in large audio system; e.g., car cassette systems, consumer audio systems
2.3.10 JFET used as a common-drain amplifier
2.3.11 JFET used as a common-gate amplifier
2.3.12 basic differential operational amplifier

3. maintain, test and troubleshoot a power amplifier

3.1 troubleshoot a multistage common-emitter amplifier to determine which amplifier stage is faulty

4. demonstrate established laboratory procedures and safe work practices

4.1 demonstrate how to:
4.1.1 measure voltage and current in an amplifier
4.1.2 handle solid-state components
4.1.3 use electronic test equipment
4.1.4 install transistors using heat sinks

5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:
5.1.1 communicate
5.1.2 manage information
5.1.3 use numbers
5.1.4 think and solve problems
5.2 demonstrate personal management skills to:
5.2.1 demonstrate positive attitudes and behaviours
5.2.2 be responsible
5.2.3 be adaptable
5.2.4 learn continuously
5.2.5 work safely
5.3 demonstrate teamwork skills to:
5.3.1 work with others
5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals
6.2 identify steps to achieve goals

COURSE ELT3140: MOTORS

Level: Advanced

Prerequisite: None

Description: Students demonstrate knowledge of electric motor operation and loading characteristics.

Parameters: Access to single-phase alternating current (AC) motor and direct current (DC) motors and related resources.

Note: The student must have access to instruction from an individual with electrical technologist or journeyperson status when students are performing practical components other than low voltage.

Supporting Courses: ELT2080: Control Systems 2
ELT2130: Magnetic Control Devices
ELT3040: Generation/Transformation

Outcomes: The student will:

1. explain electromotive principles as applied to DC and single-phase AC motors
- 1.1 explain and demonstrate motor principles including:
  - 1.1.1 counter electromotive force (EMF)
  - 1.1.2 inductance
  - 1.1.3 conductive resistance
- 1.2 describe and explain characteristics of the following AC and DC motors:
  - 1.2.1 shaded pole
  - 1.2.2 split phase
  - 1.2.3 capacitor start and run
  - 1.2.4 three-phase
  - 1.2.5 universal
  - 1.2.6 single-phase synchronous
  - 1.2.7 stepper
  - 1.2.8 servo
  - 1.2.9 permanent magnet
- 1.3 describe methods of DC motor control including:
  - 1.3.1 pulse width modulations
  - 1.3.2 positional feedback/shaft encoding

2. **explain the operational characteristics of common DC and AC motors**
- 2.1 explain the following nameplate ratings:
  - 2.1.1 voltage
  - 2.1.2 current
  - 2.1.3 horsepower
  - 2.1.4 efficiency
  - 2.1.5 cycle
  - 2.1.6 revolutions per minute (RPM)
  - 2.1.7 phase

2.1.8 frame size
2.1.9 enclosure

3. set up selected DC and AC motors and demonstrate their loading characteristics

3.1 design and construct the following motor circuits to find torque versus load and speed regulation versus load on:
3.1.1 inductive motors including: split phase, capacitor start, permanent split capacitor, shaded pole, three-phase
3.1.2 brush motors including: universal, flat compound DC motor
3.1.3 others including: single-phase synchronous, stepper, servo, permanent magnet

4. demonstrate established laboratory procedures and safe work practices

4.1 identify and follow safe wiring practices
4.2 use protection devices for all circuits
4.3 describe dangers of shaft rotation regarding:
4.3.1 vibration
4.3.2 long hair
4.3.3 clothing
4.3.4 jewelry

5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:
5.1.1 communicate
5.1.2 manage information
5.1.3 use numbers
5.1.4 think and solve problems
5.2 demonstrate personal management skills to:
5.2.1 demonstrate positive attitudes and behaviours
5.2.2 be responsible
5.2.3 be adaptable
5.2.4 learn continuously
5.2.5 work safely
5.3 demonstrate teamwork skills to:
5.3.1 work with others
5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals
6.2 identify steps to achieve goals

COURSE ELT3150: ROBOTICS 3

Level: Advanced

Prerequisite: ELT2140: Robotics 2

Description: Students demonstrate remote/autonomous control systems by constructing circuits to control robotic behaviour.

Parameters: Access to robotic trainer, surplus electromechanical components (optional) and related resources.

Supporting Course: NET3040: Microprocessor Interface

Outcomes: The student will:

1. **identify and assemble the required components to build a frequency remote control or microprocessor control for a robotics unit**
   - 1.1 demonstrate the principles of either a remote frequency control or a programming address code control
   - 1.2 explain the operation of the electronic components and circuit used to build either a remote control robot or a programmable control robot
   - 1.3 research the benefits and drawbacks of various remote and/or microprocessor controls that are used to operate a robot
   - 1.4 describe where industry is making use of remote and microprocessor control robots
2. **identify various microprocessor control systems and subsystems used in robotic units**
   - 2.1 draw and explain the various blocks in either a remote control system or programmable microprocessor/control system
   - 2.2 describe and explain use of sight, sound and tactile sensor control systems with either the remote control system or the programmable microprocessor control system
3. **explain frequency control or microprocessor control circuits and components in robotics units**
   - 3.1 explain the fundamentals of either the remote control system or the programmable microprocessor control system controlling the motor drives in the robotic system
   - 3.2 identify the differences between a remote control system and a programmable control system on how the robot gains information about its environment
   - 3.3 explain how sensor controls help either the remote control or the programmable control robot to receive feedback from the environment
4. **operate a robotic system that has various feedback controls**
   - 4.1 demonstrate knowledge of either a remote control or a programmable control system by building either a remote control or a microprocessor control for a mobile robot system
   - 4.2 prototype either a remote control system or a programmable control system and construct the circuit so that either the remote control or the programmable control will control the motors on the mobile robot
   - 4.3 draw the schematic diagram of the printed circuit board and wiring schematic of the control circuitry
   - 4.4 assemble electronic components to build a mobile robot
   - 4.5 build either a remote control or a programmable control and mount either control on the mobile robot

5. demonstrate established laboratory procedures and safe work practices

5.1 identify and follow safe wiring practices when working with radio frequency (RF)

5.2 use protection devices for all circuits

5.3 operate robotics systems within design tolerances

6. demonstrate basic competencies

6.1 demonstrate fundamental skills to:

- 6.1.1 communicate
- 6.1.2 manage information
- 6.1.3 use numbers
- 6.1.4 think and solve problems

6.2 demonstrate personal management skills to:

- 6.2.1 demonstrate positive attitudes and behaviours
- 6.2.2 be responsible
- 6.2.3 be adaptable
- 6.2.4 learn continuously
- 6.2.5 work safely

6.3 demonstrate teamwork skills to:

- 6.3.1 work with others
- 6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

7.1 identify short-term and long-term goals

7.2 identify steps to achieve goals

COURSE ELT3160: CONTROL APPLICATIONS

Level: Advanced

Prerequisite: ELT2150: Electronic Controls

Description: Students demonstrate the fundamentals of programmed controls and demonstrate how sensing devices are integrated to control output devices.

Parameters: Access to program logic controller, associated input/output devices and related resources.

Note: The student must have access to instruction from an individual with electrical technologist or journeyperson status when he or she is performing practical components using anything other than low voltage.

Supporting Courses: ELT2130: Magnetic Control Devices
ELT3140: Motors

Outcomes: The student will:

1. **identify and describe input and output hardware components and the methods of programming**
   - 1.1 draw and identify addressing, ladder logic and wiring diagram of a programmable logic controller (PLC) installation
   - 1.2 describe and explain numbering systems and codes for internal logic control
   - 1.3 plan PLC ladder programs and wiring diagrams using advanced programming logic functions
   - 1.4 create a flow diagram to write programming logic
   - 1.5 compare relay logic and PLC programming
2. **use programming logic, including real or programmed inputs, to control electromagnetic devices**
   - 2.1 demonstrate principles of electromagnetic motor starters to control large current flow to output devices
   - 2.2 demonstrate principles of feedback loop input sensors to protect output devices
   - 2.3 demonstrate the action of overload and limit switch feedback loop input sensors to protect the output system
   - 2.4 demonstrate knowledge of how either a direct current (DC) or an alternating current (AC) motor is operated by a PLC
   - 2.5 demonstrate knowledge of how analog to digital conversions are done on a PLC
3. **use various instruction codes to operate and control electromagnetic devices**
   - 3.1 identify the difference between real-world devices and internal program devices when programming the PLC
   - 3.2 research the benefits and drawbacks of using PLCs
   - 3.3 research how PLCs are used in computer-integrated manufacturing
   - 3.4 build a multiple motor and PLC-controlled installation and write a program to control the installation
   - 3.5 demonstrate a knowledge of PLC function by writing advanced programs to operate a relay-controlled AC motor

3.6 design programming functions with input and output devices so the PLC can control electromagnetic devices and indicator lamps
3.7 draw PLC ladder programs complete with wiring diagrams of input and output systems

4. demonstrate established laboratory procedures and safe work practices

4.1 identify and follow safe wiring practices when wiring input and output circuits
4.2 use protection devices for all circuits

5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:
- 5.1.1 communicate
- 5.1.2 manage information
- 5.1.3 use numbers
- 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:
- 5.2.1 demonstrate positive attitudes and behaviours
- 5.2.2 be responsible
- 5.2.3 be adaptable
- 5.2.4 learn continuously
- 5.2.5 work safely

5.3 demonstrate teamwork skills to:
- 5.3.1 work with others
- 5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals
6.2 identify steps to achieve goals

COURSE ELT3170: ROBOTICS MICROPROCESSORS

Level: Advanced

Prerequisites: ELT1140: Robotics Applications
CSE3120: Object Oriented Programming 1

Description: Students compare central processing unit (CPU) architecture of programmable robotics engineered systems and interface with analog sensors.

Parameters: Access to a programmable robotics system and manufacturer's engineering literature, analog sensors and related interfaces.

Outcomes: The student will:

1. **compare the internal architecture of various programmable robotics systems**
   - 1.1 compare the difference in internal architecture between different robotics system microprocessors
   - 1.2 explain the differences between machine and assembly language and interpretive and compiler language
   - 1.3 explore the types of microprocessors used in at least three types of robotics systems
2. **analyze the engineering data of a programmable robotics system**
   - 2.1 define the following terms:
     - 2.1.1 microprocessor
     - 2.1.2 input/output
     - 2.1.3 instruction set
     - 2.1.4 operand
     - 2.1.5 mnemonic
     - 2.1.6 opcode
     - 2.1.7 data/address
   - 2.2 define and explain how the following are used in programming:
     - 2.2.1 inherent, immediate and direct addressing
     - 2.2.2 conditional and unconditional branching
     - 2.2.3 stack operation/pointer, cascade, pop/push/pull instructions
     - 2.2.4 subroutines
     - 2.2.5 carry, negative, zero, overflow and flag operation
   - 2.3 explain the purpose of the following functional sections in a microprocessor:
     - 2.3.1 input/output
     - 2.3.2 accumulator
     - 2.3.3 program counter
     - 2.3.4 instruction decoder
     - 2.3.5 controller
     - 2.3.6 data register
     - 2.3.7 address register
     - 2.3.8 stack pointer
     - 2.3.9 index pointer
   - 2.4 illustrate a block diagram of a microprocessor system showing its internal architecture
   - 2.5 define a machine cycle and explain how it impacts microprocessor programming
   - 2.6 explain how clock frequency affects microprocessor speed

2.7 define how sensor input cycle relates to microprocessor speed
2.8 describe the function of input interfacing
2.9 explain how an analog input is interpreted by a microprocessor

3. build and program a robot to accomplish specified tasks

3.1 write and execute programs that use analog and/or digital input devices
3.2 solve a design problem and build a programmed robotics system incorporating the solution
3.3 program a robotics system using one digital input and calculate the machine cycles required for a programmed robotics system to complete a task given a digital input device
3.4 program a robotics system using one analog input and calculate the machine cycles required for a programmed robotics system to complete a task given an analog input device
3.5 program a robotics system using one analog input requiring an interface and calculate the machine cycles required for a programmed robotics system to complete a task
3.6 build, program and verify the operation of a robotics system that uses at least one sensor interface to perform a specified task

4. demonstrate established laboratory procedures and safe work practices

4.1 identify and follow laboratory safety procedures
4.2 be aware of potential damage to the microprocessor due to voltage and current conditions
4.3 demonstrate proper safety procedures while testing microprocessor systems

5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:
- 5.1.1 communicate
- 5.1.2 manage information
- 5.1.3 use numbers
- 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:
- 5.2.1 demonstrate positive attitudes and behaviours
- 5.2.2 be responsible
- 5.2.3 be adaptable
- 5.2.4 learn continuously
- 5.2.5 work safely

5.3 demonstrate teamwork skills to:
- 5.3.1 work with others
- 5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals
6.2 identify steps to achieve goals

COURSE ELT3180: ROBOTICS VISION SYSTEMS

Level: Advanced

Prerequisite: ELT2170: Robotics Sensor 2

Description: Students examine various types of vision in a programmable robotics system.

Parameters: Access to a programmable robotics system with data acquisition and manipulation capabilities and passive or active vision sensor input.

Outcomes: The student will:

1. **describe the difference between active and passive vision sensors**
   - 1.1 describe the difference in vision types in robotics systems including:
     - 1.1.1 differentiate between active and passive vision
     - 1.1.2 describe at least three types of passive vision
     - 1.1.3 describe at least three types of active vision
   - 1.2 describe how each of the following could be used in a robotics vision system:
     - 1.2.1 presence or absence of light
     - 1.2.2 light intensity
     - 1.2.3 night vision capabilities
     - 1.2.4 distance away from an object
2. **identify and describe how global positioning can be used for vision**
   - 2.1 describe global positioning
   - 2.2 describe how the following devices are used to track locations:
     - 2.2.1 compass sensor
     - 2.2.2 motor feedback
     - 2.2.3 gyroscopic sensor
   - 2.3 describe a strategy for using global positioning systems (GPS) for robotics vision where actual GPS is used
3. **identify and describe methodologies for object recognition**
   - 3.1 describe how a simulated GPS system can be integrated with visual sensors to allow a robotics system to navigate using:
     - 3.1.1 shape
     - 3.1.2 colour
     - 3.1.3 heat signature
4. **identify and describe methods for object avoidance**
   - 4.1 utilize robot footprint requirements to identify and describe object avoidance strategies including:
     - 4.1.1 barriers
     - 4.1.2 hazards
     - 4.1.3 environment
5. **design, build and program a passive vision robotics system**
   - 5.1 solve a design problem and build a programmed robotics system incorporating the solution
   - 5.2 design, build and program a robotics system that uses at least two different passive vision devices to accomplish a specific task; the robotics system must have an interaction between inputs and outputs

6. **design, build and program an active vision robotics system**
   - 6.1 design, build and program a robotics system that uses at least one active vision device to accomplish a specified task; the robotics system must use the active vision device to interact with the environment
7. **demonstrate established laboratory procedures and safe work practices**
   - 7.1 identify and follow laboratory safety procedures
   - 7.2 be aware of potential damage to robotics systems due to voltage and current conditions
   - 7.3 demonstrate proper safety procedures while working with robotics systems
8. **demonstrate basic competencies**
   - 8.1 demonstrate fundamental skills to:
     - 8.1.1 communicate
     - 8.1.2 manage information
     - 8.1.3 use numbers
     - 8.1.4 think and solve problems
   - 8.2 demonstrate personal management skills to:
     - 8.2.1 demonstrate positive attitudes and behaviours
     - 8.2.2 be responsible
     - 8.2.3 be adaptable
     - 8.2.4 learn continuously
     - 8.2.5 work safely
   - 8.3 demonstrate teamwork skills to:
     - 8.3.1 work with others
     - 8.3.2 participate in projects and tasks
9. **create a transitional strategy to accommodate personal changes and build personal values**
   - 9.1 identify short-term and long-term goals
   - 9.2 identify steps to achieve goals

COURSE ELT3190: ROBOTICS KINEMATICS & BEHAVIOUR

Level: Advanced

Prerequisite: ELT3170: Robotics Microprocessors

Description: Students examine the calibration of robots and programmed behaviours in a programmable robotics system.

Parameters: Access to a programmable robotics system and manufacturer's engineering literature.

Outcomes: The student will:

1. **examine various sources of robot motion error, methods of error recovery and calibration**
   - 1.1 identify and describe sources of motion error such as:
     - 1.1.1 mechanical
     - 1.1.2 accumulated
     - 1.1.3 inertia
     - 1.1.4 propagation
   - 1.2 identify and describe methods of error recovery for each of the following errors:
     - 1.2.1 mechanical
     - 1.2.2 accumulated
     - 1.2.3 inertia
     - 1.2.4 propagation
   - 1.3 identify and describe methods of error measurement and calibration utilizing both mechanical and software solutions
2. **describe a coordinate system and its implementation in a programmable robotics system**
   - 2.1 define a coordinate system
   - 2.2 explain how a coordinate system can be implemented for control of a robotics system
   - 2.3 explain how a polar coordinate system can be implemented for control of a programmable robotics system
3. **develop a programmable robotics system through a coordinate system and calculate motion error for a specific task**
   - 3.1 solve a design problem and build a programmable robotics system incorporating the solution
   - 3.2 build and program a programmable robotics system using a Cartesian and/or polar coordinate system to complete a specified task
   - 3.3 calculate motion error for the specified task
   - 3.4 calibrate a programmable robotics system to perform within the specified task parameters
4. **demonstrate established laboratory procedures and safe work practices**
   - 4.1 identify and follow laboratory safety procedures
   - 4.2 be aware of potential damage to the microprocessor due to voltage and current conditions
   - 4.3 demonstrate proper safety procedures while testing microprocessor systems
5. **demonstrate basic competencies**
   - 5.1 demonstrate fundamental skills to:
     - 5.1.1 communicate
     - 5.1.2 manage information
     - 5.1.3 use numbers
     - 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:
    5.2.1 demonstrate positive attitudes and behaviours
    5.2.2 be responsible
    5.2.3 be adaptable
    5.2.4 learn continuously
    5.2.5 work safely
5.3 demonstrate teamwork skills to:
    5.3.1 work with others
    5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals
6.2 identify steps to achieve goals

COURSE ELT3200: ROBOTICS ARTIFICIAL INTELLIGENCE

Level: Advanced

Prerequisite: ELT3170: Robotics Microprocessors

Description: Students examine artificial intelligence in a robotics system.

Parameters: Access to a programmable robotics system with data acquisition and manipulation capabilities.

Outcomes: The student will:

1. **identify and describe how artificial intelligence can be used in a programmable robotics system**
   - 1.1 define artificial intelligence with respect to robotics systems
   - 1.2 examine an existing artificial intelligence system (hardware and software) and report on the key components of the system including:
     - 1.2.1 behaviour
     - 1.2.2 movement strategies
     - 1.2.3 task learning
     - 1.2.4 sensor location
     - 1.2.5 actuation feedback
     - 1.2.6 exploration
     - 1.2.7 research
   - 1.3 describe how artificial intelligence can be used in a robotics system to allow it to learn a task
   - 1.4 describe the effects artificial intelligence systems have on society with respect to:
     - 1.4.1 law enforcement
     - 1.4.2 military applications
     - 1.4.3 disaster and/or accident response
     - 1.4.4 medical
     - 1.4.5 manufacturing
2. **identify and describe knowledge acquisition strategies and implementation in programmable robotics systems**
   - 2.1 identify and describe knowledge acquisition strategies in robotics systems including:
     - 2.1.1 sensor type and input information
     - 2.1.2 learned time-sequencing
     - 2.1.3 sampling
     - 2.1.4 maze analysis and learning
   - 2.2 identify and describe methodologies for task repeatability in a robotics system
   - 2.3 describe how a task can be accomplished in a robotics system without repeating the "search" pattern
3. **design, build and program a robotics system incorporating artificial intelligence**
   - 3.1 solve a design problem and build a programmable robotics system incorporating the solution
   - 3.2 build and program a robotics system that uses artificial intelligence to accomplish a specific task including:
     - 3.2.1 sampling for learning a task/behaviour
     - 3.2.2 repeating without sampling

4. **demonstrate established laboratory procedures and safe work practices**
   - 4.1 identify and follow laboratory safety procedures
   - 4.2 be aware of potential damage to robotics systems due to voltage and current conditions
   - 4.3 demonstrate proper safety procedures while working with robotics systems
5. **demonstrate basic competencies**
   - 5.1 demonstrate fundamental skills to:
     - 5.1.1 communicate
     - 5.1.2 manage information
     - 5.1.3 use numbers
     - 5.1.4 think and solve problems
   - 5.2 demonstrate personal management skills to:
     - 5.2.1 demonstrate positive attitudes and behaviours
     - 5.2.2 be responsible
     - 5.2.3 be adaptable
     - 5.2.4 learn continuously
     - 5.2.5 work safely
   - 5.3 demonstrate teamwork skills to:
     - 5.3.1 work with others
     - 5.3.2 participate in projects and tasks
6. **create a transitional strategy to accommodate personal changes and build personal values**
   - 6.1 identify short-term and long-term goals
   - 6.2 identify steps to achieve goals

COURSE ELT3205: EXPERT SYSTEMS

Level: Advanced

Prerequisite: None

Description: Students acquire knowledge of expert systems, such as artificial intelligence and virtual reality. They gain competence by developing or modifying programs that incorporate computer-controlled environments and multimedia interactive activities and applications.

Parameters: Access to an appropriate computer work station, software and support materials.

Outcomes: The student will:

1. **develop an information portfolio on expert systems and other advanced technologies**
   - 1.1 identify simulation software/application(s); e.g., telerobotics, telecollaboration, telepresence systems, architecture, audio and/or airline industry, medicine, physical fitness and entertainment
   - 1.2 plan, create and modify a program and/or activity according to provided instructions
   - 1.3 collect required support resources
2. **program an application, using one of these systems and present the results**
   - 2.1 apply expert systems software commands/instructions/codes to:
     - 2.1.1 load, create, customize and modify expert systems software templates, stacks, files or simulation applications that support artificial intelligence and/or virtual reality projects; or to scratch program/modify existing program(s)
   - 2.2 input data by:
     - 2.2.1 designing/defining project parameters; e.g., flowchart sequence
     - 2.2.2 entering data; e.g., key, load data
   - 2.3 create or import graphic elements and manipulates using appropriate software by:
     - 2.3.1 creating backgrounds
     - 2.3.2 editing, modifying and updating data and information
     - 2.3.3 using resident commands
     - 2.3.4 linking file(s)
     - 2.3.5 incorporating text (alphabetic, numeric), graphics, motion and sound
     - 2.3.6 demonstrating artificial intelligence, virtual reality and other high technology capability
   - 2.4 output expert systems activities by:
     - 2.4.1 displaying, printing and exporting artificial intelligence files and virtual reality files
3. **apply appropriate work station routines consistently**
   - 3.1 apply efficient work station positions and routines that encourage:
     - 3.1.1 good health and safety; e.g., posture, positioning of hardware and furniture
     - 3.1.2 security for hardware, software, supplies and personal work
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems

- 4.2 demonstrate personal management skills to:
  - 4.2.1 demonstrate positive attitudes and behaviours
  - 4.2.2 be responsible
  - 4.2.3 be adaptable
  - 4.2.4 learn continuously
  - 4.2.5 work safely
- 4.3 demonstrate teamwork skills to:
  - 4.3.1 work with others
  - 4.3.2 participate in projects and tasks

5. create a transitional strategy to accommodate personal changes and build personal values

- 5.1 identify short-term and long-term goals
- 5.2 identify steps to achieve goals

COURSE ELT3910: ELT PROJECT D

Level: Advanced

Prerequisite: None

Description: Students develop project design and management skills to extend and enhance competencies and skills in other CTS courses through contexts that are personally relevant.

Parameters: Advanced project courses must connect with a minimum of two CTS courses, one of which must be at the advanced level and be in the same occupational area as the project course. The other CTS course(s) must be at least at the intermediate level from any occupational area.

Project courses cannot be connected to other project courses or practicum courses.

All projects and/or performances, whether teacher- or student-led, must include a course outline or student proposal.

Outcomes:

The teacher/student will:

1. **identify the connection between this project course and two or more CTS courses**
   - 1.1 identify the outcome(s) from each identified CTS course that support the project and/or performance deliverables
   - 1.2 explain how these outcomes are being connected to the project and/or performance deliverables
2. **propose the project and/or performance**
   - 2.1 identify the project and/or performance by:
     - 2.1.1 preparing a plan
     - 2.1.2 clarifying the purposes
     - 2.1.3 defining the deliverables
     - 2.1.4 specifying time lines
     - 2.1.5 explaining terminology, tools and processes
     - 2.1.6 defining resources; e.g., materials, costs, staffing
   - 2.2 identify and comply with all related health and safety standards
   - 2.3 define assessment standards (indicators for success)
   - 2.4 present the proposal and obtain necessary approvals

The student will:

3. **meet goals as defined within the plan**
   - 3.1 complete the project and/or performance as outlined
   - 3.2 monitor the project and/or performance and make necessary adjustments
   - 3.3 present the project and/or performance, indicating the:
     - 3.3.1 outcomes attained
     - 3.3.2 relationship of outcomes to goals originally set

3.4 evaluate the project and/or performance, indicating the:
    3.4.1 processes and strategies used
    3.4.2 recommendations on how the project and/or performance could have been improved

4. demonstrate basic competencies

4.1 demonstrate fundamental skills to:
    4.1.1 communicate
    4.1.2 manage information
    4.1.3 use numbers
    4.1.4 think and solve problems
4.2 demonstrate personal management skills to:
    4.2.1 demonstrate positive attitudes and behaviours
    4.2.2 be responsible
    4.2.3 be adaptable
    4.2.4 learn continuously
    4.2.5 work safely
4.3 demonstrate teamwork skills to:
    4.3.1 work with others
    4.3.2 participate in projects and tasks

5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals
5.2 identify steps to achieve goals

COURSE ELT3920: ELT PROJECT E

Level: Advanced

Prerequisite: None

Description: Students develop project design and management skills to extend and enhance competencies and skills in other CTS courses through contexts that are personally relevant.

Parameters: Advanced project courses must connect with a minimum of two CTS courses, one of which must be at the advanced level and be in the same occupational area as the project course. The other CTS course(s) must be at least at the intermediate level from any occupational area.

Project courses cannot be connected to other project courses or practicum courses.

All projects and/or performances, whether teacher- or student-led, must include a course outline or student proposal.

Outcomes:

The teacher/student will:

1. **identify the connection between this project course and two or more CTS courses**
   - 1.1 identify the outcome(s) from each identified CTS course that support the project and/or performance deliverables
   - 1.2 explain how these outcomes are being connected to the project and/or performance deliverables
2. **propose the project and/or performance**
   - 2.1 identify the project and/or performance by:
     - 2.1.1 preparing a plan
     - 2.1.2 clarifying the purposes
     - 2.1.3 defining the deliverables
     - 2.1.4 specifying time lines
     - 2.1.5 explaining terminology, tools and processes
     - 2.1.6 defining resources; e.g., materials, costs, staffing
   - 2.2 identify and comply with all related health and safety standards
   - 2.3 define assessment standards (indicators for success)
   - 2.4 present the proposal and obtain necessary approvals

The student will:

3. **meet goals as defined within the plan**
   - 3.1 complete the project and/or performance as outlined
   - 3.2 monitor the project and/or performance and make necessary adjustments
   - 3.3 present the project and/or performance, indicating the:
     - 3.3.1 outcomes attained
     - 3.3.2 relationship of outcomes to goals originally set

3.4 evaluate the project and/or performance, indicating the:
    3.4.1 processes and strategies used
    3.4.2 recommendations on how the project and/or performance could have been improved

4. demonstrate basic competencies

4.1 demonstrate fundamental skills to:
    4.1.1 communicate
    4.1.2 manage information
    4.1.3 use numbers
    4.1.4 think and solve problems
4.2 demonstrate personal management skills to:
    4.2.1 demonstrate positive attitudes and behaviours
    4.2.2 be responsible
    4.2.3 be adaptable
    4.2.4 learn continuously
    4.2.5 work safely
4.3 demonstrate teamwork skills to:
    4.3.1 work with others
    4.3.2 participate in projects and tasks

5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals
5.2 identify steps to achieve goals

COURSE ELT3950: ELT ADVANCED PRACTICUM

Level: Advanced

Prerequisite: None

Description: Students apply prior learning and demonstrate the attitudes, skills and knowledge required by an external organization to achieve a credential/credentials or an articulation.

Parameters: This practicum course, which may be delivered on- or off-campus, should be accessed only by students continuing to work toward attaining a recognized credential/credentials or an articulation offered by an external organization. This course must be connected to at least one CTS course from the same occupational area and cannot be used in conjunction with any introductory (1XXX) level course. A practicum course cannot be delivered as a stand-alone course, cannot be combined with a CTS project course and cannot be used in conjunction with the Registered Apprenticeship Program or the Green Certificate Program.

Outcomes: The student will:

1. **perform assigned tasks and responsibilities, as required by the organization granting the credential(s) or articulation**
   - 1.1 identify regulations and regulatory bodies related to the credential(s) or articulation
   - 1.2 describe personal roles and responsibilities, including:
     - 1.2.1 key responsibilities
     - 1.2.2 support functions/responsibilities/expectations
     - 1.2.3 code of ethics and/or conduct
   - 1.3 describe personal work responsibilities and categorize them as:
     - 1.3.1 routine tasks; e.g., daily, weekly, monthly, yearly
     - 1.3.2 non-routine tasks; e.g., emergencies
     - 1.3.3 tasks requiring personal judgement
     - 1.3.4 tasks requiring approval of a supervisor
   - 1.4 demonstrate basic employability skills and perform assigned tasks and responsibilities related to the credential(s) or articulation
2. **analyze personal performance in relation to established standards**
   - 2.1 evaluate application of the attitudes, skills and knowledge developed in related CTS courses
   - 2.2 evaluate standards of performance in terms of:
     - 2.2.1 quality of work
     - 2.2.2 quantity of work
   - 2.3 evaluate adherence to workplace legislation related to health and safety
   - 2.4 evaluate the performance requirements of an individual who is trained, experienced and employed in a related occupation in terms of:
     - 2.4.1 training and certification
     - 2.4.2 interpersonal skills
     - 2.4.3 technical skills
     - 2.4.4 ethics

3. demonstrate basic competencies

3.1 demonstrate fundamental skills to:

- 3.1.1 communicate
- 3.1.2 manage information
- 3.1.3 use numbers
- 3.1.4 think and solve problems

3.2 demonstrate personal management skills to:

- 3.2.1 demonstrate positive attitudes and behaviours
- 3.2.2 be responsible
- 3.2.3 be adaptable
- 3.2.4 learn continuously
- 3.2.5 work safely

3.3 demonstrate teamwork skills to:

- 3.3.1 work with others
- 3.3.2 participate in projects and tasks

4. create a transitional strategy to accommodate personal changes and build personal values

4.1 identify short-term and long-term goals

4.2 identify steps to achieve goals