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 aquisition 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 aquisition strategies and implementation in programmable robotics systems**
   - 2.1 identify and describe knowledge aquisition 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