COURSE CURRICULUM AND ASSESSMENT STANDARDS: SECTION E: INTERMEDIATE LEVEL

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

Intermediate level courses help students build on the competencies developed at the introductory level and focus on developing more complex competencies. They provide a broader perspective, helping students recognize the wide range of related career opportunities available within the strand.

COURSE ELT2010: ELECTRO-ASSEMBLY 2

Level: Intermediate

Theme: Fabrication and Service Principles

Prerequisite: ELT1010 Electro-assembly 1

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

Parameters: Printed circuit fabrication kit and related resources.

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• identify appropriate construction methods to fabricate a circuit board	• identifying and describing the three methods to prepare an electronic circuit board for etching. *Assessment Tool* *ELT2010–1: Presentations/Reports: Circuit Boards* *Standard* *Performance rating of 2 for each applicable task*	10
• lay out and construct a simple electronic circuit board, using approved construction techniques	• identifying, designing and drawing the circuit board foil layout and constructing electronic circuit boards. *Assessment Tool* *ELTPAF: Project Assessment Form* *Standard* *Performance rating of 2 for each applicable task*	35
• use a PC board and proper fabrication techniques to assemble a project	• cleaning, drilling, mounting, soldering components, applying protective coating to foil and assembling a printed circuit (PC) board project. *Assessment Tool* *ELTPAF: Project Assessment Form* *Standard* *Performance rating of 2 for each applicable task*	50

COURSE ELT2010: ELECTRO-ASSEMBLY 2 (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • demonstrate established laboratory procedures and safe work practices	*Assessment of student achievement should be based on:* • observed performance in following: – established laboratory procedures – use and disposal of chemicals related to circuit board construction – use of solder and fluxes. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • research illnesses caused by chemical, solder and flux used in prototype construction • demonstrate appropriate safety techniques when using solder and chemicals for prototype construction • identify and follow safe home/laboratory procedures while using solder, flux, photochemicals, cleaning chemicals and etching chemicals.	Observe WHMIS regulations when using solder, flux chemicals, and PCB board materials.
Fundamentals	• research the benefits and drawbacks of prototype construction assembly methods.	List and explain the differences between various prototype assembly methods.

COURSE ELT2010: ELECTRO-ASSEMBLY 2 (continued)

Concept	Specific Outcomes	Notes
System Identification	*The student should:* • use schematic symbols to represent electronic components • draw and/or modify schematic diagrams for a simple electronic circuit • match actual components to schematic symbols.	IEEE standards. *Electronic workbench*, project books/ magazines
Designing and Prototyping	• prototype an electronic circuit on a breadboard • create the artwork circuit layout drawing for a printed circuit board • practise printed circuit board building and component installation.	Circuit on SK10 breadboard, matrix board with pins, wire wrap boards, nail and wood board, printed circuit board.
Fabrication	• use an etch-resistance pen or photographic method to make a circuit board project.	Students to research circuit work required in other ELT courses; e.g.: • Robotics courses • Communication Systems courses • Power Systems courses • Computer Logic Systems courses.
Problem Solving	• evaluate the circuit using electronic instruments • demonstrate how to troubleshoot an electronic circuit board.	Continuity check.
Careers	• research employment opportunities in photographic and breadboard circuit design and construction • maintain a record of completed activities within a portfolio or create and/or add information to an existing portfolio.	

COURSE ELT2020: ELECTRICAL SERVICING

Level: Intermediate

Theme: Fabrication and Service Principles

Prerequisite: ELT1010 Electro-assembly 1

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

Parameters: Basic hand tools, testing equipment and related resources.

Supporting Course: ELT2010 Electro-assembly 2

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• develop a basic repair and maintenance schedule for an electrical/electronic device	• preparation of a service schedule for an electrical/electronic system, including: – basic information – factors to consider. *Assessment Tool* *ELTCSR: Customer Service, Part 3* *Standard* *Performance rating of 2 for each applicable task*	30
• identify faults in an electrical/electronic device, and propose solutions for repair	• identifying the failure of an electrical/electronic device, and providing a repair/replacement solution and cost estimate. *Assessment Tool* *ELTCSR: Customer Service, Part 4* *Standard* *Performance rating of 2 for each applicable task*	20
• use appropriate testing procedures to assess/repair an electrical/electronic device	• testing and repairing an electronic/electrical device. *Assessment Tool* *ELTCSR: Customer Service, Parts 2, 3 and 4* *Standard* *Performance rating of 2 for each applicable task*	45

COURSE ELT2020: ELECTRICAL SERVICING (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • demonstrate established laboratory procedures and safe work practices	*Assessment of student achievement should be based on:* • observed performance in following: – established laboratory procedures – electrical grounding – current protection – static protection. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • demonstrate a professional attitude of personal safety • use proper grounding techniques, current protection and static protection when testing electronic circuits.	Fusing, grounding, ground fault, static grounding. WHMIS, soldering chemicals.
Fundamentals	• define current, resistance, magnetic field, voltage rating, temperature and wattage.	
System Identification	• identify the types of data found on a name plate • explain why the Canadian Standards Association (CSA) standards are applied to appliances • identify stages of operation of various types of electrical/electronic systems • interpret a flow connection chart or wiring schematic of the system.	Have students locate CSA approval stickers.

COURSE ELT2020: ELECTRICAL SERVICING (continued)

Concept	Specific Outcomes	Notes
Problem Solving	*The student should:* • describe standard procedures to locate circuit/component faults • identify the problem and propose a solution to effect the repair.	
Testing	• use measurement techniques related to voltage, current, resistance, wattage and continuity to appraise the condition of the circuit.	
Repair/Service/ Maintenance	• troubleshoot an electrical/electronic device • create a service schedule, considering: – nameplate data – stages of operation – charts and wiring schematics – grounding techniques – protection devices; the schedule should also reflect the following variables: – function of the unit – frequency of use – subjected conditions – age – cost of service – cost of replacement service/maintain and repair electrical/electronic devices identifying potential problems and correcting • explain and demonstrate how to repair electronic printed circuit boards • measure the voltage, current and wattage of repaired items and compare the values with the nameplate ratings.	Repair to printed circuit boards, electrical heating element appliance, motor appliance, incandescent and florescent light equipment, troubleshooting electrical house wiring, small radios.
Careers	• research employment opportunities in small appliance repair • create and/or add information to an existing portfolio.	Apprenticeship. Appliance technicians.

COURSE ELT2030: BRANCH CIRCUIT WIRING

Level: Intermediate

Theme: Power Systems

Prerequisite: ELT1030 Conversion & Distribution

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

Parameters: Basic hand tools, multimeter and related resources.

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

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• identify and describe various branch wiring systems used in residential and commercial applications	• using the proper pictorial schematic, line diagram, ladder diagram, terminal connection and bill of materials to show how a branch wiring system is installed according to the Canadian Electrical Code (CEC). *Assessment Tool* *ELTLAB–1: Laboratory Practice, Parts 1 and 2* *Standard* *Performance rating of 2 for each applicable task*	15
• apply Canadian Electrical Code (CEC) standards to various branch wiring system designs	• installing and wiring an electrical system using the proper CEC codes for wiring: – receptacles – switching – lighting – wiring. *Assessment Tool* *ELTLAB–1: Laboratory Practice, Parts 2 and 3* *Standard* *Performance rating of 2 for each applicable task*	15
• wire a branch circuit for a residential application	• application of the CEC standards when constructing a branch circuit. *Assessment Tool* *ELTLAB–1: Laboratory Practice, Part 1* *Standard* *Performance rating of 2 for each applicable task*	65

COURSE ELT2030: BRANCH CIRCUIT WIRING (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • demonstrate established laboratory procedures and safe work practices	*Assessment of student achievement should be based on:* • observed performance in following: – established laboratory procedures – CEC code practices – grounding and overload protection practices – lockout/tag out practices – treatment for electrical shocks and burns. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • demonstrate how to connect wiring to comply with CEC, local and Alberta standards • demonstrate safe practices regarding grounding and overload protection of circuits and devices, such as case/receptacle grounding • describe danger of electrical shocks and burns • describe lock out/tag out practices.	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).

COURSE ELT2030: BRANCH CIRCUIT WIRING (continued)

Concept	Specific Outcomes	Notes
Fundamentals	*The student should:* • use CEC standards in branch circuit design and installation • draw schematic and pictorial diagrams of branch circuit wiring • interpret architectural drawings regarding branch circuit wiring • identify various wiring systems, methods and materials; e.g.: – nonmetallic shielded cable (NMSC) – armoured cable (BX) – conduit and conductors – Teck cable – raceway systems – mineral insulated cable (Pyrotenex) – wire mold.	
System Identification	• compare series and parallel branch wiring circuits • identify live, grounding, grounded branch circuit conductors • measure voltage, current and continuity.	Live – black (hot); grounded – white (neutral); grounding – green (bare).
Fabricating/Testing	• construct, according to CEC standards, the following branch circuits in NMSC: – standard receptacle – single location lamp switching – switch receptacle – range and/or dryer receptacle – split receptacle – multiple locations lamp switching – ground-fault interrupter (GFI) receptacle • construct, according to CEC standards, one of the above branch circuits using: – armoured cable – conduit raceway • install breakers and terminate branch circuit wiring in single-phase panel board.	Dimmer switch, lamp fixtures. Standard house panel including explanations of protection function.

COURSE ELT2030: BRANCH CIRCUIT WIRING (continued)

Concept	Specific Outcomes	Notes
Real-world Applications	*The student should:* • research requirements for obtaining an electrical permit.	
Careers	• research Alberta apprenticeship related to electrical work • research Interprovincial and Master Certification • create and/or add information to an existing portfolio.	

COURSE ELT2050: ELECTRONIC POWER SUPPLY 2

Level: Intermediate

Theme: Power Systems

Prerequisite: ELT1050 Electronic Power Supply 1

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

Parameters: Oscilloscope, multimeter, isolation transformer and related resources.

Supporting Course: ELT2010 Electro-assembly 2

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• construct, analyze and evaluate single-phase rectifiers	• constructing, analyzing and evaluating various single-phase rectifier systems such as: – half-wave rectifier circuit – two-diode rectifier circuit – bridge rectifier circuit. *Assessment Tool* *ELTLAB–2: Assessment Checklist: Laboratory Practice, Parts 2 and 3* *Standard* *Performance rating of 2 for each applicable task*	25
• observe and test the voltage and waveform of a switching power supply	• identification of components and circuits using a schematic diagram and testing the voltage and waveform of a switching power supply. *Assessment Tool* *ELTLAB–2: Assessment Checklist: Laboratory Practice, Part 3* *Standard* *Performance rating of 2 for each applicable task*	10
• build and analyze the characteristics of a power supply regulated by a zener transistor	• identifying components/circuits using a schematic then building and analyzing a regulated power supply. *Assessment Tool* *ELTLAB–2: Assessment Checklist: Laboratory Practice, Part 2* *Standard* *Performance rating of 2 for each applicable task*	30

COURSE ELT2050: ELECTRONIC POWER SUPPLY 2 (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• build, test and analyze filtering circuits used in electronic power supplies	• identifying components/circuits using a schematic then building and analyzing an electronic regulated power supply filter circuits. *Assessment Tool* *ELTLAB–2: Assessment Checklist: Laboratory Practice, Part 2* *Standard* *Performance rating of 2 for each applicable task*	30
• demonstrate established laboratory procedures and safe work practices	• observed performance in following: – established laboratory procedures – correct procedures for grounding and use of oscilloscope. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • use an isolation transformer • demonstrate safe practices, especially regarding grounding and use of oscilloscope.	

COURSE ELT2050: ELECTRONIC POWER SUPPLY 2 (continued)

Concept	Specific Outcomes	Notes
Fundamentals	*The student should:* • identify components responsible for improved output of a regulated filtered power supply • explain fundamentals of diodes, zeners, transistors and operational amplifiers (OP amps) • diagram half-wave, full-wave bridge and centre tap rectifiers • identify current path in half-wave, full-wave bridge, and centre tap rectifiers.	
Applied Mathematics	• mathematically analyze output voltage, ripple frequency and required peak inverse voltage of half-wave, full-wave bridge and centre tap rectifiers • mathematically determine component values for construction of a regulated power supply.	Introductory trigonometry. Introductory algebra.
Designing and Prototyping	• construct, energize, measure and graph the input and output of a half-wave, full-wave bridge, centre tap rectifiers and regulated power supply.	Permanent construction on PC board made in ELT2010. Zener, IC, op-amps, transistor regulated.
Stages of Operation	• set up, test and analyze a switching power supply.	Test existing power supply.
Fabricating/Testing	• construct a full-wave, filtered and regulated power supply • test regulated power supply.	Can be linked to Electro-assembly 3 (ELT3010).

COURSE ELT2060: DIGITAL TECHNOLOGY 2

Level: Intermediate

Theme: Computer Logic Systems

Prerequisite: ELT1060 Digital Technology 1

Description: Students demonstrate knowledge of digital principles, by using small-scale transistor–transistor logic (TTL) and complementary metal oxide semiconductor (CMOS) integrated technology.

Parameters: Digital logic trainer, oscilloscope, function generator and related resources.

Supporting Course: ELT2010 Electro-assembly 2

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • identify and interface components with TTL and CMOS small-scale integrated circuit (IC) families	*Assessment of student achievement should be based on:* • use TTL and CMOS small-scale integrated technology ICs to: – identify the IC by number on the case and identify the family it belongs to using data manuals, CD ROMs, data programs – identify the pinouts concerning ground and voltage of both TTL and CMOS ICs using data manuals or CD ROMs, data programs – experiment with both CMOS and TTL ICs involving AND, NAND, NOR, OR, X-NOR, NOT gates using computer simulation or logic trainers – interface between various TTL and CMOS ICs – develop boolean expressions for all basic gates used in TTL and CMOS technology – develop truth tables for basic gates used in both TTL and CMOS ICs – explain various numbering systems and binary codes. *Assessment Tool* *ELTLAB–3: Assessment Checklist: Laboratory Practice, Part 1* *Standard* *Performance rating of 2 for each applicable task*	40

COURSE ELT2060: DIGITAL TECHNOLOGY 2 (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• identify components and construct a prototype of typical small-scale and complex logic networks, using TTL and CMOS families of ICs	• given both TTL and CMOS small-scale and complex logic networks, the student will: – identify each according to gate function, type of Flip-Flop or counter or register according to number system and data reference manuals or computer programs – experiment with various gates connected into a logic network (actual or computer simulation) – develop boolean expression for gate networks – demonstrate simplification of boolean expressions, gate minimization, Karnaugh mapping – experiment with devices, such as registers, decoders, converters, multiplexes, etc. • using small-scale logic networks, prototype the solution using digital logic circuits in combination and sequential logic design – construct and fabricate the circuit. *Assessment Tool* *ELTLAB–3: Assessment Checklist: Laboratory Practice, Parts 1 and 2* *Standard* *Performance rating of 2 for each applicable task*	55
• demonstrate established laboratory procedures and safe work practices	• observed performance in following: – established laboratory procedures – correct procedures when working with electrostatic charges and grounding straps – recommended voltage and current rating of IC families. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

COURSE ELT2060: DIGITAL TECHNOLOGY 2 (continued)

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • explain and demonstrate how to avoid electrostatic discharges around IC chips, using static mats, grounding straps • demonstrate an understanding of grounding, voltage and current rating of various IC families.	Grounding, VCC, VDD, VSS, positive and negative voltages.
Fundamentals	• explain the difference between various gate applications, counters and registers • distinguish the difference among various numbering systems and binary codes, such as: – binary – octual – hexadecimal – Binary Coded Decimal (BCD) – American Code for Information Interchange (ASCII).	Demonstrate the use of: • Flip-Flops • JK • RS • D Type • T Type.
Real-world Applications	• solve, construct and experiment with real-world problems using combination and sequential logic design for applications such as traffic lights, aircraft landing gear and motor controls • prototype the solution for a logic problem on a breadboard and develop a truth table • use emulation software on a design problem.	*Electronic workbench.*
Applied Mathematics	• demonstrate the use of boolean algebra to analyze a logic circuit.	DeMorgan's theorems. Boolean expressions for gate networks. Simplification of boolean expressions. Gate minimization. Karnaugh mapping.

COURSE ELT2060: DIGITAL TECHNOLOGY 2 (continued)

Concept	Specific Outcomes	Notes
Designing and Prototyping	*The student should:* • demonstrate how to prototype and troubleshoot the following fundamental logic gates in typical and complex logic networks: – AND – NAND – NOR – X-NOR – OR, Registers – F/F counters – simple comparators.	
Fabricating/Testing	• use a printed circuit board (PC board) to fabricate a digital circuitry project, such as: – digital dice – sound generator decision maker – electronic scoreboard – IC tester • use a PC board software to layout a digital circuit.	

COURSE ELT2070: COMPUTER TECHNOLOGY

Level: Intermediate

Theme: Computer Logic Systems

Prerequisite: None

Description: Students develop the knowledge and skills required to install and configure a disc operating system and to set up a computer network.

Parameters: A working computer, modem, printer, cables, software, basic hand tools and related resources.

Supporting Course: ELT2060 Digital Technology 2

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • disassemble/assemble a working computer, and perform basic troubleshooting procedures	*Assessment of student achievement should be based on:* • identifying the various subsystems of a computer • dissembling a computer into its subsystems • assembling a computer from the above parts • setting the system configurations switches • installing monitor/keyboard • demonstrating basic computer troubleshooting techniques • demonstrating consumer maintenance • reformatting a hard disk drive. *Assessment Tool* *ELTLAB–1: Laboratory Practice, Parts 2, 3 and 4* *Standard* *Performance rating of 2 for each applicable task*	30

COURSE ELT2070: COMPUTER TECHNOLOGY (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• identify and explain computer system components	• given a computer system board, explain the following: – central processing unit (CPU) – arithmetic logic unit (ALU) – instruction set – instruction cycle – RAM, EPROM, ROM – expansion boards – serial and parallel ports – multi, input/output option adapter cards – explain the operation of a computer system board's internal architecture. *Assessment Tool* *ELT2070–1: Presentations/Reports: Computer Systems* *Standard* *Performance rating of 2 for each applicable task*	25
• install and configure a disk operating system	• performing the following tasks: – use a disk operating system user's guide – install a disk operating system (DOS) – recognize simple disk operating commands – install various files and programs – create basic programs – set up DOS to recognize external devices such as: • printer • modem • joysticks – create a config.sys file – create an autoexec batch file – other similar systems. *Assessment Tool* *ELTLAB–1: Laboratory Practice, Part 2* *Standard* *Performance rating of 2 for each applicable task*	30

COURSE ELT2070: COMPUTER TECHNOLOGY (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• set up a computer network	• observed performance in: – connecting a modem to a computer – connecting more than one printer to a network – connecting several computers to form a network. *Assessment Tool* *ELTLAB–1: Laboratory Practice, Part 3* *Standard* *Performance rating of 2 for each applicable task*	10
• demonstrate established laboratory procedures and safe work practices	• observed performance in following: – established laboratory procedures including: • protective covering on power supplies • working with metal jewelry • using personal grounding systems. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • recognize the purpose of the protective covering on computer power supply and understand voltage and current levels • describe grounding methods when working on computers and use personal grounding systems, such as ankle, wrist straps.	Remove metal jewelry while working on the computer.

COURSE ELT2070: COMPUTER TECHNOLOGY (continued)

Concept	Specific Outcomes	Notes
Fundamentals	*The student should:* • research the history of computer and processors • research the various operating systems of computers • define the following terms: – central processing unit – bus – arithmetic logic unit – execute/fetch – instruction set – instruction cycle – memory: RAM, EPROM, ROM – software – microprocessor – data (8-bit versus 16-bit versus 32-bit bus) – macro instruction – micro instruction – mnemonics – operating code – address – assembler • describe the environmental, social, economic and political contribution that computers have made to our social fabric • use a disk operating system user's guide.	

COURSE ELT2070: COMPUTER TECHNOLOGY (continued)

Concept	Specific Outcomes	Notes
System Identification	*The student should:* • identify the following parts of a computer: – power supply – system board (mother board) – random access memory (RAM) – read only memory (ROM) – jumpers – config switches – video adapter – disk controller card – floppy disk – hard drive – signal cable (disk drive) – monitor – keyboard – printer – video control card – power cable • assemble a computer from the above parts • set the system configuration switches • install computer operating system • install monitor/keyboard • test out computer • demonstrate basic computer troubleshooting techniques • use a system board flow chart to locate a system board fault • list symptoms of hard disk drive failure • demonstrate consumer maintenance • explain the use of debug, Fdisk and format • reformat a hard disk drive.	
System Application	• connect a modem to a computer • connect more than one printer to a network • connect several computers to form a network	

COURSE ELT2070: COMPUTER TECHNOLOGY (continued)

Concept	Specific Outcomes	Notes
System Application (continued)	*The student should:* • install an operating system • perform simple operating system commands • create a config.sys file • create an autoexec.bat batch file • describe basic commands • create a basic program.	DOS-format commands: • Xcopy • Comp. MAC: • System folder • Start-up item • Extension • Control panels.
Real-world Applications	• define a computer clone • name eight basic hardware courses that make up a computer • identify the system and explain its layout • explain the different sizes and types of expansion boards • identify and compare serial and parallel ports • identify a multi-input/output option adapter cards • explain memory expansion methods • explain the operation of a hard drive • explain how a floppy diskette operates • name the types of cathode-ray tube (CRT) video monitors • define and describe various purposes of software • explain the computer's initialization process • differentiate between start-up procedures.	

COURSE ELT2080:	**CONTROL SYSTEMS 2**
Level:	Intermediate
Theme:	Computer Logic Systems
Prerequisite:	ELT1080 Control Systems 1
Description:	Students demonstrate how process control technology is used in real-world applications.
Parameters:	Power supply, oscilloscope, transistor checker, breadboards, frequency counter, digital multimeter and related resources.

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • identify discrete components used in process control	*Assessment of student achievement should be based on:* • identifying the following discrete components using computer simulation, computer-assisted instruction (CAI) package or actual components: – rectifiers – silicon controlled rectifier (SCR) – transistors – junction transistor – tricode, alternating current (TRIAC) – diode, alternating current (DIAC) – field effect transistor (FET) – junction field effect transistor (JFET) – metal-oxide semiconductor field effect transistor (MOSFET) – timers (555 ICs) – OP amps (741 ICs) – solid-state relays. *Assessment Tool* *ELT2080–1: Presentations/Reports: Process Controls* *Standard* *Performance rating of 2 for each applicable task*	20

COURSE ELT2080: CONTROL SYSTEMS 2 (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• identify and describe analog and sensor components used in process control	• explaining the following analog and sensor components used in process control: – thermistor – pressure sensor – photoelectric transducers – hall effect – opto couplers – bar codes – light controlled resistors – light emitting diode (LED) – photodiode – phototransistor – proximity switches using computer simulation, experimental boards, CAI package or actual devices. *Assessment Tool* *ELT2080–1: Presentations/Reports: Process Controls* *Standard* *Performance rating of 2 for each applicable task*	20
• construct a process control device, using analog and sensor components	• construction of a process control project, using the appropriate components. *Assessment Tool* *ELTLAB–1: Laboratory Practice, Part 3* *Standard* *Performance rating of 2 for each applicable task*	55
• demonstrate established laboratory procedures and safe work practices	• observed performance in following: – established laboratory procedures – correct procedures when working with high voltage including capacitor discharges. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5

COURSE ELT2080: CONTROL SYSTEMS 2 (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • demonstrate basic competencies.	*Assessment of student achievement should be based on:* • observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • describe hazards associated with voltage (including capacitor discharge), currents, grounded systems, floating systems and isolated systems.	.
Fundamentals	• relate schematic diagrams and connection symbols to real-world devices • explain the differences among the following circuit conditions: – grounded system – floating system – isolated system.	
Applied Mathematics	• explain the voltage, current and resistance differences among series, parallel and series parallel circuits, using OHM's Law • explain differences between AC and DC as they related to semi-conductor components.	Practise mathematics skills to calculate resistance, voltage and current values.
Testing	• demonstrate correct use and procedure in operating an oscilloscope • describe an analog signal through both open and closed-loop control systems.	

Concept	Specific Outcomes	Notes
System Identification	*The student should:* • explain, experiment with and demonstrate knowledge of various semi-conductor components by prototyping *mini* control circuits in various applications, such as: – rectifiers – SCR – transistors – uni-junction transistor – TRIAC – DIAC – FET – JFET – MOSFET – timers (e.g., 555s) – operational amplifiers – solid-state relays • explain, experiment and demonstrate various semi-conductor transducers and sensors, such as: – thermistor – pressure sensor – photoelectric transducers – hall effect – opto couplers – bar codes – light controller resistors – LED – photodiode – phototransistor – proximity switches.	Temperature control circuits. Light control circuits. Fluid level control circuits, etc. Students may explain, experiment and demonstrate knowledge by breadboarding circuit projects, or using various software programs and trainers. Resource: *Electronics for Industrial Electricians*. Any number of methods may be used by the student to demonstrate knowledge, e.g., breadboarding circuits with various sensors, projects, software programs and trainers.
Real-world Applications	• research applications of solid-state control circuits in automotive, home and industrial application systems.	

COURSE ELT2080: CONTROL SYSTEMS 2 (continued)

Concept	Specific Outcomes	Notes
Fabrication/ Troubleshooting	*The student should:* • construct an electronic project(s) to control home environment or vehicle function: – troubleshoot the project – write a technical report describing the control system operation – develop flow chart and block diagram to show process control in project(s).	E.g., *Electronic Projects to Control Your Home* (Dalton T. Horn). Project could link with ELT2010 Electro-assembly 2 Project could be for car, car alarms, light indicators, fluid level indicators. Home projects could be electronic thermometer, smart thermostat, radiation monitor, automated ventilator, humidifier controller, electronic pest repeller.
	• demonstrate knowledge of testing semi-conductor components such as: – transducers and sensors – use components, transducers and sensors listed above using multimeters, oscilloscopes, solid-state testers.	Signature analysis.
Careers	• research careers primarily in control system environments • list post-secondary institutions that provide control system training.	Collect sample work for portfolio.

COURSE ELT2090: ANALOG COMMUNICATION 2

Level: Intermediate

Theme: Communication Systems

Prerequisite: ELT1090 Analog Communication 1

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

Parameters: Oscilloscope, signal generator, transistor checker, multimeter, dB meter and related resources.

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • identify characteristics of analog communication systems	*Assessment of student achievement should be based on:* • using block diagram to explain the operation of a: – telephone – audio amplifier – intercom system – light and sound board – automotive sensor. *Assessment Tool* *ELT2090–1: Presentations/Reports: Analog Communication Systems* *Standard* *Performance rating of 2 for each applicable task*	20
• explain analog communication technology through project design, construction, experimentation, circuit analysis and electronic component identification	• identification of the following electronic components: – diodes – transistors – field effect transistors (FET) – capacitors – resistors using computer simulation, experimental boards, CAI package or actual devices	75

COURSE ELT2090: ANALOG COMMUNICATION 2 (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:* • analysis of the following electronic circuits: – crossover networks – small audio amplifiers – intercoms • using analog test instruments such as multimeters, oscilloscopes, transistor checker, signal generator, IB meters • prototyping mini circuits that demonstrate amplification, filters, crossover networks and transducers • troubleshooting and repairing or maintaining an analog communication system such as a: – portable stereo systems – cassette tape players • observed performance in the design and construction of an audio system project. *Assessment Tool* *ELTLAB–2: Assessment Checklist: Laboratory Practice, Parts 1, 2 and 3* *Standard* *Performance rating of 2 for each applicable task*	
• demonstrate established laboratory procedures and safe work practices	• observed performance in following: – established laboratory procedures – avoidance of dangers of excessive noise levels. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

COURSE ELT2090: ANALOG COMMUNICATION 2 (continued)

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • identify and describe the difference between dBm and dB ratings of communications systems and the effects on human hearing.	Ear nerve damage resulting from excessive noise levels.
Fundamentals	• research the history of the beginnings of electrical communication • describe what is meant by an analog signal • explain how an electrical signal is turned into sound • identify various devices used to convert sound into electrical signals.	Reference: *Modern Electronic Communication*, p.4.
Applied Mathematics	• mathematically determine component values for crossover/band pass filters.	Speaker design.
System Identification	• draw and explain the block diagram of a simple communication model • identify the differences between wire and wireless telephone systems' technology and networking.	Speakers. Microphones.
Real-world Applications	• using a block diagram, explain the operation of the following forms of analog electronic communication systems: – telephone – audio amplifiers – intercom systems – light and sound boards – automotive sensors (analog).	Fuel/temperature/oil pressure gauges.
Fabricating/Testing	• build a small audio amplifier and/or intercom for personal student use • construct a speaker system with low-, mid- and high-range speakers with appropriate crossover networks such as an intercom system • test project using analog test instruments such as analog multimeter, oscilloscope.	

COURSE ELT2090: ANALOG COMMUNICATION 2 (continued)

Concept	Specific Outcomes	Notes
Problem Solving	*The student should:* • troubleshoot, repair, maintain analog communication systems used in the home: – portable stereo systems – cassette tape players.	
Careers	• describe how an FM or AM radio station, TV station or theatre uses communication equipment.	

COURSE ELT2100:	**RADIO COMMUNICATION**
Level:	Intermediate
Theme:	Communication Systems
Prerequisite:	ELT2090 Analog Communication 2
Description:	Students demonstrate the fundamental concepts of electromagnetic communication systems.
Parameters:	Frequency generator, counter, digital multimeter, hand tools and related resources.

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • describe the principles of electromagnetic communication systems	*Assessment of student achievement should be based on:* • drawing block diagrams to explain the following communication systems: – AM, FM radio – TV – short-wave radio – satellite communication – cellular telephone – cable television – two-way radio • explaining electromagnetic communication terms, such as: – carrier modulation/demodulation – amplitude modulation – frequency modulation – frequency spectrum – stereo – decoder – sidebands – oscillators. *Assessment Tool* *ELT2100–1: Presentations/Reports: Electromagnetic Communication Systems* *Standard* *Performance rating of 2 for each applicable task*	20

COURSE ELT2100: RADIO COMMUNICATION (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• construct and test electromagnetic communication systems	• constructing and testing the following electromagnetic communication systems: – garage door opener – wireless microphone – AM radio – wireless intercom system • given an oscilloscope, the ability to observe input and/or output frequency associated with the communication system chosen from above. *Assessment Tool* *ELTLAB–2: Assessment Checklist: Laboratory Practice, Parts 2 and 3* *Standard* *Performance rating of 2 for each applicable task*	20
• explain wireless communication technology through project construction, experimentation, circuit analysis and electronic component identification of oscillation amplification and detection	• explaining the operation of the following electronic components: – coils – capacitors – field effect transistors (FET) – metal-oxide semiconductor field effect transistors (MOSFET) – operational amplifiers (OP amps) – piezoelectric crystal – varactor • explaining the operation of the following circuits: – resistor capacitor (RC) filters – resistor inductor (RL) – resistor inductor capacitor (RLC) – inductor capacitor (LC) – detector circuits – resonant circuits	55

COURSE ELT2100: RADIO COMMUNICATION (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:* • demonstrating an understanding of the following circuits through experimentation and/or computer simulation: – Hartley oscillator – Colpitts oscillator – audio amplifier – tuned collector oscillator. *Assessment Tool* *ELTLAB–2: Assessment Checklist: Laboratory Practice, Parts 1, 2 and 3* *Standard* *Performance rating of 2 for each applicable task*	
• demonstrate established laboratory procedures and safe work practices	• observed performance in following: – established laboratory procedures – avoidance of radiation hazards – avoidance of radio frequency burns. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • demonstrate appropriate safety techniques with respect to: – radiation hazards – radio frequency burns.	

COURSE ELT2100: RADIO COMMUNICATION (continued)

Concept	Specific Outcomes	Notes
Fundamentals	*The student should:* • research the benefits and drawbacks of a wireless communication • research the rules that govern Radio Frequency (RF) communication • explain electromagnetic communication terms leading towards such topics as: – carrier modulation/demodulation – amplitude modulation (AM) – frequency modulation (FM) – frequency spectrum.	Department of Communication, Industry Canada pamphlets.
System Identification	• identify different communication systems that employ electromagnetic communication: – cellular telephones – short-wave radio – AM, FM, TV – satellite communication – high definition TV – cable television (CATV) – facsimile – HAM radio – citizen band – two-way radio • draw and explain a block diagram of a AM/FM communication systems • block diagram various RF communication systems such as cellular phones, cable.	
Fabricating/Testing	• construct a RF communication project • design an antenna to receive a radio signal to include: – determining length of antenna – impedance match • evaluate completed projects.	Project could link with ELT2010 Electro-assembly 2: • AM/FM radio project kit • wireless speaker system • wireless microphone • short-wave antenna • wireless intercom system • garage door opener.

COURSE ELT2100: RADIO COMMUNICATION (continued)

Concept	Specific Outcomes	Notes
Real-world Applications	*The student should:* • list the Radio Frequency Spectrum (RFS) and its use in the local area • tour radio/TV station.	Alberta frequency list.
Applied Mathematics/ Testing	• describe signal present at each block of an AM receiver • identify the frequency present in each wave form with an oscilloscope • use an oscilloscope to determine period in seconds and frequency in Hertz (Hz).	Vary the tuning and observe the changes, e.g., carrier frequency, modulating from local oscillating frequency to intermediate frequency.
Careers	• research the conditions required to obtain a HAM radio licence • identify the careers in electronic communication • list the skills of a electronic technologist.	

COURSE ELT2110:	**SECURITY SYSTEMS 2**
Level:	Intermediate
Theme:	Communication Systems
Prerequisite:	ELT1110 Security Systems 1
Description:	Students demonstrate the fundamentals of security technology used in homes, businesses and transportation systems.
Parameters:	Digital multimeter, soldering station, breadboard, power supply, hand tools and related resources.
Supporting Course:	ELT2080 Control Systems 2

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • identify and describe elements of a security system	*Assessment of student achievement should be based on:* • identification and description of the components of a security system and how they interface, such as: – control panel – detection device – notification device. *Assessment Tool* *ELT2110–1: Presentations/Reports: Security Systems* *Standard* *Performance rating of 2 for each applicable task*	10

COURSE ELT2110: SECURITY SYSTEMS 2 (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• identify detection and notification devices	• identifying the following detection devices: – proximity switch – contact switch – vibration detector – glass breakage detector – photoelectric beam – ultrasonic motion detector – microwave motion detector – infrared motion detector – dual technology detector – various alarms using computer simulation and instruction, actual devices or experimental boards. *Assessment Tool* *ELT2110–1: Presentations/Reports: Security Systems* *Standard* *Performance rating of 2 for each applicable task*	10
• fabricate and operate a detection and notification alarm system for home or car use	• designing/fabricating and operating an electronic security system for personal use. *Assessment Tool* *ELTLAB–2: Assessment Checklist: Laboratory Practice, Part 2* *Standard* *Performance rating of 2 for each applicable task*	75
• demonstrate established laboratory procedures and safe work practices	• observed performance in following: – established laboratory procedures – voltage and current requirements of a security system – correct handling and charging batteries. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5

COURSE ELT2110: SECURITY SYSTEMS 2 (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • demonstrate basic competencies.	*Assessment of student achievement should be based on:* • observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • describe voltage and current hazards of security systems • demonstrate correct handling of batteries used in security systems • demonstrate how to recharge a battery safely.	If hardwired in a building, have unit inspected by journeyman.
Fundamentals	• explain terms such as: – transceivers – frequency – microwave – infrared radiation – relays – open and closed contact switches	

COURSE ELT2110: SECURITY SYSTEMS 2 (continued)

Concept	Specific Outcomes	Notes
Fundamentals (continued)	*The student should:* • identify and describe the following detection devices: – proximity switches – contact switches – vibration detector – glass breakage detector (foil strip) – photoelectric beam – ultrasonic motion detector – microwave motion detector – passive infrared motion detector – dual technology detectors – audio switch or sound discriminators • explain, experiment or connect various notification devices.	Use audio tapes of breaking glass to test "audio breaking glass detectors" (sound discriminators).
System Identification	• identify the three basic elements of a security system: – control panel – detection devices – means of notification (alarm) • research the differences between two different security systems.	Tour an off-premise monitoring station of a local security company.
Real-world Applications	• install, test and demonstrate an advanced security system incorporating a control panel, detectors, notification devices • explain the operation of various alarms (notification alarms): – identify who is notified by each type of alarm • research long-range security monitoring.	Advanced security systems can be purchased for $150 to $200.

COURSE ELT2110: SECURITY SYSTEMS 2 (continued)

Concept	Specific Outcomes	Notes
Fabricating/Testing	*The student should:* • design or construct an electronic security system for personal use • create a flowchart and block diagram to show detection, monitoring and alarm signals • write a technical report describing the security system.	These SOs are for the students to build a personal security system for home, car, etc. They will have to research, design, build and install a system, such as: • computalarm • automotive burglar alarm • security alarm • antitheft alarm • tamper-proof alarm • motion-activated motorcycle alarm • blown fuse alarm • sun-powered alarm • freezer meltdown alarm • multiple alarm circuitry • photoelectric alarm system • semiconductor fail-safe alarm • one-chip burglar alarm • high power alarm driver • multi-loop parallel alarm • burglar chaser • heat or light-activated alarm • strobe alert system • exit delay for burglar alarm.
Careers	• identify careers in the security field • create and/or add information to an existing portfolio.	

COURSE ELT2120:	**ELECTRO-OPTICS**
Level:	Intermediate
Theme:	Communication Systems
Prerequisite:	ELT2100 Radio Communication
Description:	Students demonstrate basic knowledge of lasers and other light wave communication applications in various electronic systems.
Parameters:	Laser experimental kit and related resources.

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• identify common types and classes of lasers	• identification of four classes and six types of lasers *Assessment Tool* *ELT2120–1: Presentations/Reports: Lasers and Fibre Optics* *Standard* *Performance rating of 2 for each applicable task*	10
• explain the operation of laser, fibre optic, infrared and hologram light wave technology	• explanation of the operation of various electro-optic devices related to laser, fibre optics, infrared and hologram light wave technology. *Assessment Tool* *ELT2120–1: Presentations/Reports: Lasers and Fibre Optics* *Standard* *Performance rating of 2 for each applicable task*	15
• construct an electro-optical project	• design and construction of an electro-optical device such as: – lasers – fibre-optics – infrared – holograms. *Assessment Tool* *ELTLAB–1: Laboratory Practice, Part 3* *Standard* *Performance rating of 2 for each applicable task*	70

COURSE ELT2120: ELECTRO-OPTICS (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • demonstrate established laboratory procedures and safe work practices	*Assessment of student achievement should be based on:* • observed performance in following: – established laboratory procedures – correct handling of electro-optic materials – procedures to prevent eye damage from laser light radiation – correct handling of high voltage including capacitors. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • follow safe practices when: – potentially hazardous materials are used in project construction – in the presence of laser light radiation – exposed to high voltages around lasers – using laser classes I, II, III, IV – working with high voltage capacitors.	
Fundamentals	• define the word laser • define fibre optics, infrared, hologram • describe how light can be used as a modulation medium • research Canadian Standards Association (CSA) standards/guidelines for lasers • research laser technology applications	

Concept	Specific Outcomes	Notes
Fundamentals (continued)	*The student should:* • explain terms used in laser technology: – photon – ground state – excited state – spontaneous emission – stimulated emission of radiation – pumping – population inversion – light amplification – lenses – multiwatt lasers • identify and explain operation of the following laser components: – power supply – pumping device – lazing medium – optical resonant cavity • define the following types of lasers: – crystal and glass lasers – gas lasers such as: • helium – neon • helium – cadmium • argon • carbon dioxide • krypton – excimer lasers – chemical lasers – semi-conductor lasers • define lasers in terms of power • draw a block diagram of a laser • explain four unique properties of laser light • explain following terms as related to fibre optics: – reflection – refraction – lenses – focal length – absorption – angle of incidence – bar code – cladding – core – attenuation	

COURSE ELT2120: ELECTRO-OPTICS (continued)

Concept	Specific Outcomes	Notes
Fundamentals (continued)	*The student should:* • explain the operation of infrared communication systems • explain the process of producing a hologram • explain the six major types of lenses • explain the effect prisms have upon light • explain beam splitters • describe the effects the following filters have on light: – coloured gel filters – interference filters – dichroic filters • explain diffraction gratings • draw a diagram of a helium-neon laser.	
Designing and Prototyping	• prototype, experiment and analyze the following light wave communication devices: – a visible LED transmitter – an alarm circuit using a phototransistor or opto coupler – a simple infrared remote control device – use a fiber optic cable to route light to a remote location – transmit an analog data through a fibre using a diode laser – construct a simple alarm using high intensity visible light emitting diode • prototype, analyze and construct an advanced laser, fibre optical, infrared or hologram project; e.g.: – build a He-Ne laser experimenters system – build a pocket laser diode – infrared push-button remote control – infrared wireless speaker system – retrofit old equipment with a remote control – a laser light show – develop a fibre optical communication system – investigate a fibre optic vibration detection system for the home – construct a split-beam transmission hologram.	Use traditional laboratories. Use CAI packages. Use fibre and laser experimental kits. The intent of this SO is for the student to work from easier LED circuits to laser experiments. Depending on the project chosen by the student, additional time may be required – link this course with a Career Transitions course. References: • *The Laser Cookbook, 88 Practical Projects* (Gordon McCombs).

COURSE ELT2130: MAGNETIC CONTROL DEVICES

Level: Intermediate

Theme: Robotic and Control Systems

Prerequisite: ELT1010 Electro-assembly 1

Description: Students demonstrate the fundamentals of electromagnetic control devices.

Parameters: Multimeter, clamp-on ammeter, power supply, hand tools and related resources.

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • identify and state the function of electromagnetic control devices	*Assessment of student achievement should be based on:* • observation of work related to: – identifying the components in an electromagnetic system – identifying the symbols of contactor, magnetic starter, overload protection device, overcurrent protection device, safety disconnect, mechanical relay and solid-state relay components – stating the function of contactor, magnetic starter, overload protection device, overcurrent protection device, safety disconnect, mechanical relay and solid-state relay – drawing the wiring schematic diagram for various electromagnetic systems. *Assessment Tool* *CTSPRE: Assessment Framework: Presentations/Reports* *Standard* *Performance rating of 2 for each applicable task*	20

COURSE ELT2130: MAGNETIC CONTROL DEVICES (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• explain the operation of electromagnetically controlled systems	• explaining the operation of various electromagnetically controlled systems as related to: – identify the symbols used in relay logic and wiring schematic diagrams – drawing both relay logic and ladder logic diagrams – explaining the sequence of operation of various electromagnetically controlled systems. *Assessment Tool* *CTSPRE: Assessment Framework: Presentations/Reports* *Standard* *Performance rating of 2 for each applicable task*	20
• design and construct electromagnetic circuits, using ladder logic systems and wiring diagrams	• ongoing performance observation in designing and constructing the electromagnetic circuits as related to: – low voltage and current relay control of a lamp or solenoid – solid-state relay control of a lamp or solenoid – solid-state variable control of a lamp or motor – timing relay control of a lamp or solenoid – manual single-phase toggle motor starter – manual single-phase drum controller motor starter – manual single-phase variable speed control motor starter – two-light source relay operated circuit – single-location panic stop, key start of a power contactor – single-location start/stop of a single-phase magnetic motor starter – two-location start/stop of a single-phase magnetic motor starter – single-location forward reverse stop of a single-phase magnetic motor starter – single-location start/stop jog of a single-phase magnetic motor starter – single-location solid-state relay and low voltage control circuit of a single-phase magnetic motor starter. *Assessment Tool* *ELTLAB–1: Laboratory Practice, Parts 2 and 3* *Standard* *Performance rating of 2 for each applicable task*	55

COURSE ELT2130: MAGNETIC CONTROL DEVICES (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • demonstrate established laboratory procedures and safe work practices	*Assessment of student achievement should be based on:* • observed performance in following: – established laboratory procedures – prevention procedures for current leakage in solid-state relays – correct use of protective devices for circuits. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • demonstrate safety in all practices including solid-state relay current leakage • follow safe wiring practices • use protective devices for all circuits.	Breakers, fuses, O/L coils and safety disconnects. Observe lockout and tagout procedures.
Fundamentals	• research the benefits and drawbacks of electro-magnetic and solid-state relays • identify coil voltage and frequency rating • identify contact voltage and current ratings • compare and contrast the use of relays, solenoids, actuators in electrical circuits	Better circuit isolation. Nameplate ratings.

COURSE ELT2130: MAGNETIC CONTROL DEVICES (continued)

Concept	Specific Outcomes	Notes
Fundamentals (continued)	*The student should:* • demonstrate knowledge of electromagnetism	Magnetic fields around: • single conductor • coil • magnetic polarity • left-/right-hand rule.
	• demonstrate knowledge of activation principles.	Solenoid principles. Relay principle.
Designing and Prototyping	• draw a schematic and wiring diagram and construct the following electromagnetic circuits: – toggle switch controls load – stop/start button controls loads – stop/start from two locations – jogging – reversing – annuciator and indicators – limit switches.	Electric valve control. Circuit initiation control.
	• create a flow chart of various magnetic control systems.	Elevator, ski lift, light control, fail-safe latching control, AC/DC isolation relay, assembly line.
Careers	• research application in industry of magnetic control devices and employment opportunities.	

COURSE ELT2140: ROBOTICS 2

Level: Intermediate

Theme: Robotic and Control Systems

Prerequisite: ELT1130 Robotics 1

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

Parameters: Multimeter, power supply, soldering stations, hand tools and related resources.

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• design and build a sensor device and control system for the robotic system	• designing and building a sensory control circuit to operate and control a robotic system. *Assessment Tool* *ELTLAB–1: Laboratory Practice, Parts 2 and 3* *Standard* *Performance rating of 2 for each applicable task*	65
• identify sensor control systems and subsystems used in robotic systems	• identifying sensor control system and subsystem used in the robotic system, such as: – photoelectric – sound – tactile – proximity – thermal. *Assessment Tool* *ELT2140–1: Presentations/Reports: Robotic Sensor Controls* *Standard* *Performance rating of 2 for each applicable task*	10
• explain sensory control circuits and components used in the robotic control system	• explanation of the sensory control circuits and components used to control a drive circuit. *Assessment Tool* *ELT2140–1: Presentations/Reports: Robotic Sensors* *Standard* *Performance rating of 2 for each applicable task*	10

COURSE ELT2140: ROBOTICS 2 (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• operate and demonstrate the capabilities of a robotic system equipped with sensor controls	• operating the various sensor control system and subsystem used in the robotic system. *Assessment Tool* *ELTLAB–1: Laboratory Practice, Part 4* *Standard* *Performance rating of 2 for each applicable task*	10
• demonstrate established laboratory procedures and safe work practices	• observed performance in following: – established laboratory procedures – safe wiring practices related to sensory control system – use and disposal of chemicals related to circuit board construction – use of solder and fluxes. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal exploration during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • demonstrate safe wiring practices when building a sensory control system • use protection devices for all circuits including fusing and temperature cutoff • operate robotic systems within design tolerances.	

COURSE ELT2140: ROBOTICS 2 (continued)

Concept	Specific Outcomes	Notes
Fundamentals	*The student should:* • demonstrate the principles of a photoelectric, sound, tactile, proximity and thermal sensor • explain the operation of the electronic components and circuits used to build sensor controls • explain how sensor control systems are used to control the drive circuit.	Project constructed and/or available robotic units.
System Identification	• draw and explain the various blocks in a sensor control system • describe and explain sight, sound and tactile sensor devices • explain the fundamentals of the control system operating the motor drives in the robotic system • identify the differences among drive systems, sensor control systems and processing systems.	Project built in Electro-assembly and use with other robotic units.
System Application	• research the benefits and drawbacks of various sensory devices that are used to control the robot • describe where industry is making use of sensory control robots.	Tour an industrial plant using robots.
Designing and Prototyping	• demonstrate a knowledge of sensory control systems by building a sensor control for the robot system selecting from the following: – photoelectric – sound – tactile – proximity – thermal • prototype a sensory control system and construct the circuit so that the sensor controls the motors on the robot • draw the schematic diagram of the sensor control circuit.	Robotic kit.

COURSE ELT2140: ROBOTICS 2 (continued)

Concept	Specific Outcomes	Notes
Fabricating/Testing	*The student should:* • assemble electronic components to build a sensor • build a sensory control and mount the sensory control on the control robot.	

COURSE ELT2150: ELECTRONIC CONTROLS

Level: Intermediate

Theme: Robotic and Control Systems

Prerequisite: ELT2130 Magnetic Control Devices

Description: Students demonstrate the fundamentals of ladder/relay logic programming, and demonstrate how the program's logic controller system operates.

Parameters: Programmable logic controller, soldering station, hand tools and related resources.

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

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• explain basic input and output hardware and fundamentals of basic programming in programmable logic controller systems	• explaining the basic input and output hardware components used with the fundamentals of basic programming as found in programmable logic controller (PLC)systems. *Assessment Tool* *ELT2150–1: Presentations/Reports: Programmable Controls* *Standard* *Performance rating of 2 for each applicable task*	10
• write a basic programming logic code, through real or programmed inputs on a programmable logic system, to operate and control electromagnetic devices	• writing the basic programming logic code using real or programmed inputs to operate electromagnetic devices in a programmable logic system	85

COURSE ELT2150: ELECTRONIC CONTROLS (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• wire, operate and test a programmable electromagnetic device	• wiring the input control and output electromagnetic devices that are operated by various programming instruction codes set up in a PLC such as: – timing relay control of a lamp or a solenoid – two-light source relay operated circuit – single-location panic stop, key start of a power contactor – single-location start/stop of a single-phase motor – two-location start/stop of a single-phase motor – single-location forward/reverse/stop of a single-phase motor – single-location start/stop/jog of a single-phase motor. *Assessment Tool* *ELTLAB–3: Assessment Checklist: Laboratory Practice, Parts 2, 3 and 4* *Standard* *Performance rating of 2 for each applicable task*	
• demonstrate established laboratory procedures and safe work practices	• observed performance in following: – established laboratory procedures – procedures for correct use of electrical protective devices. *Assessment Tool* *ELTPSP: Assessment Checklist: Laboratory Procedures and Safety Practices* *Standard* *Performance rating of 2 for each applicable task*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

COURSE ELT2150: ELECTRONIC CONTROLS (continued)

Concept	Specific Outcomes	Notes
Safety/Resource Management	*The student should:* • demonstrate safe wiring practices when wiring the inputs and output circuits • use protection devices for all circuits.	Low voltage wiring, grounding, separation of voltages, fusing. 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).
System Identification	• draw and identify the various blocks of a PLC system • describe and explain numbering systems and codes • plan PLC ladder programs and wiring diagrams of the PLC system • demonstrate the fundamentals of logic • compare relay logic control and PLC programming • identify the differences between a wired relay motor control panel and a PLC motor control panel.	Housing, addresses, wiring diagram, relay logic, ladder logic. Application of Boolean logic.
System Application	• research the benefits and drawbacks of using the PLC • research where, how and why PLCs are used in industry.	Tour mill, gas plant or other industrial plants.
Fundamentals	• demonstrate principles of electromagnetic relay output devices to control motors • demonstrate the action of switch devices as an input sensor device • explain how an AC motor is operated from a PLC.	

COURSE ELT2150: ELECTRONIC CONTROLS (continued)

Concept	Specific Outcomes	Notes
Designing and Prototyping	*The student should:* • demonstrate a knowledge of PLC function by writing basic programs to operate a simple relay logic control of AC motors • design the relay logic program and construct the input and output devices so that the PLC can control electromagnetic and indicator lamps • convert relay ladder diagrams into PLC ladder programs • draw PLC ladder programs complete with wiring diagram of inputs and outputs systems.	Inputs: limit switches, sensors, push buttons. Outputs: lamps, motors relays.
Fabricating/Testing	• build and program a multi input/output PLC control installation.	
Careers	• describe where industry is making use of PLC and employment opportunities.	Tour an industrial plant.

COURSE ELT2310:	**NETWORK STRUCTURES**
Level:	Intermediate
Theme:	Computer Networking Systems
Prerequisite:	None
Description:	Students acquire an understanding of network infrastructure and assess the advantages and disadvantages of different types of networks. They also develop knowledge of data transmission principles in a computer network and compare features of different network topologies and transmission methods.

Parameters:

Designed to be delivered in conjunction with other intermediate level courses in the Computer Networking Systems theme. Schools have the option of delivering courses within this theme in conjunction with one or more Project courses from the Career Transitions theme if they wish to extend learning and/or address other vendor-specific technologies.

Access to a computer work centre equipped with networking hardware, software, tools and consumable supplies, and to instruction from an individual with specialized knowledge and skills in computer networking.

Particular emphasis is given to network infrastructure and concepts/ terminology relevant to network topology and architecture. Students model and assume personal responsibility for ethical behaviour in their use of networking technologies and in their access to electronic sources of information. They also demonstrate an understanding of industry-based policies regarding network use and security.

Supporting Courses: ELT1010: Electro-assembly 1, ELT1060: Digital Technology 1, ELT2070: Computer Technology, INF2010: Workstation Operations, INF2190: Telecommunications 1

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • describe and explain the evolution of computer networks, and the general structure and function of: – peer-to-peer and server-based networks – local area networks and wide area networks	*Assessment of student achievement should be based on:* • a teacher-directed evaluation on: – specific milestones in the history of computer networking – the structure and function of: • peer-to-peer networks and server-based networks • local area networks (LANs) and wide area networks (WANs) – the sharing of resources within a network environment	10

COURSE ELT2310: NETWORK STRUCTURES (cointinued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• describe and demonstrate basic principles of data transmission in a computer network	• a presentation or project demonstrating knowledge of: – the characteristics of analog and digital signaling and related technical terms – basic processes for structuring data packets and frames – strategies used to address data collision in a shared media environment	25
• describe and compare the features of: – bus, star, ring, mesh, wireless and hybrid topologies – Ethernet, token ring, Fibre Distributed Data Interface (FDDI) and wireless transmission methods	• a presentation or project demonstrating knowledge of: – bus, star, ring, mesh, wireless and hybrid topologies with respect to: • physical layout • unique characteristics, advantages and disadvantages – the main features of common network architectures, including Ethernet, token ring, Fibre Distributed Data Interface (FDDI) and wireless networks, with respect to: • topology • methodology and access strategy • media type • speed • selecting an appropriate topology and network architecture, given a particular set of network requirements	50
• demonstrate established laboratory procedures and safe work practices	• observed performance in following: – established laboratory procedures – safety regulations specific to the networking technologies being used	5
• identify career paths in computer networking	• a project or report identifying technical and professional career paths in computer networking and related training requirements/qualifications *Assessment Tools* *Assessment Checklist: Network Structures (ELT2310–1)* *Assessment Checklist: Laboratory Procedures and Safety Practices, ELTPSP* *Standard* *Performance rating of 2 on each criterion*	10

COURSE ELT2310: NETWORK STRUCTURES (cointinued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • demonstrate basic competencies.	*Assessment of student achievement should be based on:* • observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
History of Networks	*The student should:* • summarize the history of networking, from the telegraph to modern computer technology • describe the evolution of standards for data transmission, from Morse code to the American Standard Code for Information Interchange (ASCII) • create a timeline of specific milestones in the history of computer networking • identify emerging networking technologies and their impact on global communications.	Relate the evolution of networking devices to the evolution of computers. Milestones should include military and Internet applications. Research one or more recent initiatives or issues in the development of networking technologies.
Network Structure and Function	• describe a computer network and solutions provided by computer networking; i.e.: – file sharing – hardware sharing – program sharing – user communication • give examples of resources commonly shared within a network environment • describe the structure, purpose and function of peer-to-peer and server-based networks	Discuss and develop a rationale for networking standards. Examine advantages, disadvantages and applications of peer-to-peer and server-based networks.

COURSE ELT2310: NETWORK STRUCTURES (cointinued)

Concept	Specific Outcomes	Notes
Network Structure and Function (continued)	*The student should:* • compare and contrast peer-to-peer and server-based networks with respect to: – number of workstations – relative cost – security – administration – data backup • describe and compare the structure, purpose and function of local area networks (LANs), metropolitan area networks (MANs) and wide area networks (WANs) • create schematic diagrams for the physical layout of LANs, MANs and WANs • describe and give examples of how networks may be categorized according to: – topology – protocol – architecture – media.	Discuss and give examples of: • Workgroup LANs • Departmental LANs • Enterprise networks. Examine the structure of the Internet within the context of LANs, MANs and WANs.
Data Transmission Principles	• describe characteristics of digital and analog signaling • explain concepts and technical terms associated with data signaling and transmission; e.g.: – propagation, modulation and encoding – baseband and broadband signaling – transmission speed and bandwidth – attenuation, reflection and noise – dispersion, jitter and latency – data collision • describe and illustrate the structure of data packets and frames • explain applications of packet sniffing software to capture and analyze data packets and frames • convert binary and hexadecimal numbers to decimal numbers • identify problems and solutions related to data collision in a shared media environment.	Examine the significance of bandwidth and differences in media bandwidth. Explain throughput and variables that determine throughput. Discuss where and when collisions occur, and the application of hubs, repeaters and segmentation.

COURSE ELT2310: NETWORK STRUCTURES (cointinued)

Concept	Specific Outcomes	Notes
Network Topology and Architecture	*The student should:* • describe and compare the unique characteristics, advantages and disadvantages of common physical network topologies; i.e.: – bus – star – ring – mesh – wireless – hybrid • explain the function of network segments and backbones • create schematic diagrams for the physical layout of bus, star, ring, mesh, wireless and hybrid topologies • describe the architecture of an Ethernet network with respect to: – physical topology – access strategy – Carrier Sense Multiple Access with Collision Detection (CSMA/CD) – media and hardware devices – Institute of Electrical and Electronics Engineers (IEEE) standards • describe and compare the main features of token ring, Fibre Distributed Data Interface (FDDI), LocalTalk and wireless networks with respect to: – topology – methodology and access strategy – media type – speed • select an appropriate topology and network architecture, and design a network to address user needs, given a particular set of network requirements.	Students should: • recognize a logical/ physical topology from a description or diagram • identify IEEE 802 and other standards for Ethernet, token ring and FDDI networking technologies. Examine reasons for the extensive use of Ethernet technology. Compare and contrast two Ethernet frame types. Cite reasons why Attached Resource Computer network (ARCnet) has been replaced with other network architectures. Conduct an interview with a network manager or client regarding network design, benefits and issues. Create a questionnaire to gather information when planning or expanding a network.

COURSE ELT2310: NETWORK STRUCTURES (cointinued)

Concept	Specific Outcomes	Notes
Career Paths	*The student should:* • research technical and professional career paths and employment opportunities in computer networking • evaluate current employment opportunities based on employment statistics • identify training requirements and qualifications associated with one or more employment opportunities • write a detailed job description for one or more internetworking positions • research trends in computer networking and emerging career opportunities.	Plan for individual/group research and presentations that address: • job description • employment market • education/training • salary range. Arrange/facilitate: • information interviews • work study/ experience • job shadowing.

COURSE ELT2320:	**NETWORK MEDIA & DEVICES**
Level:	Intermediate
Theme:	Computer Networking Systems
Prerequisite:	None
Description:	Students develop an understanding of different connectivity strategies for linking computers and other devices in a local area network (LAN). They acquire knowledge of industry standards for network cables and gain practical experience through installing cabling, connectors and other hardware components.
Parameters:	Designed to be delivered in conjunction with other intermediate level courses in the Computer Networking Systems theme. Schools have the option of delivering courses within this theme in conjunction with one or more Project courses from the Career Transitions theme if they wish to extend learning and/or address other vendor-specific technologies. Access to a computer work centre equipped with networking hardware, software, tools and consumable supplies, and to instruction from an individual with specialized knowledge and skills in computer networking. Particular emphasis is given to safe processes for the installation of network cabling and connectors and to an understanding of how topology, cabling and connectors need to coexist in a network environment. Students model and assume personal responsibility for ethical behaviour in their use of networking technologies and in their access to electronic sources of information. They also demonstrate an understanding of industry-based policies regarding network use and security.
Supporting Courses:	ELT1010: Electro-assembly 1, ELT1060: Digital Technology 1, ELT2070: Computer Technology, INF2010: Workstation Operations, INF2190: Telecommunications 1

COURSE ELT2320: NETWORK MEDIA & DEVICES (continued)

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• identify and describe the characteristics, standard names and applications for common network media and connectors	• a teacher-directed evaluation designed to determine knowledge of: – the characteristics and uses of major types of network cables and common media connectors – the characteristics and uses of major types of wireless network devices – cable identifiers for an Ethernet network as defined by the Institute of Electrical and Electronics Engineers (IEEE) standards – categories for networking cable as defined by the Electronics Industries Association and the Telecommunications Industries Association (EIA/TIA)	20
• identify and explain the purpose, features and basic operation of network hardware components	• a presentation or project demonstrating the functionality and performance of: – basic hardware components, including network interface card (NIC), hub, repeater, switch, bridge, router, gateway, wireless access point and modem – different types of power fault-tolerance equipment	20

• demonstrate knowledge of cabling tools; and demonstrate ability to install network cabling, connectors and hardware components	• a series of projects that demonstrate adherence to codes/regulations and safe practices for compliant installation; i.e.:
	– crimping and testing an Ethernet cable
	– safely installing
	  • jacks and outlets
	  • cable and structured cable runs
	  • patch panels and patch cords
	– utilizing basic test equipment and analyzers for continuity, proper grounding and correct cable termination
	– choosing an appropriate cable type and connector to add a new client to an existing network
	– installing and configuring one or more network components
		50

• demonstrate established laboratory procedures and safe work practices	• observed performance in following: – established laboratory procedures – safe procedures for the installation of cabling, connectors and hardware components	5

COURSE ELT2320: NETWORK MEDIA & DEVICES (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • identify and describe career paths and employment opportunities in network infrastructure design and installation	*Assessment of student achievement should be based on:* • a project or report identifying technical and professional career opportunities in network infrastructure design and installation, and related training requirements/qualifications *Assessment Tools* *Assessment Checklist: Network Media & Devices (ELT2320–1)* *Assessment Checklist: Laboratory Procedures and Safety Practices, ELTPSP* *Standard* *Performance rating of 2 on each criterion*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
Network Media and Connectors	*The student should:* • identify and describe the structural components and uses of major types of network cables: – coaxial (thick and thin) – twisted pair (unshielded and shielded) – fibre-optic • identify and describe the characteristics and uses of common media connectors; e.g.: – Registered Jack 11 (RJ-11) – Registered Jack 45 (RJ-45) – Attachment Unit Interface (AUI) – British Naval Connector (BNC) – Small Computer System Interface (SCSI) – Single Mode Fibre-Optic Connector (SC-type and ST-type)	Match common types of cable with their attributes and applications. Students should be able to choose the best media for a specific situation. Focus attention on: • structural components • topology • advantages/ disadvantages • applications.

COURSE ELT2320: NETWORK MEDIA & DEVICES (continued)

Concept	Specific Outcomes	Notes
Network Media and Connectors (continued)	*The student should:* • identify Institute of Electrical and Electronics Engineers (IEEE) standards for Ethernet cabling; i.e.: – bandwidth/speed – transmission mode – maximum segment length – cable type • identify and describe categories for unshielded twisted pair (UTP) cable defined by the Electronics Industries Association and the Telecommunications Industries Association (EIA/TIA) • describe the media and function of network backbones and segments • explain the relationship between media type, connector and topology in a network environment • choose an appropriate cable type and connector to add a client, given a practical network scenario.	Students should be able to identify 802.3 Ethernet standards for: • 10Base2 • 10Base5 • 10BaseF • 10BaseT • 100Base FX • 100 BaseT • 1000Basex. Particular emphasis should be placed on Categories 3, 4 and 5. Discuss potential applications of Category 6 UTP cable for Gigabit Ethernet networks.
Hardware Components	• explain the purpose of hardware components in: – connecting network devices – boosting data signals – determining data flow • demonstrate an understanding of the features, functionality and performance of basic hardware components; i.e.: – network interface card (NIC) – hub – repeater – switch – bridge – router – gateway – wireless access point – modem	Hardware components are typically used to connect: • devices to networks • networks to other networks. Identify different types of NICs and NIC connectors. Compare and contrast the function of bridges, switches and routers. Investigate functionality and applications of: • Integrated Services Digital Network (ISDN) adapters • system-area network cards.

COURSE ELT2320: NETWORK MEDIA & DEVICES (continued)

Concept	Specific Outcomes	Notes
Hardware Components (continued)	*The student should:* • identify layers of the Open System Interconnection (OSI) reference model at which specific hardware components operate • describe the features and functionality of power fault-tolerance hardware; i.e.: – surge suppressor – power (line) conditioner – uninterruptible power supply (UPS) • choose an appropriate hardware component to use or replace an existing device, given a practical network scenario • physically install a network interface card (NIC) and verify that the NIC is operational.	ELT2330: OSI Model provides an opportunity for more extensive study of the OSI model. Discuss damages that may occur as a result of typical power line problems; e.g.: • surges and spikes • sags and brownouts • oscillation. Recommend a hardware solution for a small company.
Cabling Tools and Procedures	• demonstrate correct use of cabling tools; e.g.: – wire crimper – punch down tool • demonstrate appropriate use of basic test equipment; e.g.: – media testers/certifiers – crossover cable – tone generator and probe (fox and hound) – optical testers • demonstrate proper sequence of steps to crimp and test Ethernet cable • select the appropriate cabling tool and test equipment, given a practical cabling task.	Follow wiring specifications and sequences established through EIA/TIA 568 standards. Demonstrate correct use of cabling tools to strip cables and attach connectors. Explain the concept of termination and the use of terminating resistors.

COURSE ELT2320: NETWORK MEDIA & DEVICES (continued)

Concept	Specific Outcomes	Notes
Compliant Installation	*The student should:* • demonstrate procedures for compliant installation of: – jacks and outlets – cable and structured cable runs – patch panels and patch cords • demonstrate appropriate use of test equipment in checking for: – continuity – proper grounding – correct cable termination • create a proposal for a new or refit cabling project • design, build and troubleshoot a small Ethernet network.	Apply EIA/TIA standards and recommendations for structured and backbone cabling. Physical aspects of installing structured cabling include: • planning the installation • pulling and connecting cables • testing cable runs and tracing cables. Discuss strategies for integrating old and new cabling systems. Emphasize relationships among topology, cabling and connectors in a network environment.
Career Paths	• research technical and professional career opportunities in network infrastructure design and installation • place network infrastructure design and installation job titles in a progressive sequence • identify training requirements and qualifications associated with one or more employment opportunities • write a detailed job description for one or more network infrastructure design and/or installation positions.	Plan for individual/group research and presentations that address: • job description • employment market • education/training • salary range. Research available network industry certification tracks.

COURSE ELT2330:	**OSI MODEL (Open System Interconnection)**
Level:	Intermediate
Theme:	Computer Networking Systems
Prerequisite:	None
Description:	Students develop knowledge of the Open System Interconnection (OSI) reference model and its use as a conceptual framework for analyzing network communication tasks. They examine OSI reference model characteristics, the functions of each of its seven layers, and how data moves between layers of the reference model when computers establish a network connection.

Parameters: Designed to be delivered in conjunction with other intermediate level courses in the Computer Networking Systems theme. Schools have the option of delivering courses within this theme in conjunction with one or more Project courses from the Career Transitions theme if they wish to extend learning and/or address other vendor-specific technologies.

Access to a computer work centre equipped with networking hardware, software, tools and consumable supplies, and to instruction from an individual with specialized knowledge and skills in computer networking.

Primary focus should be placed on the physical, data link, network and transport layers of the OSI reference model, and on the real-world protocols and networking devices that operate at each of these layers. Students model and assume personal responsibility for ethical behaviour in their use of networking technologies and in their access to electronic sources of information. They also demonstrate an understanding of industry-based policies regarding network use and security.

Supporting Courses: ELT1010: Electro-assembly 1, ELT1060: Digital Technology 1, ELT2070: Computer Technology, INF2010: Workstation Operations, INF2190: Telecommunications 1

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • describe the general purpose and structure of the OSI reference model as a conceptual framework for network communication	*Assessment of student achievement should be based on:* • a test, presentation or project designed to address the following topics: – the general purpose of the OSI reference model as a standard blueprint for designing, implementing and operating network hardware and software – the seven layers of the OSI reference model and their functions – how data moves between layers of the OSI reference model	20

COURSE ELT2330: OSI MODEL (Open System Interconnection) (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• explain and illustrate how hardware components, network protocols and encapsulation defined in lower layers of the OSI reference model move data across the network; i.e.: – physical layer – data link layer – network layer – transport layer	• a presentation, project or examination designed to demonstrate knowledge of: – the characteristics and design structure of components and devices associated with the physical layer – processes used to select, install and configure a network adapter – network protocols, hardware components and addressing associated with the data link layer, and ability to relate these to the logical link control (LLC) and media access control (MAC) sublayers – Institute of Electrical and Electronics Engineers (IEEE) standards for the data link layer – network protocols, hardware components and addressing associated with the network layer – basic processes of path determination and routing – physical and logical addressing systems – the function of transport layer protocols in flow control, error handling and name resolution	60
• explain the function of upper layers of the OSI reference model in providing client support; i.e.: – session layer – presentation layer – application layer	• a presentation or project designed to demonstrate the function of application protocols associated with the upper layers of the OSI reference model in providing client support	10

COURSE ELT2330: OSI MODEL (Open System Interconnection) (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• demonstrate established laboratory procedures and safe work practices	• observed performance in following: – established laboratory procedures – safety regulations specific to the networking technologies being used	5
• identify and describe information and communication technology careers within the context of the OSI reference model	• a project or report identifying technical and professional career opportunities relevant to communication tasks defined at different layers of the OSI reference model *Assessment Tools* *Assessment Checklist: OSI Model (ELT2330–1)* *Assessment Checklist: Laboratory Procedures and Safety Practices, ELTPSP* *Standard* *Performance rating of 2 on each criterion*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
OSI Reference Model	*The student should:* • explain the purpose of the OSI reference model as a blueprint for designing, implementing and operating network hardware and software • identify the functions of each of the seven layers of the OSI reference model • explain and diagram data transfer between layers of the OSI reference model • explain processes of data encapsulation and de-encapsulation in the OSI reference model • describe the process of data packet delivery and the function of a data frame	Each layer of the OSI reference model defines a set of functions, protocols, hardware and procedures used to move information over a network. Students should understand what each layer of the OSI reference model defines and which network elements (e.g., protocols, devices) operate at each layer.

COURSE ELT2330: OSI MODEL (Open System Interconnection) (continued)

Concept	Specific Outcomes	Notes
OSI Reference Model (continued)	*The student should:* • match network components and connectivity devices to the layers of the OSI reference model at which they operate • analyze networking tasks with respect to the OSI reference model.	
Physical Layer	• identify physical layer components and their function; i.e.: – cabling – connectors – network interface cards – repeaters – hubs • describe data signaling at the physical layer • identify Ethernet standards for media type and maximum segment length • demonstrate ability to: – select appropriate cables and connectors – select, install and configure a network adapter – terminate an Ethernet network – test for connectivity • given specific user requirements: – design physical layer topology and components for a small Ethernet network – create a plan for cabling based on Ethernet standards.	This layer is concerned with the physical nature of a network, which includes cabling, connectors, network interface cards, and the processes that convert bits into signals for sending and signals into bits when receiving. Compare and contrast 802.3 Ethernet media standards for: • 10BaseT • 100BaseFX • 1000Basex. Discuss elements of a logical diagram, and create a logical diagram for a network topology.
Data Link Layer	• identify data link layer devices and their function; i.e.: – bridges – switches • explain the effects of segmentation in switched networks • identify data link sublayers and their function: – logical link control (LLC) sublayer – media access control (MAC) sublayer • outline Institute of Electrical and Electronics Engineers (IEEE) standards for the data link layer	This layer provides context to the physical layer's bits by formatting them into packets, providing error-checking and correction services, and avoiding transmission conflicts on the network. Students should understand the role of the data link layer in packaging data for transmission by the physical layer.

COURSE ELT2330: OSI MODEL (Open System Interconnection) (continued)

Concept	Specific Outcomes	Notes
Data Link Layer (continued)	*The student should:* • describe connectionless and connection-oriented services associated with the LLC sublayer • explain the nature and limitations of physical addressing associated with the MAC sublayer • explain applications of framing in the transport of data packets • describe and illustrate the structure of a data frame • explain the function of frame addressing and frame relay in the transport of data packets.	Research the function of switching hardware with respect to: • store-and-forward and cut-through data transport • half-duplex and full-duplex network access. Convert between hexadecimal and decimal notation. Compare unicast, multicast and broadcast addressing.
Network Layer	• identify network layer devices and their function; i.e.: – router – brouter • explain the process of routing and the function of: – routing metrics – routing tables • distinguish between: – static and dynamic routing – routable and nonroutable protocols • identify common routing protocols and their function; e.g.: – Open Shortest Path First (OSPF) – Routing Information Protocol (RIP) – Novell NetWare Link-Services Protocol (NLSP) • compare physical addressing associated with the data link layer and logical addressing associated with the network layer • identify logical addressing protocols and their function; i.e.: – Internet Protocol (IP) – Internetwork Packet Exchange (IPX).	This layer addresses data for delivery and converts network addresses into physical addresses. Routing of messages on the network and internetwork also occurs at the network layer. Identify common routing metrics: • maximum transmission units (MTUs) • hop count. Compare static and dynamic routers with respect to: • configuration • routing • efficiency • security. Compare logical addressing in a network to addressing schemes used by the postal system.

COURSE ELT2330: OSI MODEL (Open System Interconnection) (continued)

Concept	Specific Outcomes	Notes
Transport Layer	*The student should:* • identify and explain types of error checking performed at the transport layer: – cyclic redundancy checks – parity bits – checksum calculations • provide a rationale for flow control, and identify hardware and software solutions implemented at the transport layer • explain name resolution functions performed at the transport layer • identify common transport layer protocols and their function; e.g.: – Transmission Control Protocol (TCP) – User Datagram Protocol (UDP) – Sequenced Packet Exchange (SPX) – AppleTalk Transaction Protocol/Name Binding Protocol (ATP/NBP) – Network Basic Input Output System/NetBIOS Enhanced User Interface (NetBIOS/NetBEUI).	This layer handles the connection among network computers as they communicate and match messages to the capabilities and restrictions of the network medium. Messages are divided into smaller pieces for transmission and reassembled at their destination. The transport layer supports the delivery of messages as well as error detection and recovery. Distinguish between connection-oriented and connectionless protocols.
Session, Presentation and Application Layers	• identify modes for communication associated with the session layer: – simplex – half-duplex – full-duplex • describe data compression and encryption processes associated with the presentation layer • identify file formats that serve as standards for the presentation layer • describe network services provided by the application layer: – message handling – file transfer – database queries	These layers are primarily concerned with providing client support. The functions of upper layer application protocols include: • transfer of electronic mail • transport of files from one computer to another • monitoring network devices.

COURSE ELT2330: OSI MODEL (Open System Interconnection) (continued)

Concept	Specific Outcomes	Notes
Session, Presentation and Application Layers (continued)	*The student should:* • identify upper layer application protocols and their function; e.g.: – Simple Mail Transfer Protocol (SMTP) – File Transfer Protocol (FTP) – Simple Network Management Protocol (SNMP).	
Career Paths	• research technical and professional career opportunities relevant to communication tasks defined at different layers of the OSI reference model • place networking job titles relevant to one or more layers of the OSI reference model in a progressive sequence • identify training requirements and qualifications associated with one or more employment opportunities • write a detailed job description for a networking position, and explain how duties support communication tasks defined by the OSI reference model.	Plan for individual/group research and presentations that address: • job description • employment market • education/training • salary range. Research available network industry certification tracks.

COURSE ELT2340:	**NETWORK PROTOCOLS**
Level:	Intermediate
Theme:	Computer Networking Systems
Prerequisite:	None
Description:	Students acquire basic knowledge of upper-layer protocol suites that permit the networking of computers. They examine reasons for the extensive use of the Transmission Control Protocol/Internet Protocol (TCP/IP) in computer networks, and develop knowledge and skills relevant to installing, configuring and maintaining a TCP/IP client on a network.

Parameters:

Designed to be delivered in conjunction with other intermediate level courses in the Computer Networking Systems theme. Schools have the option of delivering courses within this theme in conjunction with one or more Project courses from the Career Transitions theme if they wish to extend learning and/or address other vendor-specific technologies.

Access to a computer work centre equipped with networking hardware, software, tools and consumable supplies, and to instruction from an individual with specialized knowledge and skills in computer networking.

Particular emphasis is placed on developing knowledge of TCP/IP and its suite of protocols. Students model and assume personal responsibility for ethical behaviour in their use of networking technologies and in their access to electronic sources of information. They also demonstrate an understanding of industry-based policies regarding network use and security.

Supporting Courses: ELT1010: Electro-assembly 1, ELT1060: Digital Technology 1, ELT2070: Computer Technology, INF2010: Workstation Operations, INF2190: Telecommunications 1

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • describe and compare standard networking protocol suites with respect to function, addressing requirements, interoperability and naming conventions	*Assessment of student achievement should be based on:* • a teacher-directed evaluation designed to determine knowledge of, and ability to differentiate among, the following networking protocol suites in terms of routing, addressing schemes, interoperability and naming conventions – Transmission Control Protocol/Internet Protocol (TCP/IP) – Internetwork Packet Exchange/Sequenced Packet Exchange (IPX/SPX) – NetBIOS Enhanced User Interface (NetBEUI) – AppleTalk	10

COURSE ELT2340: NETWORK PROTOCOLS (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• identify and explain reasons for the extensive use of the TCP/IP suite in computer networks, and identify and explain major protocols that operate within the TCP/IP suite	• a presentation or project designed to identify and explain: – criteria involved in selecting a network protocol – characteristics of the TCP/IP suite that contribute to its extensive use – the basic function of application, transport and network protocols that operate within the TCP/IP suite – layers of the Open System Interconnection (OSI) reference model on which each of the TCP/IP protocols operate	25
• demonstrate basic knowledge of logical addressing, and the use of subnets and subnet masks to maximize address utilization	• a teacher-directed evaluation or project designed to test the student's ability to describe and/or illustrate: – conventions for IP addressing – the characteristics of Class A, B and C addresses – the purpose of subnetting and default gateways – classful versus classless approaches to subnetting – static versus dynamic approaches to IP addressing – the function of well-known TCP/UDP (User Datagram Protocol) ports	30
• demonstrate ability to: – install and configure TCP/IP on a user workstation – validate, troubleshoot and manage a network connection using TCP/IP utilities	• a project designed to demonstrate ability to: – build a small peer-to-peer or server-based network – use appropriate processes and settings to install and configure a workstation for TCP/IP – use appropriate TCP/IP utilities to validate, troubleshoot and manage a network connection	30
• demonstrate established laboratory procedures and safe work practices	• observed performance in following: – established laboratory procedures – safety regulations specific to the networking technologies being used *Assessment Tools* *Assessment Checklist: Network Protocols (ELT2340–1)* *Assessment Checklist: Laboratory Procedures and Safety Practices, ELTPSP* *Standard* *Performance rating of 2 on each criterion*	5

COURSE ELT2340: NETWORK PROTOCOLS (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • demonstrate basic competencies.	*Assessment of student achievement should be based on:* • observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
Network Protocols	*The student should:* • describe the nature and purpose of a protocol and a protocol suite/stack within the context of computer networking • describe and compare standard networking protocol suites, including Transmission Control Protocol/Internet Protocol (TCP/IP), Internetwork Packet Exchange/Sequenced Packet Exchange (IPX/SPX), NetBIOS Enhanced User Interface (NetBEUI), and AppleTalk, with respect to: – function – routing – addressing requirements – interoperability – naming conventions – advantages and limitations • match communication tasks performed within TCP/IP, IPX/SPX, NetBEUI and AppleTalk to communication tasks defined at different layers of the Open System Interconnection (OSI) reference model • identify criteria involved in selecting a network protocol.	Computers need to use the same language in order to communicate successfully on a network. In computer networking, these languages are known as protocols. Even though a computer may have the appropriate network operating system, an operational network interface card, and the appropriate network cable, communication is not able to occur without a network protocol. It is common practice to install more than one network protocol on each computer in a network. Illustrate/diagram the relationship of each protocol suite to the OSI reference model.

Concept	Specific Outcomes	Notes
Transmission Control Protocol/Internet Protocol (TCP/IP)	*The student should:* • describe the general characteristics and features of the TCP/IP suite • compare and contrast the TCP/IP suite with the OSI reference model • provide reasons for the extensive use of the TCP/IP suite; e.g.: – universal interconnectivity – conformity with the OSI reference model – modularity – Internet addressing – interoperability • identify the basic function of protocols operating within the TCP/IP suite; e.g.: – Transmission Control Protocol (TCP) – User Datagram Protocol (UDP) – Internet Protocol (IP) – Address Resolution Protocol (ARP) – File Transfer Protocol (FTP) – Simple Mail Transfer Protocol (SMTP) – Post Office Protocol (POP) – Internet Mail Access Protocol (IMAP) – Internet Control Message Protocol (ICMP) – Routing Information Protocol (RIP) – Open Shortest Path First (OSPF) – Hypertext Transfer Protocol (HTTP) • match TCP/IP protocols to layers of the OSI reference model on which they operate • compare and contrast TCP and UDP segment formats.	TCP/IP is the industry-standard suite of protocols, but is often recognized as the Internet protocol. It is designed for wide area networks and as a result is a routable protocol. TCP/IP uses a number of protocols, including the two primary protocols TCP and IP. Features of TCP include: • connection-oriented • reliability • packet handling • error-checking. Explain and/or diagram the: • TCP/IP three-way handshake/open connection • TCP/IP simple acknowledgement and windowing • IP datagram. Describe ICMP testing. Identify three or more ICMP messages.
Logical Addressing	• describe and illustrate conventions for Internet Protocol (IP) addressing; i.e.: – structure and components – characteristics of Class A, B and C addresses • convert between binary and decimal notation • explain the purpose of subnetting and default gateways	Briefly discuss Class D, E and special network addresses.

Concept	Specific Outcomes	Notes
Logical Addressing (continued)	*The student should:* • describe and compare classful and classless approaches to subnetting • provide a rationale for implementing Classless Inter-Domain Routing (CIDR) • demonstrate processes for subnetting a Class A, B or C address into a given number of subnetworks • determine the subnet mask for a subnetted network • describe and compare static and dynamic approaches to IP addressing, and applications of Dynamic Host Configuration Protocol (DHCP) • describe the concept of address resolution, and applications of the Address Resolution Protocol (ARP): – diagram how ARP is used in address resolution – describe gratuitous and proxy ARP – interpret an ARP cache • describe the concept of TCP and UDP port numbers: – define the function of a port – identify the range of port numbers – explain the function of well-known TCP/UDP ports.	Discuss and compare IP (version 4) and IP (version 6) addresses. Compare and contrast the IP and IPX logical addressing schemes. Students should understand the process of assigning a subnet mask to an IP address and be able to: • recognize default subnet masks • identify network and host IDs • define a custom subnet mask • determine local and remote hosts.
Installation, Configuration and Troubleshooting	• identify criteria involved in: – network planning – selecting a network protocol • plan and construct a small peer-to-peer or server-based network	

COURSE ELT2340: NETWORK PROTOCOLS (continued)

Concept	Specific Outcomes	Notes
Installation, Configuration and Troubleshooting (continued)	*The student should:* • install and configure a workstation for TCP/IP: – identify options for obtaining IP addresses – assign a static IP address – assign a subnet mask to an IP address • validate, troubleshoot and manage a network connection through the use of appropriate TCP/IP utilities; e.g.: – Simple Network Management Protocol (SNMP) – Packet Internet Groper (PING) – Internet Protocol Configuration (IPCONFIG) – Trace Route (TRACERT) – Network Statistics (NETSTAT).	Demonstrate the use of appropriate commands for verifying address configuration.

COURSE ELT2350: LOCAL AREA NETWORKS

Level: Intermediate

Theme: Computer Networking Systems

Prerequisite: None

Description: Students extend their understanding of technologies used in a local area network (LAN) and examine specifications for an Ethernet LAN. They develop knowledge of a general strategy for network design and apply the strategy to design, implement and troubleshoot a small LAN.

Parameters: Designed to be delivered in conjunction with other intermediate level courses in the Computer Networking Systems theme. Schools have the option of delivering courses within this theme in conjunction with one or more Project courses from the Career Transitions theme if they wish to extend learning and/or address other vendor-specific technologies.

Access to a computer work centre equipped with networking hardware, software, tools and consumable supplies, and to instruction from an individual with specialized knowledge and skills in computer networking.

Particular emphasis is placed on IEEE standards for cabling, and on safe procedures for preparing and connecting network media and devices. Students model and assume personal responsibility for ethical behaviour in their use of networking technologies and in their access to electronic sources of information. They also demonstrate an understanding of industry-based policies regarding network use and security.

Supporting Courses: ELT1010: Electro-assembly 1, ELT1060: Digital Technology 1, ELT2070: Computer Technology, INF2010: Workstation Operations, INF2190: Telecommunications 1

Curriculum and Assessment Standards

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • describe and explain the nature and evolution of LAN technologies and the specific features that differentiate one LAN from another	*Assessment of student achievement should be based on:* • a teacher-directed evaluation designed to test ability to: – identify and describe the general structure and purpose of a LAN – describe and compare past and present LAN technologies, with attention to their respective topologies, protocols and media – explain the physical characteristics and potential data capacities of emerging LAN technologies, and their benefits to the user	10

COURSE ELT2350: LOCAL AREA NETWORKS (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will:	*Assessment of student achievement should be based on:*	
• explain and demonstrate characteristics of an Ethernet LAN and strategies for improving network performance	• a presentation or project designed to explain and demonstrate: – basic characteristics of an Ethernet LAN – cabling and hardware devices that support data delivery across an Ethernet LAN – data transmission issues in a LAN environment – strategies used to improve LAN performance	25
• describe the characteristics, function and benefits of a virtual local area network (VLAN)	• a presentation or project designed to describe or illustrate: – the benefits offered by VLANs, and specific circumstances in which a VLAN might be implemented – the capabilities and functions of port-based, MAC-addressed-based, and protocol-based VLANs – a simple VLAN configuration	10
• design and implement a small LAN	• a project in which the student demonstrates ability to design and implement a small Ethernet LAN suitable for home or office and adhering to the Institute of Electrical and Electronics Engineers (IEEE) standards. The student should: – outline a general strategy for network design – apply the design strategy to design, implement and test a small Ethernet LAN, given a specific set of network requirements	40
• analyze and troubleshoot basic problems related to LAN design and implementation	• the ability to analyze and determine the cause of a LAN implementation problem, within the context of the project above. The student should: – outline a general strategy for troubleshooting network problems – apply the troubleshooting strategy to determine the cause of a LAN implementation problem	10

COURSE ELT2350: LOCAL AREA NETWORKS (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
The student will: • demonstrate established laboratory procedures and safe work practices	*Assessment of student achievement should be based on:* • observed performance in following: – established laboratory procedures – established network use policies and practices – safety regulations specific to the network technologies being used *Assessment Tools* *Assessment Checklist: Local Area Networks (ELT2350–1)* *Assessment Checklist: Laboratory Procedures and Safety Practices, ELTPSP* *Standard* *Performance rating of 2 on each criterion*	5
• demonstrate basic competencies.	• observations of individual effort and interpersonal interaction during the learning process. *Assessment Tool* *Basic Competencies Reference Guide and any assessment tools noted above*	Integrated throughout

Concept	Specific Outcomes	Notes
LAN Technologies	*The student should:* • describe the general structure and purpose of a local area network (LAN) • describe and compare past and present LAN technologies, with attention to their respective topologies, protocols and media; e.g.: – Attached Resource Computer network (ARCnet) – LocalTalk – Ethernet – Token Ring – Fibre Distributed Data Interface (FDDI) – Asynchronous Transfer Mode (ATM) – Wireless LAN (WLAN)	Although Ethernet networks are commonly used in many network environments, there are a number of other technologies available for implementation. Following Ethernet, Token Ring is the most frequently used LAN technology. ARCNet and LocalTalk are examples of past technologies. FDDI and ATM are two high-speed networking standards used in current networking environments. WLAN provides new end-user benefits, and is likely to become widely available in the future.

COURSE ELT2350: LOCAL AREA NETWORKS (continued)

Concept	Specific Outcomes	Notes
LAN Technologies (continued)	*The student should:* • describe new and/or emerging LAN technologies with respect to: – physical characteristics and potential data capacities – new applications and end-user benefits – historical and/or business perspectives that drive development and adoption.	
Ethernet LANs	• describe basic characteristics of an Ethernet LAN: – topology or physical layout – use of Carrier Sense Multiple Access with Collision Detection (CSMA/CD) – specifications for Ethernet LANs • identify and describe cabling and hardware devices that support data delivery across an Ethernet LAN; e.g.: – cabling specifications and options – data flow through hubs, repeaters, bridges and switches – network interface card (NIC) functions and options – the function of terminating resistors • identify data transmission issues in an Ethernet LAN networking environment; e.g.: – latency and bandwidth – contention – congestion and collision – attenuation • explain the concept of segmentation and strategies used to design a collision domain: – describe segmentation of a collision domain by bridges, switches and routers – illustrate the 5-4-3 rule used in 10BaseT networks – design and illustrate a small Ethernet collision domain network	Current Ethernet standards facilitate large, flexible and fast networks. Where older Ethernet networks transmitted data at 10 Mbps, current Ethernet networks can operate at 100 or 1000 Mbps. Twisted-pair wiring and/or fibre-optic wiring have replaced coaxial cable in many hybrid topologies installed throughout the networking industry. Examine data transmission issues in a LAN networking environment, and current/emerging strategies for improving LAN performance. Compare the distinguishing features of two Ethernet frame types. Distinguish between a collision domain and broadcast domain.

Concept	Specific Outcomes	Notes
Ethernet LANs (continued)	*The student should:* • explain applications of bridge and switch technology: – illustrate the function of learning bridges and the Spanning Tree Protocol (STP) – explain the function of switches at the data link layer and network layers – identify different types of switching architecture • store-and-forward and cut-through data transport • half-duplex and full-duplex network access.	Examine the relationship between bridging and switching technology. Explain how switching can affect utilization load and collision rate. Compare and contrast the function of switches at the data link and network layers. Explain the capabilities and limitations of 10BaseT Ethernet, and the advantages/ disadvantages of 100 Mbps and 1000 Mbps Ethernet over 10 Mbps Ethernet environments.
Virtual Local Area Networks (VLANs)	• describe the structure and function of a VLAN • identify the benefits offered by a VLAN, and specific circumstances in which a VLAN might be implemented • describe capabilities and functions of different types of VLANs: – port-based – address-based – protocol-based • illustrate/diagram a simple VLAN configuration.	VLANs are useful for maximizing the efficiency and security of a network. They are logical LANs within a physical LAN. Discuss the benefits of VLANs, and their advantages over multiple LANs.
LAN Design and Implementation	• outline a general strategy for network design; e.g.: – consider the purpose of the network – determine the overall size of the network – select a network topology – determine the type of file system to be used – select network and client operating systems – establish a naming scheme and name conventions – determine the level and type of fault tolerance – establish the type and level of security required	Discuss the need for, and criteria involved in, network planning. Student projects should demonstrate application of configuration concepts that ensure overall network performance.

COURSE ELT2350: LOCAL AREA NETWORKS (continued)

Concept	Specific Outcomes	Notes
LAN Design and Implementation (continued)	*The student should:* • design and implement a small Ethernet LAN suitable for home or office that adheres to the Institute of Electrical and Electronics Engineers (IEEE) standards; i.e., given a specific set of network requirements: – select an appropriate topology and architecture – recommend a hardware and connectivity solution – implement the solution by following safe procedures for connecting cabling and hardware devices – test the installation.	Examine applications of hardware and software tools in network planning. Review standards and practices for compliant installation of cabling and devices.
LAN Troubleshooting	• describe and compare proactive and reactive approaches to troubleshooting • outline a general strategy for troubleshooting network problems; e.g.: – establish the symptoms – identify the affected area – establish what has changed – select the most probable cause – implement a solution – test the results – recognize the potential effects of the solution – document the solution • identify common network problems related to: – physical topology – client connectivity – wiring and infrastructure • identify sources of support for troubleshooting; e.g.: – hardware/software manuals and help files – manufacturer's web site – technical support via telephone/e-mail • analyze and determine the cause of a LAN implementation problem.	Identify network troubleshooting tools and techniques. Discuss typical problems associated with ring, bus, star, mesh and wireless topologies. Client troubleshooting typically involves hardware, software, cabling, protocols and/or authentication. Wiring problems may relate to installation, attenuation, network device ports and/or cable lengths.