

## COURSE CURRICULUM AND ASSESSMENT STANDARDS:

### SECTION F: ADVANCED LEVEL

The following pages define the curriculum and assessment standards for the advanced level of Electro-Technologies.

Advanced level courses demand a higher level of expertise and help prepare students for entry into the workplace or a related post-secondary program.

Course ELT3010:	Electro-assembly 3 .....	F.3
Course ELT3020:	Electronic Servicing .....	F.7
Course ELT3030:	Power Systems & Services.....	F.11
Course ELT3040:	Generation/Transformation.....	F.15
Course ELT3060:	Digital Technology 3.....	F.21
Course ELT3070:	Digital Applications .....	F.25
Course ELT3080:	Microprocessors .....	F.29
Course ELT3090:	Microprocessor Interface .....	F.35
Course ELT3100:	Analog Communication 3 .....	F.41
Course ELT3110:	Amplifiers .....	F.49
Course ELT3130:	Data/Telemetry Systems .....	F.55
Course ELT3140:	Motors .....	F.61
Course ELT3150:	Robotics 3 .....	F.65
Course ELT3160:	Control Applications .....	F.69



**COURSE ELT3010: ELECTRO-ASSEMBLY 3**

<b>Level:</b>	Advanced
<b>Theme:</b>	Fabrication and Service Principles
<b>Prerequisite:</b>	ELT2010 Electro-assembly 2
<b>Description:</b>	Students apply photographic processes to construct a printed circuit for an electronic project.

**Parameters:** Photographic printed circuit board supplies, image product equipment and related resources.

**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>identify three photographic printed circuit (PC) board construction methods</li> <li>design or modify a board layout to be used for photographic PC board construction</li> <li>construct a PC board, using a photographic method</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>identifying and describing three methods to prepare an electronic circuit board for etching.</li> </ul> <p><i>Assessment Tool</i>  <i>ELT3010-1: Presentations/Reports: Printed Circuit Boards</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	10
	<ul style="list-style-type: none"> <li>identifying, designing and drawing a circuit board foil layout and constructing an electronic circuit board.</li> </ul> <p><i>Assessment Tool</i>  <i>ELTPAF: Project Assessment Form</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	30
	<ul style="list-style-type: none"> <li>identifying and constructing the circuit board foil layout by one of three photographic methods.</li> </ul> <p><i>Assessment Tool</i>  <i>ELTPAF: Project Assessment Form</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	35

**COURSE ELT3010: ELECTRO-ASSEMBLY 3 (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>assemble a project, using a PC board</li> <li>demonstrate established laboratory procedures and safe work practices</li> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>identifying, components values and polarity to construct a circuit board project.</li> </ul> <p><i>Assessment Tool</i> <i>ELTLAB-1: Laboratory Practice, Parts 3 and 4</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	20
	<ul style="list-style-type: none"> <li>observed performance in following:                             <ul style="list-style-type: none"> <li>established laboratory procedures</li> <li>chemical, solder, flux precautions for PC board construction.</li> </ul> </li> </ul> <p><i>Assessment Tool</i> <i>ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	5
	<ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i> <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	Integrated throughout

Concept	Specific Outcomes	Notes
Safety/Resource Management	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>describe illness caused by chemical, solder and flux materials used in prototype construction</li> <li>demonstrate appropriate safety techniques when using solder and chemicals for prototype construction</li> <li>identify and follow safety procedures in home/laboratory while using solder, flux, photochemicals, cleaning chemicals and etching chemicals</li> <li>use WHMIS data sheets.</li> </ul>	Discuss the safe use of hazardous materials used in the production and assembly of PC boards.

**COURSE ELT3010: ELECTRO-ASSEMBLY 3 (continued)**

Concept	Specific Outcomes	Notes
Fundamentals	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• research the benefits and drawbacks of various photographic construction methods</li> <li>• use schematic symbols to represent electronic components</li> <li>• match actual components to schematic symbols.</li> </ul>	List and explain the differences between various photographic prototype assembly methods; i.e., positive, negative, silk screening, toner transfer, computer.
System Application	<ul style="list-style-type: none"> <li>• draw and/or modify schematic diagrams for an advanced electronic circuit.</li> </ul>	<i>Electronic Workbench, circuits, magazines, etc.</i>
Designing and Prototyping	<ul style="list-style-type: none"> <li>• create the photographic artwork circuit layout for a PC board.</li> </ul>	
Fabricating/Testing	<ul style="list-style-type: none"> <li>• use the circuit layout with one of the photographic methods to make a circuit board</li> <li>• demonstrate how to troubleshoot the fabricated electronic circuit board</li> <li>• use multimeter for voltage, current and resistance checks.</li> </ul>	Continuity check of copper strip.
Careers	<ul style="list-style-type: none"> <li>• research employment opportunities in photographic and surface mount design, technology and construction.</li> </ul>	



**COURSE ELT3020: ELECTRONIC SERVICING****Level:** Advanced**Theme:** Fabrication and Service Principles**Prerequisite:** ELT2020 Electrical Servicing**Description:** Students develop and apply basic processes and skills to service and repair consumer-based electronic products.**Parameters:** DMM, Isolation transformer, oscilloscope, soldering iron, chemical cleaners, chamois cleaning sticks, foam swabs, transistor tester, capacitance meter and related resources. Optional Equipment: colour pattern generator, CRT tester/restorer, high voltage test probe, alignment tools.**Supporting Courses:** ELT2090 Analog Communication 2  
ELT2100 Radio Communication**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>use a block diagram to show the function and the stages of operation of an electronic device</li> <li>identify system faults, and propose solutions to service and repair various digital and analog consumer products</li> <li>use standard, safe practices to service/repair an electronic component or device</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>developing a block diagram and describing how each section in the block diagram operates for a given consumer electronic product.</li> </ul> <p><i>Assessment Tool</i> <i>ELT3020-1: Presentations/Reports: Electronic Service and Repair</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	30
	<ul style="list-style-type: none"> <li>identifying problems, and proposing solutions to service various consumer electronic products.</li> </ul> <p><i>Assessment Tool</i> <i>ELTCSR: Customer Service, Part 1</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	35
	<ul style="list-style-type: none"> <li>observation in using the solution to repair/service consumer electronic products.</li> </ul> <p><i>Assessment Tool</i> <i>ELTCSR: Customer Service, Part 2</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	35

**COURSE ELT3020: ELECTRONIC SERVICING (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>create a profile of a trade or occupation within the field of electronic servicing</li> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>completing a career profile within the field of electronic equipment servicing.</li> </ul> <p><i>Assessment Tool</i> <i>ELTCPC: Assessment Guide: Career Profiles</i></p> <p><i>Standard</i> <i>Completing all sections of career profile chart</i></p> <ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i> <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>5</p> <p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
Safety/Resource Management	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>demonstrate a safe attitude</li> <li>use proper grounding techniques when testing consumer electronic devices</li> <li>use proper handling techniques when working on cathode-ray tubes and high voltages.</li> </ul>	<p>Personal protection.</p> <p>Always ground out high voltage capacitors.</p> <p>Implosion hazard.</p>
System Identification	<ul style="list-style-type: none"> <li>identify stages of operation of various consumer systems</li> <li>interpret a flow diagram and schematics of various consumer systems.</li> </ul>	<p>TV, VCR, camcorder, receiver, computer, microwave oven and other consumer devices.</p>
Problem Solving	<ul style="list-style-type: none"> <li>identify problems associated with various consumer products and propose a solution to affect the repair.</li> </ul>	<p>VCR head cleaning and alignment.</p> <p>TV alignment and colour adjustment.</p>
Applied Mathematics	<ul style="list-style-type: none"> <li>use an oscilloscope to determine period in seconds and frequency in Hertz (Hz)</li> <li>identify measurements in engineering notation.</li> </ul>	

**COURSE ELT3020: ELECTRONIC SERVICING (continued)**

Concept	Specific Outcomes	Notes
Testing	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• identify and test components in faulty section(s).</li> </ul>	Transistor, diodes, capacitors, VCR drive systems, PC boards.
Repair/Service/Maintenance	<ul style="list-style-type: none"> <li>• demonstrate how to:               <ul style="list-style-type: none"> <li>– service faulty section</li> <li>– clean user controls</li> <li>– adjust colour balance, vertical height/linearity of a TV or monitor</li> <li>– clean a VCR head and tape running system</li> <li>– adjust VCR tape tracking system</li> <li>– clean belts and lubricate a VCR</li> <li>– repair or replace PC boards.</li> </ul> </li> </ul>	<p>Tuner, volume control, etc.</p> <p>Games systems or other consumer devices.</p> <p>Upgrading personal computers.</p>
Careers	<ul style="list-style-type: none"> <li>• research employment opportunities in electronic service and repair.</li> </ul>	Consumer electronic.



**COURSE ELT3030: POWER SYSTEMS & SERVICES****Level:** Advanced**Theme:** Power Systems**Prerequisite:** ELT2030 Branch Circuit Wiring**Description:** Students construct, operate, analyze and evaluate various single-phase and three-phase power systems and services.**Parameters:** Three-phase power supply, three-phase panel, transformers, wattmeter, multimeter, AC current meter, knife switches, fused safety disconnect switch, volt-amp clamp or probe and related resources.**Note:** The student must have access to instruction from an individual with Electrical Technologist or journeyman status when students are performing practical components other than low voltages**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>follow established, safe laboratory procedures and practices when working with three-phase systems</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>observed performance in following: <ul style="list-style-type: none"> <li>established laboratory procedures</li> <li>using proper levels of circuit protection.</li> </ul> </li> </ul> <p><i>Assessment Tool</i> <i>ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	5
<ul style="list-style-type: none"> <li>construct and analyze a three-wire, single-phase electrical system</li> </ul>	<ul style="list-style-type: none"> <li>constructing, analyzing and evaluating a three-wire Edison system.</li> </ul> <p><i>Assessment Tool</i> <i>ELTLAB-1: Laboratory Practice, Part 3</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	25

**COURSE ELT3030: POWER SYSTEMS & SERVICES (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• analyze common reluctance inductance (RLC) vector diagrams</li>   <li>• construct and analyze three-wire, three-phase and four-wire, three-phase wye systems</li>   <li>• construct and analyze three-wire, three-phase delta systems</li>   <li>• create a profile of a trade or occupation within the field of power systems and services</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• explaining the operating principles of the following voltage and current vector diagrams:               <ul style="list-style-type: none"> <li>– resistive circuit</li> <li>– inductive reactive circuit</li> <li>– capacitive reactive circuit</li> <li>– inductive and capacitive circuit</li> <li>– resistor inductor capacitor circuit</li> <li>– line voltage in a wye and delta system.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB–1: Laboratory Practice, Parts 1 and 2</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• constructing, analyzing and evaluating various three-wire and four-wire three-phase systems such as:               <ul style="list-style-type: none"> <li>– three-phase, three-wire wye system</li> <li>– three-phase, four-wire wye system.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB–2: Assessment Checklist: Laboratory Practice, Parts 2 and 3</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• constructing, analyzing and evaluating various three-wire and four-wire three-phase systems such as:               <ul style="list-style-type: none"> <li>– three-phase, three-wire delta system</li> <li>– three-phase, four-wire delta system.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB–2: Assessment Checklist: Laboratory Practice, Parts 2 and 3</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• completing a career profile of a trade or occupation within the field of electrical power systems and services.</li> </ul> <p><i>Assessment Tool</i>  <i>ELTCPC: Assessment Guide: Career Profiles</i></p> <p><i>Standard</i>  <i>Completing all sections of profile chart</i></p>	<p>15</p> <p>25</p> <p>25</p> <p>5</p>

**COURSE ELT3030: POWER SYSTEMS & SERVICES (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
Safety/Resource Management	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>demonstrate safe practices in all activities, observing lockout and tagout procedures.</li> </ul>	<p>Individual fuses (e.g., five amps for each laboratory set-up).                      Live voltage projects must be activated through GFI circuit breaker.                      When instructional journeyman qualifications restrict high voltage use, projects may be done in low voltages (less than 30 volts).</p>
System Identification	<ul style="list-style-type: none"> <li>analyze single-phase three-wire systems for voltages and currents</li> <li>identify and diagram wye and delta systems.</li> </ul>	<p>Use a scientific calculator.</p>
Applied Mathematics	<ul style="list-style-type: none"> <li>mathematically analyze three-phase three-wire delta and three-phase three-wire wye systems for line and phase voltage and currents</li> <li>mathematically analyze three-phase four-wire wye systems for neutral currents</li> <li>energize various three-phase wye and delta circuits; measure line, phase voltages and currents</li> <li>solve phasor diagrams using trigonometry</li> <li>develop and use three-phase power formula</li> <li>energize various three-phase wye and delta circuits; calculate and measure three-phase power consumed.</li> </ul>	<p>Use a scientific calculator.</p>

**COURSE ELT3030: POWER SYSTEMS & SERVICES (continued)**

Concept	Specific Outcomes	Notes
Testing	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• diagram two-meter and three-meter wattmeter connections to measure three-phase power</li> <li>• diagram current transformer connections.</li> </ul>	Keep currents as low as possible
Real-world Applications	<ul style="list-style-type: none"> <li>• diagram and construct a mock-up of a house service, according to Canadian Electrical Code (CEC)</li> <li>• diagram and construct a mock-up of a three-phase service, according to CEC</li> <li>• evaluate three-phase three- and four-wire data systems.</li> </ul>	
Careers	<ul style="list-style-type: none"> <li>• explore areas where certification as an electrician is required.</li> </ul>	Electrician, power electrician, lineman, elevator electrician, communication electrician.

**COURSE ELT3040: GENERATION/TRANSFORMATION****Level:** Advanced**Theme:** Power Systems**Prerequisite:** ELT1030 Conversion & Distribution**Description:** Students operate, experiment with and analyze alternators and transformers used in power generation and distribution.**Parameters:** AC/DC motor generator set, transformer kit, AC/DC volt ammeters, multimeter and related resources.**Note:** The student must have access to instruction from an individual with Electrical Technologist or journeyman status when students are operating low voltage alternators.**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>explain the principles of operation of electrical components used in safety devices</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>identifying and explaining the principles of operation of the following electrical safety protection devices:               <ul style="list-style-type: none"> <li>– plug and cartridge fuse</li> <li>– renewable and time-delay fuse</li> <li>– bi-metal and time-delay circuit breaker</li> <li>– overload protection by means of fuses and magnetic or thermal overload relays</li> <li>– ground-fault interrupter circuit protectors</li> <li>– safety switches.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELT3040–1: Presentations/Reports: Power Generation and Transformation</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	<p>10</p>

**COURSE ELT3040: GENERATION/TRANSFORMATION (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• set up and operate three-phase low voltage alternators in no load and load conditions</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• setting up and operating a three-phase alternator under load and no load conditions</li> <li>• demonstrating resistive, inductive and capacitive load conditions</li> <li>• collecting data to plot the load graph.</li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB-1: Laboratory Practice, Part 2</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	25
<ul style="list-style-type: none"> <li>• explain the operational and loading parameters for alternators</li> </ul>	<ul style="list-style-type: none"> <li>• explaining the following alternator parameters: <ul style="list-style-type: none"> <li>– voltage generation</li> <li>– alternator regulation</li> <li>– voltage regulators</li> <li>– paralleling alternators</li> <li>– hunting</li> <li>– losses and efficiency</li> <li>– ratings</li> <li>– power factor</li> <li>– load characteristics graphs.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELT3040-1: Presentations/Reports: Power Generation and Transformation</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	10
<ul style="list-style-type: none"> <li>• operate a low voltage alternator in parallel with another alternator(s)</li> </ul>	<ul style="list-style-type: none"> <li>• setting up and operating a three-phase low voltage alternator in parallel with another power source.</li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB-1: Laboratory Practice, Part 2</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	15

**COURSE ELT3040: GENERATION/TRANSFORMATION (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• describe the operating principles of single-phase transformers</li>   <li>• identify fundamental loading characteristics of single-phase transformers</li>   <li>• demonstrate established laboratory procedures and safe work practices</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• setting up and operating a single-phase transformer in these conditions:               <ul style="list-style-type: none"> <li>– transformation characteristics</li> <li>– transformer polarity</li> <li>– transformer regulation</li> <li>– autotransformer characteristics</li> <li>– distribution transformers</li> <li>– transformers in parallel.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELT3040–1: Presentations/Reports: Power Generation and Transformation</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	<p>25</p>
	<ul style="list-style-type: none"> <li>• explaining the following single-phase transformer fundamentals:               <ul style="list-style-type: none"> <li>– theory of operation; no load</li> <li>– theory of operation; under load</li> <li>– transformer ratings</li> <li>– transformer ratios</li> <li>– losses and efficiency</li> <li>– autotransformer.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELT3040–1: Presentations/Reports: Power Generation and Transformation</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	
	<ul style="list-style-type: none"> <li>• observed performance in following:               <ul style="list-style-type: none"> <li>– established laboratory procedures</li> <li>– correct procedures for high voltage applications</li> <li>– correct use of isolation transformers</li> <li>– correct use of overcurrent and overload protection.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	<p>5</p>

**COURSE ELT3040: GENERATION/TRANSFORMATION (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
Safety/Resource Management	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>demonstrate safe practices especially regarding high voltage system application, use of isolation transformers</li> <li>differentiate between overload and overcurrent protection</li> <li>use various electrical tests to insure safety of equipment/projects</li> <li>describe dangers relating to rotating shafts.</li> </ul>	<p>Observe hazards associated with backfeed on transformers.</p> <ul style="list-style-type: none"> <li>Sloblow fuse</li> <li>HRC fuse</li> <li>circuit breaker</li> <li>other overload devices.</li> </ul> <p>Live voltage projects must be activated through GFI circuit breaker.</p> <p>When instructional qualifications restrict high voltage use, projects may be done in low voltages (less than 30 volts).</p>
Testing	<ul style="list-style-type: none"> <li>demonstrate a knowledge of alternator function by operating a three-phase alternator for various voltages, frequencies and phase sequences.</li> </ul>	<p>Small motor-generator sets are available on 1/3 horsepower machines. Surplus automotive alternator could be used.</p>
Designing and Prototyping	<ul style="list-style-type: none"> <li>build a working model of a three-phase alternator.</li> </ul>	<p>Stationary coil moving magnet or vice versa.</p>

**COURSE ELT3040: GENERATION/TRANSFORMATION (continued)**

Concept	Specific Outcomes	Notes
Real-world Applications	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• set up and operate or report on the operation of alternators in parallel</li> <li>• compare alternators and generators</li>   <li>• inspect transformer installations used to produce correct voltage for consumer's equipment.</li> </ul>	<p>Alternators are brought "on-line" as necessary to supply loads in commercial power grids. Students could operate two or more alternators to supply a load in the laboratory.</p> <p>Electronic power supplies, school power service, field trip to substation, etc.</p>
Designing and Prototyping	<ul style="list-style-type: none"> <li>• construct, operate and analyze step-up, step-down, 1:1, isolation and variable transformers such as: <ul style="list-style-type: none"> <li>– Jacob's ladder</li> <li>– Tesla coil</li> <li>– mutual induction coil.</li> </ul> </li> </ul>	<p><i>Radio Electronics Magazine.</i></p>
Applied Mathematics/Fundamentals	<ul style="list-style-type: none"> <li>• explain principles of transformer action such as: <ul style="list-style-type: none"> <li>– apparent power</li> <li>– voltage ratio</li> <li>– turns ratio</li> <li>– power transfer</li> <li>– voltage, amperage rating</li> </ul> </li> <li>• explain schematic symbols and nameplate ratings.</li> </ul>	<p>A report could be prepared on the specific transformer built.</p>
Careers	<ul style="list-style-type: none"> <li>• research employment opportunities in power generation and transformation.</li> </ul>	



**COURSE ELT3060: DIGITAL TECHNOLOGY 3****Level:** Advanced**Theme:** Computer Logic Systems**Prerequisite:** ELT2060 Digital Technology 2**Description:** Students demonstrate knowledge of digital principles by using medium-scale transistor–transistor logic (TTL) and complementary metal oxide semiconductor (CMOS) integrated technology.**Parameters:** Digital logic trainer, logic probe, oscilloscope, function generator and related resources.**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• identify, interface and experiment with medium-scale integrated circuit (IC) families</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• identifying medium-scale integrated circuits using data manuals, disks and CD-ROM programs on a given a manufactured chip</li> <li>• explaining the difference between typical and complex networks such as: <ul style="list-style-type: none"> <li>– decoders</li> <li>– encoders</li> <li>– multiplexers</li> <li>– parity generators</li> <li>– subtractors</li> <li>– shift registers</li> </ul> </li> <li>• prototyping, measuring and evaluating medium-scale integrated (MSI) circuits such as: <ul style="list-style-type: none"> <li>– keyboard encoder</li> <li>– binary coded decimal (BCD) decoder</li> <li>– comparators</li> <li>– arithmetic circuits.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB–3: Assessment Checklist: Laboratory Practice, Parts 1, 2 and 3</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	40



**COURSE ELT3060: DIGITAL TECHNOLOGY 3 (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>create a profile of a trade or occupation within the field of digital technology</li> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>completing career profile chart within the field of digital technology.</li> </ul> <p><i>Assessment Tool</i> <i>ELTCPC: Assessment Guide: Career Profiles</i></p> <p><i>Standard</i> <i>Completing all sections of profile chart</i></p> <ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i> <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>5</p> <p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
Safety/Resource Management	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>demonstrate correct handling of MSIC chips</li> <li>describe antistatic procedures.</li> </ul>	<p>Demonstrate use of wristwraps.</p> <p>MSIC=medium-scale integrated circuits, wristwraps.</p>
Fundamentals	<ul style="list-style-type: none"> <li>explain the difference between typical and complex logic networks.</li> </ul>	<p>Decoder, encoder, code converter, multiplexers, parity generators, subtractors.</p>
Designing and Prototyping	<ul style="list-style-type: none"> <li>fabricate digital circuitry using medium-scale integration</li> <li>construct, experiment and solve real-world applications, using medium-scale integration.</li> </ul>	<p>Tachometer, DHTA decoder, Music Box.</p> <p>Electronic keyboard to seven-segment display.</p> <p>Could be linked to ELT2010 or ELT3010 for printed circuit board.</p>
Testing	<ul style="list-style-type: none"> <li>measure and evaluate medium-scale integrated circuits.</li> </ul>	<p>Keyboard endcoder, BCD decimal decoder, four-bit magnitude comparators.</p>

**COURSE ELT3060: DIGITAL TECHNOLOGY 3** (continued)

Concept	Specific Outcomes	Notes
Careers	<i>The student should:</i> <ul style="list-style-type: none"><li>• research employment opportunities in medium-scale TTL and CMOS integrated technology.</li></ul>	

**COURSE ELT3070: DIGITAL APPLICATIONS****Level:** Advanced**Theme:** Computer Logic Systems**Prerequisite:** ELT2060 Digital Technology 2**Description:** Students experiment with large-scale and very large-scale integrated circuits, and demonstrate their applications to practical situations.**Parameters:** Logic probes, logic analyzer, signature analysis, oscilloscopes and related resources.**Supporting Course:** ELT3060 Digital Technology 3**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• identify applications and develop prototypes of large-scale integrated circuits</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• demonstrating correct handling and use of large-scale integrated circuits (LSICs). Prototyping and troubleshooting digital system such as: <ul style="list-style-type: none"> <li>– microcomputer</li> <li>– liquid crystal display (LCD) timer with alarm</li> <li>– electronic game</li> <li>– digital voltmeter</li> <li>– digital light meter</li> </ul> </li> <li>• constructing circuits using LSICs incorporated within any video, stereo, audio or computer systems or advanced project of student choice</li> <li>• experimenting with a practical large digital integration (LDI) system such as: <ul style="list-style-type: none"> <li>– clock</li> <li>– data transmission</li> <li>– video games.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB–3: Assessment Checklist: Laboratory Practice, Parts 1 and 2</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	50

**COURSE ELT3070: DIGITAL TECHNOLOGY APPLICATION** (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• troubleshoot a digital system or prototype with digital equipment</li> <li>• demonstrate established laboratory procedures and safe work practices</li> <li>• demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• incorporating a LSIC digital system on a given previous student project or a consumer product, using one of the following instruments to analyze and troubleshoot a circuit:               <ul style="list-style-type: none"> <li>– logic probes</li> <li>– pulser</li> <li>– logic analyzer</li> <li>– signature analyzer</li> <li>– oscilloscopes</li> </ul>               using computer simulation, experimental boards, CAI package or actual equipment.             </li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB-3: Assessment Checklist: Laboratory Practice, Part 3</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• observed performance in following:               <ul style="list-style-type: none"> <li>– established laboratory procedures</li> <li>– correct handling and storage of LSIC and VLSIC chips.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>45</p> <p>5</p> <p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
<p>Safety/Resource Management</p>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• demonstrate correct handling and storage of large integrated circuit (LSIC) and very large integrated circuit (VLSIC) chips.</li> </ul>	

**COURSE ELT3070: DIGITAL APPLICATIONS (continued)**

Concept	Specific Outcomes	Notes
Real-world Applications	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• prototype and troubleshoot a digital system such as a calculator, computer, adder/subtractor, digital clock, frequency counter, alarms, games</li>   <li>• identify the application of pinouts and use of complex IC chips from several manufacturers.</li> </ul>	<p>Any electronic problem with multiple inputs and outputs will do. Truth tables will need to be constructed.            Texts: <i>Digital Electronics</i> (Chapter 12), <i>Principles of Digital Audio</i>.</p> <p>Use memory interfacing, drivers, support and advanced support IC.</p>
Fundamentals	<ul style="list-style-type: none"> <li>• research and investigate a complex digital system</li> <li>• identify the function of ICs in a large complex digital circuit</li>   <li>• explain, experiment with and demonstrate the differences among digital memories</li> <li>• research memory configuration and organization</li> <li>• construct various memory circuits</li> <li>• explain and demonstrate the differences among various digital displays and drivers</li> <li>• explain and demonstrate the differences among various digital interfacing devices</li>   <li>• explain and demonstrate the differences among various support and advanced support ICs.</li> </ul>	<p>Examples of texts that may be helpful:  <i>18 Advanced Electronic Projects, Video, Stereo and Opto Electronics. Digital Computer Circuits and Concepts.</i></p> <p>For example, RAM, ROM, PROM, EPROM, magnetic core memory, computer bulk storage devices.</p> <p>LCD, seven segments, etc.</p> <p>Line drivers and receivers, digital to analog converters, analog to digital converters, serial and parallel transfer, UART, RS-232C operational amplifiers.</p> <p>UART, Parallel I/O, 8253 Counter Timer, 8225 Programmable CRT controller, 1535-488 controlled cursor generator.</p>

**COURSE ELT3070: DIGITAL APPLICATIONS (continued)**

Concept	Specific Outcomes	Notes
Fabricating/Testing	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• construct circuits using LSICs</li>   <li>• use one of the following instruments to analyze a complex digital circuit:               <ul style="list-style-type: none"> <li>– logic probes</li> <li>– pulser</li> <li>– logic analyzer</li> <li>– signature analyzer</li> <li>– oscilloscopes.</li> </ul> </li> </ul>	<p>Could be linked with Electro-assembly 2 or Electro-assembly 3, robotics unit for printed circuit board.</p> <p>In place of some of these actual instruments, student may have to use software such as <i>Electronic Workbench</i>.</p>

**COURSE ELT3080: MICROPROCESSORS****Level:** Advanced**Theme:** Computer Logic Systems**Prerequisite:** ELT2060 Digital Technology 2**Description:** Students compare the internal architecture of microprocessors and program them, using instruction sets.**Parameters:** Microprocessor trainer/CAI program and related resources.**Supporting Courses:** ELT3060 Digital Technology 3  
ELT3070 Digital Applications**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>compare the internal architecture of various families of microprocessors</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>explaining the difference in internal architecture between different families of microprocessors</li> <li>identifying and comparing the following functional sections in a microprocessor: <ul style="list-style-type: none"> <li>– accumulator</li> <li>– program counter</li> <li>– instruction decoder</li> <li>– controller</li> <li>– data register</li> <li>– address register</li> <li>– stack pointer</li> <li>– index pointer</li> </ul> </li> <li>drawing a block diagram of an advanced microprocessor showing its internal architecture.</li> </ul> <p><i>Assessment Tool</i> <i>ELT3080–1: Presentations/Reports:</i> <i>Microprocessors</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	20

**COURSE ELT3080: MICROPROCESSORS (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• program a microprocessor, using instruction sets</li> <li>• describe input/output operations in microprocessors</li> <li>• demonstrate established laboratory procedures and safe work practices</li> <li>• demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• writing and executing programs using mnemonic and op codes that complete the following functions:               <ul style="list-style-type: none"> <li>– branching</li> <li>– additions/subtractions</li> <li>– indexed and extended addressing</li> <li>– store data and retrieve data from the stack</li> <li>– loops</li> <li>– moving data between several places.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB–3: Assessment Checklist: Laboratory Practice, Parts 1 and 4</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• writing and executing various programs that use memory input and output devices.</li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB–3: Assessment Checklist: Laboratory Practice, Part 1</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• observed performance in following:               <ul style="list-style-type: none"> <li>– established laboratory procedures</li> <li>– procedures to avoid hazard of static electricity</li> <li>– procedures indicating awareness of high voltage requirements.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>55</p> <p>20</p> <p>5</p> <p>Integrated throughout</p>

**COURSE ELT3080: MICROPROCESSORS (continued)**

Concept	Specific Outcomes	Notes
Safety/Resource Management	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• be aware of potential damage to integrated circuits by static electricity</li> <li>• be aware of current and voltage requirements of computer trainers</li> <li>• demonstrate proper safety procedures while testing microprocessor pins.</li> </ul>	
Fundamentals	<ul style="list-style-type: none"> <li>• compare the difference in internal architecture between different families of microprocessors</li> <li>• explain the differences between machine and assembly language, interpretative and compiler language</li> <li>• define the following terms:               <ul style="list-style-type: none"> <li>– microprocessor</li> <li>– input/output</li> <li>– instruction set</li> <li>– operand</li> <li>– mnemonic</li> <li>– opcode</li> <li>– data/address</li> </ul> </li> <li>• describe and locate the types of microprocessor used in a computer or trainer</li> <li>• identify input/output pins of a microprocessor</li> <li>• identify EPROMS, RAM ICs</li> <li>• identify memory read/write address and data pins on a memory chip</li> <li>• write and execute various programs that use memory, input and output devices</li> <li>• draw the symbols used in flow charting and explain the purpose of each</li> <li>• define and explain how the following are used in programming:               <ul style="list-style-type: none"> <li>– inherent, immediate and direct addressing</li> <li>– conditional and unconditional branching</li> <li>– stack operation/pointer, cascade, pop push/pull instructions</li> <li>– subroutines</li> <li>– carry, negative, zero, overflow, flag operation.</li> </ul> </li> </ul>	<p>Use Debug in DOS.</p>

**COURSE ELT3080: MICROPROCESSORS (continued)**

Concept	Specific Outcomes	Notes
System Identification	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• explain the purpose of the following functional sections in a microprocessor:               <ul style="list-style-type: none"> <li>– accumulator</li> <li>– program counter</li> <li>– instruction decoder</li> <li>– controller</li> <li>– data register</li> <li>– address register</li> <li>– stack pointer</li> <li>– index pointer</li> </ul> </li> <li>• explain the evolution of architecture from 8 bit on</li> <li>• draw a block diagram of an advanced microprocessor showing its internal architecture</li> <li>• identify differences between data address, instruction, flag registers</li> <li>• define a machine cycle</li> <li>• relate clock frequency to microprocessor speed.</li> </ul>	<p>The accumulation for math commands in older microprocessors can be used, newer ones can store math and logic commands in any register.</p> <p>Note: Address, data size, number of instructions, size of control set.</p> <p>Done at machine or assembler level programming.</p>
Real-world Applications	<ul style="list-style-type: none"> <li>• write and execute a simple straight program using mnemonic and op codes</li> <li>• demonstrate the uses and characteristics of different addressing modes by writing and analyzing assembly language programs</li> <li>• compute the proper relative address for branching forward or backward from one point to another in a program</li> <li>• write and execute a program that can, e.g.:               <ul style="list-style-type: none"> <li>– multiply by repeated additions</li> <li>– divide by repeated subtractions</li> <li>– convert binary to BCD</li> </ul> </li> <li>• write and execute simple programs that use indexed and extended addressing</li> <li>• given an instruction, locate the op code, calculate the number of machine cycles, find the number of bytes and give the final output</li> </ul>	<p>A microprocessor trainer is required.</p> <p>It may be necessary to purchase a micro-processor programming course to cover these SOs from one of the above or others. Also, using Debug in DOS from generic computers can be used.</p>

**COURSE ELT3080: MICROPROCESSORS** (continued)

Concept	Specific Outcomes	Notes
Real-world Applications (continued)	<p><i>The student should:</i></p> <ul style="list-style-type: none"><li>• write and execute a simple program that can store data in and retrieve data from the stack</li><li>• write and execute a program that uses the stack and indenting registers to move data between two places.</li></ul>	
Careers	<ul style="list-style-type: none"><li>• research the curriculum of post-secondary institutions that teach microprocessor fundamentals</li><li>• research computer engineering, computer technologists and computer technicians occupations.</li></ul>	



**COURSE ELT3090: MICROPROCESSOR INTERFACE****Level:** Advanced**Theme:** Computer Logic Systems**Prerequisite:** ELT3080 Microprocessors**Description:** Students demonstrate how to interface microprocessors/microcontrollers with real-world applications.**Parameters:** Microprocessor trainer, interfacing trainer, with accompanying CAI package and related resources.**Supporting Course:** ELT2080 Control Systems 2**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• describe microprocessor interface output and input circuits</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• explaining the following               <ul style="list-style-type: none"> <li>– input/output circuits as they apply to microprocessors</li> <li>– the two main methods of I/O operation in microprocessors</li> <li>– a simplified microprocessor interface</li> <li>– the term “interrupt”</li> <li>– the difference between various interface devices</li> <li>– how to interface a D/A converter to a microprocessor system.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELT3090–1: Presentations/Reports:</i>  <i>Microprocessor Interface</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	<p>10</p>

**COURSE ELT3090: MICROPROCESSOR INTERFACE (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• explain the operation of a serial interface device</li>   <li>• interface a digital-to-analog (D/A) and analog-to-digital (A/D) converter to a microprocessor</li>   <li>• connect a microprocessor to a sensor device used in home, industrial and/or transportation applications</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• explaining the following: <ul style="list-style-type: none"> <li>– an interface device and its relationship to data, control circuits and data direction registers</li> <li>– how serial data can be represented using both amplitude and frequency modulation techniques</li> <li>– the difference between asynchronous and synchronous serial data transmission</li> <li>– convert serial data to parallel and vice versa.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELT3090–1: Presentations/Reports: Microprocessor Interface</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• constructing a student project that will be interfaced to a microprocessor, using D/A and A/D converter.</li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB–3: Assessment Checklist: Laboratory Practice, Parts 1 and 2</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• locating, researching, experimenting or constructing a device to be connected to a microprocessor</li> <li>• writing a program to accept data and return data to a device, such as: <ul style="list-style-type: none"> <li>– photo resistor</li> <li>– temperature and optical sensors</li> <li>– photo diodes and photo transistors</li> <li>– optocouplers</li> <li>– Hall effect devices</li> <li>– DC stepper motors</li> </ul> </li> </ul>	<p>10</p> <p>40</p> <p>35</p>

**COURSE ELT3090: MICROPROCESSOR INTERFACE (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• demonstrate established laboratory procedures and safe work practices</li> <li>• demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• constructing, connecting, interfacing and operating a microprocessor devices such as:               <ul style="list-style-type: none"> <li>– robots</li> <li>– weather stations</li> <li>– home environment systems</li> <li>– security systems</li> <li>– automotive</li> <li>– data transmission.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB-3: Assessment Checklist: Laboratory Practice, Part 2</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• observed performance in following:               <ul style="list-style-type: none"> <li>– established laboratory procedures</li> <li>– procedures indicating awareness of voltage/current transients.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>5</p> <p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
<p>Safety/Resource Management</p>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• describe voltage/current transients in real-world applications that connect to low voltage computers</li> <li>• safely interface computers to real-world applications.</li> </ul>	<p>Spikes, Surges, Static, Counter EMF.</p>

**COURSE ELT3090: MICROPROCESSOR INTERFACE (continued)**

Concept	Specific Outcomes	Notes
Fundamentals	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• describe the basic difference between system boards</li> <li>• outline the memory allocations in a typical microcomputer system using RAM, ROM, EPROM, EEROM and I/O</li> <li>• define input/output as they apply to microprocessors</li> <li>• state the two main methods of I/O operation in microprocessors</li> <li>• describe a simplified microprocessor interface device</li> <li>• define the term interrupt</li> <li>• explain the bus structure of a typical microprocessor system</li> <li>• explain three-state logic</li> <li>• draw a simplified block diagram of an interface device and explain the purpose of the data, control and data direction registers</li> <li>• write a simple program that will configure an interface device in any I/O combination</li> <li>• describe how serial data can be represented using both amplitude and frequency modulation techniques</li> <li>• explain the difference between asynchronous and synchronous serial data transmission</li> <li>• explain how to interface a ROM, EPROM or RAM</li> <li>• define the difference between a UART, BSRT and USART device</li> <li>• write and execute a program to convert serial data to parallel and parallel to serial.</li> </ul>	<p>A microprocessor trainer and interfacing application trainer may be used to complete these SOs.</p> <p>Several CAI packages are available that work through similar SOs.</p>

**COURSE ELT3090: MICROPROCESSOR INTERFACE (continued)**

Concept	Specific Outcomes	Notes
Real-world Applications	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• research/experiment with some of the following concepts that apply to microprocessors:               <ul style="list-style-type: none"> <li>– interface a D/A converter to a microprocessor system</li> <li>– describe how D/A converters are used to control the direction of rotation, speed and position of DC motors</li> <li>– define the function of a servo amplifier in a motor control circuit</li> <li>– describe and provide an example of a microprocessor-based industrial control system</li> <li>– construct a microprocessor-controlled thermometer</li> <li>– construction a microprocessor-controlled SCR or TRIAC circuit</li> <li>– explain how a microprocessor can control the effective current to a load using an SCR or TRIAC</li> <li>– state the advantages of using an opto-isolator in a microprocessor control circuit</li> <li>– design, construct and explain a microprocessor/stepper motor interface and control circuit</li> <li>– explain how a microprocessor is used to control exhaust emissions and fuel economy in an automobile</li> <li>– explain how microprocessors can be used to control a robot</li> </ul> </li> <li>• list several consumer product applications of a microprocessor</li> <li>• explain how multiple microprocessors are used in advanced personal computer and business systems</li> <li>• describe several microprocessor applicators in the aviation and medical industries</li> <li>• explain several business applications of microprocessors including computers, word processors, copiers/printers, registers and inventory control.</li> </ul>	

**COURSE ELT3090: MICROPROCESSOR INTERFACE (continued)**

Concept	Specific Outcomes	Notes
<p>Designing and Prototyping</p>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• construct, connect, interface and operate a microprocessor with devices such as:               <ul style="list-style-type: none"> <li>– photo resistive</li> <li>– temperature and optical sensors</li> <li>– photo diodes and photo transistors</li> <li>– optical interrupter and optical reflectors</li> <li>– optocouplers</li> <li>– Hall effect devices</li> <li>– DC motors</li> </ul> </li> <li>• construct a project incorporating a microprocessor/microcontroller to control the operation; e.g.:               <ul style="list-style-type: none"> <li>– robots</li> <li>– weather stations</li> <li>– home environment systems</li> <li>– security systems</li> <li>– automotive applications</li> <li>– modems</li> </ul> </li> <li>• construct a project using EPROM's memory and various interface devices.</li> </ul>	<p>Could be linked to ELT2010, ELT3010 and robotics for printed circuit.</p>

**COURSE ELT3100: ANALOG COMMUNICATION 3****Level:** Advanced**Theme:** Communication Systems**Prerequisite:** ELT2090 Analog Communication 2**Description:** Students demonstrate the principal concepts of electronic analog communication systems.**Parameters:** CAI package or ham/radio kits and related resources.**Supporting Courses:** ELT2100 Radio Communication  
ELT2080 Control Systems 2**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• identify and demonstrate applications of analog communication</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• analyzing the following electronic circuits: <ul style="list-style-type: none"> <li>– detection, clamping, filtering circuits</li> <li>– bipolar transistors operation configurations</li> <li>– power, voltage, current amplification</li> <li>– FET circuit arrangements</li> <li>– applications of unijunction transistors</li> <li>– opto-electric devices</li> <li>– operational amplifiers</li> <li>– feedback oscillators</li> <li>– LC oscillators</li> <li>– SSB</li> <li>– amplitude, frequency modulator and AM/FM detectors</li> </ul>           using a computer simulation package. </li> <li>• testing the following components: <ul style="list-style-type: none"> <li>– diodes (rectifiers, zener, tunnel, light emitting, photo, etc.)</li> <li>– transistors (bipolar, unijunction, FET, etc.)</li> <li>– operational amplifiers</li> <li>– passive and active devices</li> </ul>           using test instruments such as multimeters, transistor checkers, signature analysis, oscilloscopes. </li> </ul>	70

**COURSE ELT3100: ANALOG COMMUNICATION 3 (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• explain differences between analog communication circuit applications used in telephone systems and consumer audio equipment</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• analyzing advanced communication circuits such as:               <ul style="list-style-type: none"> <li>– FM transmitters/receivers</li> <li>– infrared transmitter/receiver</li> <li>– analog filters</li> <li>– oscillators</li> <li>– amplitude, frequency modulator</li> <li>– dial tone dual tone multifrequency (DTMF)</li> <li>– basic telephone set</li> </ul>               using computer simulation, experimental boards, CAI packages or trainers.             </li> <li>• constructing communication project, such as:               <ul style="list-style-type: none"> <li>– telephone enhancements</li> <li>– radio receiver projects</li> <li>– ham radio kit</li> <li>– infrared transmitter/receivers.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB-2: Assessment Checklist: Laboratory Practice, Part 1</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• explaining the differences between various analog communication circuits used in applications such as:               <ul style="list-style-type: none"> <li>– consumer stereo systems</li> <li>– PA sound systems</li> <li>– telephones</li> <li>– telephone switching networks</li> <li>– cellular telephones</li> <li>– multiband receivers</li> <li>– intercom systems</li> <li>– television</li> <li>– cable television</li> <li>– video cassette recorder (VCR).</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB-2: Assessment Checklist: Laboratory Practice, Part 1</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	<p>20</p>

**COURSE ELT3100: ANALOG COMMUNICATION 3 (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• demonstrate established laboratory procedures and safe work practices</li> <li>• create a profile of a trade or occupation within the field of analog communication</li> <li>• demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• observed performance in following:               <ul style="list-style-type: none"> <li>– established laboratory procedures</li> <li>– procedures indicating awareness of transformer input/output ratings</li> <li>– procedures indicating awareness of heat sinks</li> <li>– correct use of soft fuses for equipment protection.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• completing a career profile in the field of analog communication.</li> </ul> <p><i>Assessment Tool</i>  <i>ELTCPC: Assessment Guide: Career Profiles</i></p> <p><i>Standard</i>  <i>Completing all sections of the profile chart</i></p> <ul style="list-style-type: none"> <li>• observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>5</p> <p>5</p> <p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
<p>Safety/Resource Management</p>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• describe transformer input/output ratings</li> <li>• describe heat sinks</li> <li>• demonstrate knowledge of fuse ratings</li> <li>• demonstrate use of isolation transformers</li> <li>• use “soft fuses” to protect equipment</li> <li>• demonstrate correct handling of electronic components</li> <li>• use correct electronic test equipment.</li> </ul>	<p>RF frequency burns above one watt.</p> <p>Light bulb inserted in fuse holder.</p>

**COURSE ELT3100: ANALOG COMMUNICATION 3 (continued)**

Concept	Specific Outcomes	Notes
Fundamentals	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• explain such terms as:               <ul style="list-style-type: none"> <li>– sine wave</li> <li>– distortion</li> <li>– harmonic signals</li> <li>– amplification</li> <li>– noise</li> <li>– impedance</li> <li>– signal losses</li> <li>– crosstalk</li> <li>– carrier modulation, demodulation</li> <li>– amplitude modulation</li> <li>– frequency modulation</li> <li>– stereo</li> <li>– multichannel communication</li> </ul> </li> <li>• draw a block diagram of multiband receivers</li> <li>• break down diagrams using complex waveforms into their component parts</li> <li>• explain the block diagram operation of a telephone call from the local subscriber to distant subscriber to involve equipment and transmission lines in between</li> <li>• draw a block diagram of a telephone receiver</li> <li>• contrast the fundamental differences between:               <ul style="list-style-type: none"> <li>– amplitude modulation (AM)</li> <li>– frequency modulation (FM)</li> <li>– single side band (SSB)</li> </ul> </li> <li>• analyze the function of each block of multiband receiver</li> <li>• define the properties of signals in both acoustic and electrical forms</li> <li>• identify the distinction used to clarify analog versus digital techniques used in creating electrical signals</li> </ul>	<p>This course may be linked to ELT2010: Electro-assembly 2 and ELT3010: Electro-assembly 3.</p> <p>Reference: <i>Modern Electronics</i> (Miller).</p> <p>AM, FM and Shortwave Frequency.</p> <p>The intent of this SO is to encourage students to develop a strong, analog communication fundamental knowledge base.</p>

**COURSE ELT3100: ANALOG COMMUNICATION 3 (continued)**

Concept	Specific Outcomes	Notes
Fundamentals (continued)	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• describe and measure signal frequency, wavelength and phase</li> <li>• apply the terms and formulas of basic AC to electrical signals</li> <li>• use basic terminology to describe signal power, calculate power gain and show how dB units are converted to voltage, current and power ratios</li> <li>• describe the general operating characteristics of oscillator circuits used to generate sine wave signals</li> <li>• define the concepts of frequency response—power versus frequency—for telephone and audio equipment</li> <li>• state the signal-to-noise ratios required for reliable communications within telephone and audio systems</li> <li>• specify the common forms of wave form distortion applied to signals that pass through electronic circuits</li> <li>• relate the concepts of harmonic distortion and frequency generation to telephone, audio and other telecommunication systems identify the operating characteristics of a complex stereo receiver from previous block diagrams</li> <li>• specify and identify the dial tone dual tone multifrequency (DTMF)</li> <li>• identify the operating principles of a basic electronic telephone set.</li> </ul>	<p>CAI packages may be appropriate at this level to cover all the topics.</p> <p>For students who require additional time or who delve into the material, link this course with a Career Transition course.</p> <p>Text: <i>Understanding Telephone Electronics</i> 3rd edition (Stephen J. Bigelow).</p>

**COURSE ELT3100: ANALOG COMMUNICATION 3 (continued)**

Concept	Specific Outcomes	Notes
<p>Designing and Prototyping</p>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• research and construct a communication project, incorporating some of the following:               <ul style="list-style-type: none"> <li>– diodes, rectifier, zener, tunnel, etc., (used in detection, clamping, filtering circuits)</li> <li>– bipolar transistors operation (used in three-basic transistor configurations)</li> </ul> </li> <li>• list circuit arrangements preferred for power amplification, voltage amplification, current amplification, polarity inversion, impedance matching, isolation and frequency operation</li> <li>• identify three basic field effect transistor (FET) circuit arrangements:               <ul style="list-style-type: none"> <li>– identify applications of unijunction transistors</li> </ul> </li> <li>• identify opto-electric devices used in communication analog electronic circuits</li> <li>• analyze simple inverting and non-inverting amplifiers using operational amplifiers</li> <li>• list the three general classes of feedback oscillators</li> <li>• calculate the frequency of common LC oscillators</li> <li>• explain the advantages, disadvantages and characteristics of amplitude modulation, SSB and frequency modulation</li> <li>• explain the operation of a basic amplitude modulator, balanced modulator, frequency modulator and AM and FM detectors.</li> </ul>	<p>A number of methods may be used:</p> <ul style="list-style-type: none"> <li>• traditional laboratories</li> <li>• textbooks, videos</li> <li>• computer-aided instruction</li> <li>• computer-aided trainers</li> <li>• computer-aided troubleshooting.</li> </ul> <p>(Using different methods would keep up student interest and motivation. Students who require additional time to complete this SO may link this course to a Career Transitions course.)</p> <p>Ideas for this SO can be obtained from the following reference:</p> <ul style="list-style-type: none"> <li>• <i>Incredible Audio and Video Projects You Can Build</i> (Rudolf F. Graf, William Sheets).</li> </ul> <p>Texts that may be used are <i>Ready To Build Telephone Enhancement</i> (Delton J. Horn).</p>

**COURSE ELT3100: ANALOG COMMUNICATION 3 (continued)**

Concept	Specific Outcomes	Notes
Fabricating/Testing	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• analyze one of the following according to project chosen and student interest:               <ul style="list-style-type: none"> <li>– measure input, output analog signals of various transducers</li> <li>– prototype and construct a simple transmitter and/or receiver using transistors and OP amps</li> <li>– prototype an infrared transmitter/receiver for analog transmission</li> <li>– develop, test and measure various signals as they pass through various analog filters</li> <li>– prototype of light wave code transmitters and receivers</li> <li>– prototype of simple diode receivers</li> <li>– construct a simple oscillator</li> <li>– develop an active filter using OP amps.</li> </ul> </li> </ul>	<p>References:</p> <p><i>Modern Electronic Communication</i> (Gary M. Miller), and Lab Manual, 4th edition (Mark Oliver).</p> <p><i>Communication Electronics</i>, Louis Frenzel.</p> <p><i>Activities Manual for Communication Electronics</i> (Louis E. Frenzel).</p>
Careers	<ul style="list-style-type: none"> <li>• research the differences in education, training and job function for electrical engineers, technologists and technicians</li> <li>• research various careers involved in communication electronics</li> <li>• research topics covered in a post-secondary institution that has an communication electronics program.</li> </ul>	<p>College, technical institution, apprenticeship. Calendars.</p>



**COURSE ELT3110: AMPLIFIERS****Level:** Advanced**Theme:** Communication Systems**Prerequisite:** ELT3100 Analog Communication 3**Description:** Students demonstrate knowledge of various types and classes of amplifiers.**Parameters:** CAI package, assorted types of amplifiers and related resources.**Supporting Courses:** ELT2050 Electronic Power Supply  
ELT3100 Analog Communication 3**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>explain the differences among various types and classes of amplifiers</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>describing the application of various amplifiers such as: <ul style="list-style-type: none"> <li>class A, class AB, class B, class C</li> <li>operational amplifiers (OP amps)</li> <li>metal-oxide semiconductor field effect transistors (MOSFETs) and junction field effect transistors (JFETs)</li> <li>direct current (DC) amplifiers</li> <li>Darlington-pair amplifiers</li> <li>integrated current (IC) amplifiers</li> </ul> </li> <li>explaining the difference between amplifiers, using the following criteria: <ul style="list-style-type: none"> <li>transistor circuit configuration</li> <li>impedance matching (input/output)</li> <li>multistage</li> <li>types of coupling</li> <li>voltage and power gain in decibels (dB)</li> </ul> </li> <li>identifying and explaining amplifiers using the following terms: <ul style="list-style-type: none"> <li>complementary</li> <li>push-pull</li> <li>symmetry</li> </ul>           and using schematic and block diagrams generated by the student or obtain from reference sources or computer simulation programs. </li> </ul> <p><i>Assessment Tool</i>  <i>CTSPRE: Assessment Framework:</i>  <i>Presentations/Reports</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	20





**COURSE ELT3110: AMPLIFIERS (continued)**

Concept	Specific Outcomes	Notes
<p>Fundamentals/ Applied Mathematics (continued)</p>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• explain the function and operation of DC, audio, video, power, RF and IF amplifiers</li> <li>• describe a Darlington-pair arrangement</li> <li>• explain how a differential amplifier operates</li> <li>• identify three different types of power amplifiers</li> <li>• explain how volume and tone can be controlled in an audio amplifier</li> <li>• explain the basic differences between IF and RF amplifiers</li> <li>• list three ways of increasing the bandwidth in RF and IF amplifiers</li> <li>• draw a block diagram of a multistage audio amplifier</li> <li>• describe the operation of operational amplifiers using inverting and non-inverting circuits</li> <li>• choose the appropriate amplifier configuration for an application</li> <li>• calculate voltage gain and power gain in decibels (dB).</li> </ul>	
<p>Designing and Prototyping</p>	<ul style="list-style-type: none"> <li>• construct and experiment with amplification circuits such as:               <ul style="list-style-type: none"> <li>– DC amplifier</li> <li>– Class A amplifier</li> <li>– complementary Class B Amplifier</li> <li>– Class B push-pull circuit</li> <li>– Class AB amplifier</li> <li>– a two-stage, RC-coupled audio amplifier</li> <li>– a basic audio power amplifier</li> <li>– push-pull power amplifier</li> <li>– IC amplifiers used in large audio system, e.g., car cassette systems, consumer audio systems</li> <li>– use a JFET as a common-drain amplifier</li> <li>– use a JFET as a common-gate amplifier</li> <li>– a basic differential operational amplifier.</li> </ul> </li> </ul>	<p>Students may use traditional laboratory methods or any CAI amplifier package.</p> <p>Additional time may be required. Link this with a Career Transitions course.</p>

**COURSE ELT3110: AMPLIFIERS** (continued)

Concept	Specific Outcomes	Notes
Real-world Applications/ Troubleshooting	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• troubleshoot a multistage common-emitter amplifier to determine which amplifier stage is faulty.</li> </ul>	Additional time may be required. Link this with a Career Transitions course.
Fabricating/Testing	<ul style="list-style-type: none"> <li>• construct a 25 watt amplifier project (audio or video)</li> <li>• evaluate completed project.</li> </ul>	<p>Additional time may be required. Link this with a Career Transitions course.</p> <p>References:</p> <ul style="list-style-type: none"> <li>• <i>Incredible Audio and Video Projects You Can Build</i> (Rudolf F. Graf William Sheets)</li> <li>• <i>Electronic Power Control</i> (Irving Gottlieb).</li> </ul>



**COURSE ELT3130: DATA/TELEMETRY SYSTEMS****Level:** Advanced**Theme:** Communication Systems**Prerequisite:** None**Description:** Students demonstrate the fundamentals of various data/telemetry systems, and demonstrate their applications to the real world.**Parameters:** Multimeters (analog/digital), function generator, oscilloscope and related resources. Optional equipment: computers, satellite receiver, special trainer or simulators.**Supporting Courses:** ELT3100 Analogue Communication 3  
ELT2100 Radio Communication**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• distinguish the difference between analog and digital carriers with voice or data transmission</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• explaining the differences between the following data/telemetry concepts:               <ul style="list-style-type: none"> <li>– analog link versus digital link</li> <li>– digital and data communication</li> <li>– pulse code modulations (PCM) and pulse amplitude signal (PAM)</li> <li>– frequency shift keying (FSK), phase shift keying (PSK) and quadrature amplitude modulation (QAM)</li> <li>– carrier and character synchronization</li> <li>– synchronous and asynchronous modems</li> <li>– scrambler and descrambler techniques</li> <li>– circuit message network and packet switching network.</li> </ul> </li> </ul> <p><i>Assessment Tool</i> <i>CTSPRE: Assessment Framework:</i> <i>Presentations/Reports</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	20

**COURSE ELT3130: DATA/TELEMETRY SYSTEMS (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• explain data/telemetry communication through experimentation, circuit analysis and project work</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• using advanced data/telemetry circuits, such as:               <ul style="list-style-type: none"> <li>– digital sampling unit</li> <li>– parity bit checker and detector</li> <li>– digital to analog (D/A) or analog to digital (A/D) converters</li> <li>– pulse-amplitude modulation</li> <li>– time division multiplexing</li> </ul> </li> <li>• using computer simulation, experimental boards, CAI package or trainers to analyze the following data/telemetry concepts:               <ul style="list-style-type: none"> <li>– a function generator and observe how it can be used to encode digital information onto an FSK signal</li> <li>– an FSK decoder and observe how it can be used to convert a FSK signal back into a digital data</li> <li>– a PAM communication system that uses time division multiplexing</li> <li>– ongoing observed performance in the construction of an advanced data/telemetry project of student choice.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB–2: Assessment Checklist: Laboratory Practice, Parts 1 and 3</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	<p>55</p>
<ul style="list-style-type: none"> <li>• construct a voice or data transmission network</li> </ul>	<ul style="list-style-type: none"> <li>• constructing or installing one of the following data networks:               <ul style="list-style-type: none"> <li>– star</li> <li>– ring</li> <li>– multidrop</li> </ul> </li> <li>• constructing or installing one of the following voice transmission networks:               <ul style="list-style-type: none"> <li>– simplex</li> <li>– half-duplex</li> <li>– full-duplex.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB–2: Assessment Checklist: Laboratory Practice, Part 2</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	<p>20</p>



**COURSE ELT3130: DATA/TELEMETRY SYSTEMS (continued)**

Concept	Specific Outcomes	Notes
<p>Fundamentals (continued)</p>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>– radio telemetry</li> <li>– converter</li> <li>– carrier</li> <li>– modulator</li> <li>– error detection</li> <li>– modem</li> <li>– analog link versus digital link</li> </ul> <ul style="list-style-type: none"> <li>• research the following networks:               <ul style="list-style-type: none"> <li>– star</li> <li>– ring</li> <li>– multidrop</li> </ul> </li> <li>• describe the difference between the following communication systems:               <ul style="list-style-type: none"> <li>– simplex</li> <li>– half-duplex</li> <li>– full-duplex</li> <li>– full/full-duplex</li> </ul> </li> <li>• explain the difference between digital and data communication</li> <li>• describe how a wave may be sampled</li> <li>• draw a block diagram of a radio-telemetry system and describe each part of the system</li> <li>• draw a block diagram and explain each part in the following transmission alternatives:               <ul style="list-style-type: none"> <li>– standard continuous modulation</li> <li>– telegraphy</li> <li>– pulse modulation</li> <li>– pulse code modulation</li> </ul> </li> <li>• explain pulse code modulation (PCM)</li> <li>• sketch the wave form of a pulse amplitude signal (PAM)</li> <li>• explain why PCM is strictly the only true digital system of the four above</li> <li>• draw a block diagram of a computer data transmission system</li> </ul>	<p>Evolution of data transmission systems.</p>

**COURSE ELT3130: DATA/TELEMETRY SYSTEMS (continued)**

Concept	Specific Outcomes	Notes
<p>Fundamentals (continued)</p>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• explain a universal asynchronous receiver/transmitter (UART) device</li> <li>• describe the difference between the following forms of modulation by modems:               <ul style="list-style-type: none"> <li>– frequency shift keying (FSK)</li> <li>– phase shift keying (PSK)</li> <li>– quadrature amplitude modulation (QAM)</li> </ul> </li> <li>• describe three types of synchronization that must be accomplished:               <ul style="list-style-type: none"> <li>– carrier</li> <li>– bit</li> <li>– character</li> </ul> </li> <li>• explain how a modem transmits data if it were:               <ul style="list-style-type: none"> <li>– synchronous</li> <li>– asynchronous</li> </ul> </li> <li>• explain line protocol</li> <li>• explain how error detection and correction is achieved in digital data communication</li> <li>• explain the difference between scramblers and descramblers</li> <li>• explain the difference in a network between circuit message and packet switching</li> <li>• explain frequency division multiplexing (FDM) in a modem</li> <li>• research the type of local area network (LAN) his or her school uses</li> <li>• list and explain the pin functions on an RS232C interface</li> <li>• list the two broad categories of pulse modulation</li> <li>• name the two types of analog pulse modulation</li> <li>• state the sampling Nyquist rate theorem</li> <li>• compare analog and digital pulse modulation.</li> <li>• construct a digital sampling unit (frequency counter)</li> </ul>	<p>Name the basic types of multiplexing and define each one.</p>

**COURSE ELT3130: DATA/TELEMETRY SYSTEMS (continued)**

Concept	Specific Outcomes	Notes
Fabricating/Testing	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• construct an error detector in data transmission—parity bit checker and detector</li> <li>• prototype, experiment with a basic D/A converter and A/D converter ICs</li> <li>• construct a simple circuit using a UART device</li> <li>• analyze a function generator and observe how it can be used to encode digital information onto an FSK signal</li> <li>• analyze an FSK decoder and observe how it can be used to convert an FSK signal back into a digital data</li> <li>• describe pulse-amplitude modulation techniques</li> <li>• test and evaluate a simple PAM modulator and demodulator</li> <li>• test and evaluate a PAM communication system that uses time division multiplexing</li> <li>• construct a simple circuit that uses analog data, convert it to digital pulses and reproduce at the output the original analog signal</li> <li>• install a modem and check operation</li> <li>• construct a project using a UART IC</li> <li>• install a network between several computers</li> <li>• research scrambling and descrambling techniques used by local cable companies</li> <li>• construct an elementary gated five-jack descrambler</li> <li>• prototype a sine-wave decoder</li> <li>• construct an advanced video project</li> <li>• construct a telephone scrambler.</li> </ul>	<p><i>Miller's Laboratory Manual for Modern Electronic Communication.</i></p> <p><i>Communications Electronics, 2<sup>nd</sup> edition (Louis E. Frenzel).</i></p> <p>This circuit is for experimental and education use only.</p> <p>For experimental and education use only.</p>
Ethics	<ul style="list-style-type: none"> <li>• report on political, legal and consumer aspects of cable TV descrambling/scrambling.</li> </ul>	

**COURSE ELT3140: MOTORS****Level:** Advanced**Theme:** Robotic and Control Systems**Prerequisite:** None**Description:** Students demonstrate knowledge of electric motor operation and loading characteristics.

**Parameters:** AC/DC motors (single-phase AC motor and DC motors) and related resources.  
**Note:** The student must have access to instruction from an individual with Electrical Technologist or journeyman status when students are performing practical components other than low voltage.

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

**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>explain electromotive principles as applied to direct current (DC) and single-phase alternating current (AC) motors</li> <li>explain the operational characteristics of common DC and AC motors</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>explaining the electromotive principles of both a DC motor and an AC single-phase motor.</li> </ul> <p><i>Assessment Tool</i>            ELT3140–1: Presentation/Reports, Electric Motors</p> <p><i>Standard</i>            Performance rating of 3 for each applicable task</p>	15
	<ul style="list-style-type: none"> <li>describing the operating characteristics of:               <ul style="list-style-type: none"> <li>– DC series motor</li> <li>– DC shunt motor</li> <li>– DC compound motor</li> <li>– single- and/or three-phase commutator motors</li> <li>– single- and/or three-phase induction motor</li> <li>– single- and/or three-phase synchronous.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>            ELT3140–1: Presentations/Reports: Electric Motors</p> <p><i>Standard</i>            Performance rating of 3 for each applicable task</p>	20

**COURSE ELT3140: MOTORS** (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• set up selected DC and AC motors, and demonstrate their loading characteristics</li> <li>• demonstrate established laboratory procedures and safe work practices</li> <li>• create a profile of a trade or occupation within the field of electric motors</li> <li>• demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• collecting data to graph the operating characteristics of the following motors:               <ul style="list-style-type: none"> <li>– DC compound motor</li> <li>– single- and three-phase commutator motors</li> <li>– single- and three-phase induction motor</li> <li>– single-phase synchronous.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB–2: Assessment Checklist: Laboratory Practice, Part 1</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• observed performance in following:               <ul style="list-style-type: none"> <li>– established laboratory procedures</li> <li>– proper wiring practices</li> <li>– correct loading and operating procedures.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• completing a career profile chart related to servicing/repairing electric motors.</li> </ul> <p><i>Assessment Tool</i>  <i>ELTCPC: Assessment Guide: Career Profiles</i></p> <p><i>Standard</i>  <i>Completing all sections of the profile chart</i></p> <ul style="list-style-type: none"> <li>• observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>55</p> <p>5</p> <p>5</p> <p>Integrated throughout</p>

**COURSE ELT3140: MOTORS** (continued)

Concept	Specific Outcomes	Notes
<p>Safety/Resource Management</p>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• identify and follow safe wiring practices</li> <li>• use protection devices for all circuits</li> <li>• describe dangers of shaft rotation regarding:               <ul style="list-style-type: none"> <li>– vibration</li> <li>– long hair</li> <li>– clothing</li> <li>– jewelry.</li> </ul> </li> </ul>	<p>Use of overload and overcurrent devices.</p> <p>Live voltage projects must be activated through GFI circuit breaker.</p> <p>When instructional journeyman qualifications restrict high voltage use, projects may be done in low voltages (less than 30 volts).</p>
<p>Fundamentals</p>	<ul style="list-style-type: none"> <li>• explain and demonstrate motor principles:               <ul style="list-style-type: none"> <li>– counter EMF</li> <li>– inductance</li> <li>– conductive resistance</li> </ul> </li> <li>• describe and explain characteristics of the following AC and DC motors:               <ul style="list-style-type: none"> <li>– shaded pole</li> <li>– split phase</li> <li>– capacitive start and run</li> <li>– three-phase</li> <li>– universal</li> <li>– single-phase synchronous</li> <li>– stepper</li> <li>– servo</li> <li>– permanent magnet.</li> </ul> </li> <li>• describe methods of DC motor control:               <ul style="list-style-type: none"> <li>– pulse width modulations (PWM)</li> <li>– positional feedback/shaft encoding</li> </ul> </li> <li>• explain nameplate ratings:               <ul style="list-style-type: none"> <li>– voltage</li> <li>– current</li> <li>– horsepower</li> <li>– efficiency</li> <li>– cycle</li> <li>– RPM</li> <li>– phase</li> <li>– frame size</li> <li>– enclosure.</li> </ul> </li> </ul>	<p>Power small DC hobby motor with PWM circuit using 555 timer circuit Reference Industrial Electronic by Petruzella.</p>

**COURSE ELT3140: MOTORS** (continued)

Concept	Specific Outcomes	Notes
<p>Designing and Prototyping</p>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• design and construct the following motor circuits to find torque versus load and speed regulation versus load on:               <ul style="list-style-type: none"> <li>– inductive motors:                   <ul style="list-style-type: none"> <li>• split phase</li> <li>• capacitor start</li> <li>• permanent split capacitor</li> <li>• shaded pole</li> <li>• three-phase</li> </ul> </li> <li>– brush motors:                   <ul style="list-style-type: none"> <li>• universal</li> <li>• flat compound DC motor</li> </ul> </li> <li>– others:                   <ul style="list-style-type: none"> <li>• single-phase synchronous</li> <li>• stepper</li> <li>• servo</li> <li>• permanent magnet.</li> </ul> </li> </ul> </li> </ul>	<p>Starting current.</p> <p>Rotation.</p> <p>Drives in electronic components.</p> <p>Small hobby motor projects, e.g., solar cars and robots.</p>
<p>Careers</p>	<ul style="list-style-type: none"> <li>• research careers that require knowledge of electric motors.</li> </ul>	<p>Oil/gas industry.</p> <p>Computer processor control.</p> <p>Manufacturers—assembly line.</p> <p>Printing presses.</p> <p>Elevators.</p>



**COURSE ELT3150: ROBOTICS 3** (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• explain frequency control or microprocessor control circuits and components in robotic units</li> <li>• operate a robotic system that has various feedback controls</li> <li>• demonstrate established laboratory procedures and safe work practices</li> <li>• create a profile of a trade or occupation within the field of robotics</li> <li>• demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• creating block diagrams showing how the frequency or microprocessor control circuits and components function in a robotic unit.</li> </ul>	15
	<p><i>Assessment Tool</i>  <i>ELTLAB–2: Assessment Checklist: Laboratory Practice, Part 1</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	
	<ul style="list-style-type: none"> <li>• operating and explaining feedback control circuit(s) in a constructed robot.</li> </ul> <p><i>Assessment Tool</i>  <i>ELTLAB–1: Laboratory Practice, Part 1</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	10
	<ul style="list-style-type: none"> <li>• observed performance in following: <ul style="list-style-type: none"> <li>– established laboratory procedures</li> <li>– correct procedures for operation of robots within designed tolerance.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	5
	<ul style="list-style-type: none"> <li>• completing a career profile chart related to robotics.</li> </ul> <p><i>Assessment Tool</i>  <i>ELTCPC: Assessment Guide: Career Profiles</i></p> <p><i>Standard</i>  <i>Completing all sections of the profile chart</i></p>	5
<ul style="list-style-type: none"> <li>• observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	Integrated throughout	

**COURSE ELT3150: ROBOTICS 3 (continued)**

Concept	Specific Outcomes	Notes
Safety/Resource Management	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• identify and follow safe wiring practices when working with RF</li> <li>• use protection devices for all circuits</li> <li>• operate robotic systems within design tolerances.</li> </ul>	RF fusing temperature cutoff.
Fundamentals	<ul style="list-style-type: none"> <li>• demonstrate the principles of either a remote frequency control or a programming address code control</li> <li>• explain the operation of the electronic components and circuit used to build either a remote control robot or a programmable control robot.</li> </ul>	
Systems Identification	<ul style="list-style-type: none"> <li>• draw and explain the various blocks in either a remote control system or programmable microprocessor/control system</li> <li>• describe and explain use of sight, sound and tactile sensor control systems with either the remote control system or the programmable microprocessor control system</li> <li>• explain the fundamentals of either the remote control system or the programmable microprocessor control system controlling the motor drives in the robotic system</li> <li>• identify the differences between remote control systems and a programmable control system on how the robot gains information about its environment</li> <li>• explain how sensor controls help either the remote control or the programmable control robot to receive feedback from the environment.</li> </ul>	Use electronics simulation packages.

**COURSE ELT3150: ROBOTICS 3** (continued)

Concept	Specific Outcomes	Notes
Designing and Prototyping	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• 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</li> <li>• 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 controls the motors on the mobile robot</li> <li>• draw the schematic diagram of the printed circuit board and wiring schematic of the control circuitry.</li> </ul>	<p>Surplus electro-mechanical components.</p> <p>Robot kit.</p>
Fabrication	<ul style="list-style-type: none"> <li>• assemble electronic components to build a mobile robot</li> <li>• build either a remote control or a programmable control and mount either control on the mobile robot.</li> </ul>	<p>Refer to:  <i>Mobile Robots</i> (J.L. Jome and A. Flynn),  <i>Robot Builder's Bonanza, 99</i>  <i>Inexpensive Robotic Projects</i> (Gordon McComb), <i>Western Canadian Robot Games</i> (Southern Alberta Institute of Technology).</p>
Real-world Applications	<ul style="list-style-type: none"> <li>• research the benefits and drawbacks of various remote and/or microprocessor controls that are used to operate a robot</li> <li>• describe where industry is making use of remote and microprocessor control robots.</li> </ul>	<p>Tour an industrial plant using robots.</p>
Careers	<ul style="list-style-type: none"> <li>• research career opportunities in the robotic field.</li> </ul>	

**COURSE ELT3160: CONTROL APPLICATIONS****Level:** Advanced**Theme:** Robotic and Control Systems**Prerequisite:** ELT2150 Electronic Controls**Description:** Students demonstrate the fundamentals of programmed controls, and demonstrate how sensing devices are integrated to control output devices.**Parameters:** 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 journeyman status when students are performing practical components other than low voltage.**Supporting Courses:** ELT2130 Magnetic Control Devices  
ELT3140 Motors**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>identify and describe input and output hardware components and the methods of programming</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>identifying and describing two types of input devices, digital and analog input hardware components and explaining how each is used in a program</li> <li>explaining advance programming functions such as: <ul style="list-style-type: none"> <li>timers and counters</li> <li>data manipulation instructions</li> <li>shift register and sequencer instruction</li> </ul> and explain how each is used in programming a programmer logic controller (PLC).</li> </ul> <p><i>Assessment Tool</i> <i>ELTLAB-2: Assessment Checklist: Laboratory Practice, Part 1</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	20
<ul style="list-style-type: none"> <li>use programming logic, including real or programmed inputs, to control electromagnetic devices</li> </ul>	<ul style="list-style-type: none"> <li>drawing, identifying and writing a housing address, ladder logic and wiring diagram</li> </ul>	60

**COURSE ELT3160: CONTROL APPLICATIONS (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• use various instruction codes to operate and control electromagnetic devices</li> <li>• demonstrate established laboratory procedures and safe work practices</li> <li>• demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• fabricating, constructing and testing programmed logic to operate and control electromagnetic devices connected to a PLC. <i>Assessment Tool</i> <i>ELTLAB–3: Assessment Checklist: Laboratory Practice, Part 2</i></li> <li>• changing instructional codes of input devices that the logic program uses to operate and control the electromagnetic devices connected to the PLC. <i>Assessment Tool</i> <i>ELTLAB–3: Assessment Checklist: Laboratory Practice, Parts 2 and 3</i></li> <li>• observed performance in following:               <ul style="list-style-type: none"> <li>– established laboratory procedures</li> <li>– correct use of protection devices for circuits.</li> </ul> </li> <li>• observations of individual effort and interpersonal interaction during the learning process. <i>Assessment Tool</i> <i>Basic Competencies Reference Guide and any assessment tools noted above</i></li> </ul> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	<p>15</p> <p>5</p> <p>Integrated throughout</p>

**COURSE ELT3160: CONTROL APPLICATIONS (continued)**

Concept	Specific Outcomes	Notes
Safety/Resource Management	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• identify and follow safe wiring practices when wiring the input and output circuits</li> <li>• use protection devices for all circuits.</li> </ul>	<p>Low voltage wiring, grounding, separation of voltages, fusing.</p> <p>Live voltage projects must be activated through GFI circuit breaker.</p> <p>When instructional journeyman qualifications restrict high voltage use, projects may be done in low voltages (less than 30 volts).</p>
Fundamentals	<ul style="list-style-type: none"> <li>• draw and identify addressing, ladder logic and wiring diagram of a PLC installation</li> <li>• describe and explain numbering systems and codes for internal logic control</li> <li>• plan PLC ladder programs and wiring diagrams, advance programming logic functions</li> <li>• create flow diagram to write programming logic</li> <li>• compare relay logic and PLC programming</li> <li>• demonstrate principles of electromagnetic motor starters to control large current flow to output devices</li> <li>• demonstrate principles of feedback loop input sensors to protect outputs devices</li> <li>• demonstrate the action of overload and limit switch feedback loop input sensors to protect the output system</li> <li>• demonstrate knowledge of how either a DC or an AC motor is operated by a PLC</li> <li>• demonstrate knowledge on how A/D conversions are done on a PLC.</li> </ul>	
System Identification	<ul style="list-style-type: none"> <li>• identify the difference between real-world devices and internal program devices when programming the PLC.</li> </ul>	

**COURSE ELT3160: CONTROL APPLICATIONS (continued)**

Concept	Specific Outcomes	Notes
Real-world Applications	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• research the benefits and drawbacks of using PLCs</li> <li>• research how PLCs are used in computer integrated manufacturing.</li> </ul>	
Fabricating/Testing	<ul style="list-style-type: none"> <li>• build a multiple motor, PLC-controlled installation, and write a program to control the installation.</li> </ul>	Low voltage hobby motors.
Design/Prototyping	<ul style="list-style-type: none"> <li>• demonstrate a knowledge of PLC function by writing advance programs to operate a relay controlled AC motors</li> <li>• design programming functions with input and output devices so the PLC can control electromagnetic devices and indicator lamps</li> <li>• draw PLC ladder programs complete with wiring diagrams of input and output systems.</li> </ul>	
Careers	<ul style="list-style-type: none"> <li>• write a report on industries that use PLCs to control and monitor computer integrated manufacturing.</li> </ul>	