



ELECTRICAL– TECHNOLOGIST (ELITY 2021)

Preamble

The Canadian Technology Standards (CTS) are a collection of learning outcomes for Canada's engineering technology and applied science profession at the technician and technologist level.

Stakeholders

The CTS may be utilized by accreditation bodies, provincial professional associations, educational institutions, government agencies, industry and others for the purposes accreditation, certification and other applications.

Educational Programs

The Electrical CTS is relevant to programs including, but not limited to, power generation, power transmission, power distribution, electrical protection, electrical machine design, industrial control, robotics, industrial telecommunications, and electrical installation and maintenance at the at the technologist level.

Learning Outcomes

This CTS list Discipline Learning Outcomes (DLO) which describe the significant and essential learning that students have achieved and can reliably demonstrate at the time of graduation. Each DLO has a number of Learning Outcome Indicators (LOI), which are examples illustrating, defining and clarifying the level of performance expected. The list of LOI is not comprehensive and there may be other indicators which can be used to assess achievement of learning outcomes.

Graduate Capability

Students graduating from an accredited program have demonstrated achievement of all general learning outcomes, including a prescribed level of math, and discipline learning outcomes selected by the program.

Having completed a program that is based on applied mathematics and scientific and engineering theory, principles and practices and having acquired the knowledge, skills and attitudes to function in the work place, graduates are;

- able to evaluate assignments, establish objectives, set parameters and determine appropriate procedures and actions.
- able to exercise due diligence in the workplace and adhere to related practices, applicable laws and health and safety practices.
- able to work in accordance with labor-management principles and practices.
- able to work independently or interdependently as part of a discipline or multi-disciplinary team.
- prepared to assume responsibility for their work.

Graduate Career Opportunities

Graduates of Electrical Engineering Technology - Technologist programs have career opportunities in such areas as: business, industry, utilities, construction, government, and public organizations. They may find employment in careers such as: design of equipment, processes, infrastructure, or systems; maintenance of equipment or systems; interpretation or preparation of specifications, technical drawings, or instructions; quality management and inspection; project management and contract management; administration; manufacturing operations; field and customer service; estimating; technical sales; supervision of manufacturing; supervision of projects; and training activities.

Discipline Learning Outcomes (DLOs)

Note: The learning outcome are presented in two Groups. It is suggested that a program selects two learning outcomes from group A and three from group B.

Group A

ELITY01-A Electrical Distribution

- Create designs and specifications for interior and exterior electrical distribution and utilization systems up to 750V.

Learning Outcome Indicators include:

- 1.1-A Design and specify interior and exterior power transmission and distribution systems up to 750V.
- 1.2-A Design interior and exterior lighting systems for residential, commercial, and industrial installations.
- 1.3-A Design auxiliary systems including fire-alarm installations, UPS, and basic communication systems.
- 1.4-A Design and specify electrical equipment installations, including electrical machines, machine control, motor-control centers, metering, and grounding systems.
- 1.5-A Design electrical systems applying Canadian Codes.
- 1.6-A Design and specify medium-voltage installations for switchgear and substations.
- 1.7-A Develop and implement electrical installations applying project management principles.

ELITY02-A Power Systems

- Design and specify electrical generation, transmission, distribution, and utilization systems above 750V, applying knowledge of power-system configurations, electrical equipment, and protection practices.

Learning Outcome Indicators include:

- 2.1-A Evaluate, design, and commission power transmission and distribution systems over 750V (medium and high voltage).
- 2.2-A Evaluate and design power-system grounding schemes.
- 2.3-A Design and analyze power systems and faults employing MVA-base methods, symmetrical component, and per-unit methods.
- 2.4-A Evaluate, select and design protection and coordination schemes, using zones of protection and protective relays for protection of machines and transmission and distribution systems.
- 2.5-A Design and model power systems, protection and coordination applying dedicated software.
- 2.6-A Select, test, program, and calibrate protective relays.

- 2.7-A Design and implement electrical installations applying project management principles.
- 2.8-A Design and specify grounding and bonding schemes.

ELITY03-A Utility and Industrial Generation

- Test, commission, and maintain utility and industrial generation, transmission, and distribution systems and equipment.

Learning Outcome Indicators include:

- 3.1-A Plan and organize acceptance and maintenance tests on electrical equipment to meet NETA and IEEE standards.
- 3.2-A Plan and commission electrical system and equipment installations.
- 3.3-A Plan and organize maintenance testing and evaluation of cables, transformers, and circuit breakers.
- 3.4-A Design arc-flash evaluation and protection in electrical installations to NFPA-70E standards.
- 3.5-A Demonstrate a “safety first” attitude using appropriate safety equipment and practices in all fieldwork.
- 3.6-A Write thorough evaluation reports on all commissioning, acceptance, and maintenance testing.

ELITY04-A Rotating Electrical Machines

- Test, commission and maintain transformers and rotating electrical machines.

Learning Outcome Indicators include:

- 4.1-A Design and specify single-phase and three-phase transformer installations.
- 4.2-A Plan and organize open-circuit and short-circuit tests on transformers, interpreting and applying test results.
- 4.3-A Evaluate and mitigate three-phase transformer harmonics.
- 4.4-A Design and specify DC motor and DC generator installations.
- 4.5-A Design and specify AC induction motor installations.
- 4.6-A Design and specify AC alternator and synchronous motor installations.
- 4.7-A Commission, and maintain electrical machines.
- 4.8-A Generate acceptance and maintenance tests to NETA or IEEE standards.

ELITY05-A Instrumentation Systems

- Design, commission, and maintain test equipment and instrumentation systems.

Learning Outcome Indicators include:

- 5.1-A Design, specify, commission, and maintain line-voltage control systems, including field devices, relays, starters, and speed controllers.
- 5.2-A Diagnose and analyse circuits applying instrumentation, metering, and computer-based equipment.

- 5.3-A Configure and link PLCs with field devices and other controllers applying a variety of data communication protocols.
- 5.4-A Select and specify programmable logic controller systems including processors, I/O modules, controller networks, and I/O networks.
- 5.5-A Test, design, debug, commission, and maintain programs for programmable logic controllers.
- 5.6-A Test, design, debug, commission, and maintain graphics for human machine interface applications.
- 5.7-A Critique and specify power supply, protection, enclosure, cooling, and other installation requirements for industrial automations systems.
- 5.8-A Select and specify distributed control systems (DCS), including processors, I/O modules, controller networks, and I/O networks.
- 5.9-A Test, design, debug, commission, and maintain programs for distributed control systems.
- 5.10-A Select and specify industrial instrumentation equipment, including process variable sensors, transmitters, signal conditioners, recorders, and controllers.
- 5.11-A Diagnose control loops, configure feedback control loops, tune common control loops, and analyze their performance applying principles of process control.
- 5.12-A Diagnose specify, and commission, solid-state and soft starters for motors and associated wiring and equipment.
- 5.13-A Specify, install, program, and maintain variable-frequency drives.
- 5.14-A Evaluate and mitigate power-quality and harmonic content.

ELITY06-A Electrical Projects

- Plan, direct, and manage electrical engineering projects.

Learning Outcome Indicators include:

- 6.1-A Formulate organization and management of all aspects of project development applying project management principles and software.
- 6.2-A Plan and direct installation and commissioning of electrical systems for power distribution in buildings and industrial facilities.
- 6.3-A Plan and direct installation and commissioning of automation systems in buildings and industrial facilities.
- 6.4-A Plan and direct installation and commissioning of industrial data communications networks.
- 6.5-A Create and maintain project documentation including drawings, specifications, procedures, and reports.

Group B

ELITY01-B Renewable and Suitable Energy Resource

- Specify, design, analyze, and install renewable and sustainable energy resource systems.

Learning Outcome Indicators include:

- 1.1-B Analyze given site for solar energy with respect to geographical coordinates, weather patterns, physical parameters, and available electrical supply.
- 1.2-B Design solar photovoltaic system for given geographic site.
- 1.3-B Design and install ground source heat pump system.
- 1.4-B Analyze site/house for passive solar heating.
- 1.5-B Design and install solar water heating system.
- 1.6-B Analyze given site for wind energy with respect to geographical coordinates, weather patterns, physical parameters, and available electrical supply.
- 1.7-B Design and install wind energy system.
- 1.8-B Evaluate short and long-term financial and environmental costs and benefits of sustainable energy resource proposal.

ELITY02-B Computer Aided Systems

- Diagnose, plan, design, analyze, and specify computer aided/integrated manufacturing systems, robotic systems and associated controls, work cells and layouts of automated industrial/robotic systems.

Learning Outcome Indicators include:

- 2.1-B Generate specifications for robot applications.
- 2.2-B Specify hydraulic and pneumatic system requirements for robotics systems.
- 2.3-B Select electrical motor drives for robotic systems.
- 2.4-B Analyze manufacturing work cell environments.
- 2.5-B Evaluate safety, performance, and efficiencies of robotic systems.
- 2.6-B Specify programmable controllers in automated systems.
- 2.7-B Justify computer integrated systems for manufacturing applications.
- 2.8-B Analyze and develop control systems for industrial automation applying control theory and principles.
- 2.9-B Evaluate and plan layouts of automated industrial/manufacturing systems.
- 2.10-B Interpret technical literature dealing with industrial automation technologies.

ELITY03-B Microprocessor/ Microcontroller Based Systems

- Diagnose, select, design, specify, and build microprocessor or microcontroller-based systems for engineering applications.

Learning Outcome Indicators include:

- 3.1-B Create a clear functional specification document for a microprocessor or microcontroller-based system.
- 3.2-B Select and specify computer-related hardware and software to meet design specifications.
- 3.3-B Design microprocessor or microcontroller-based systems using knowledge of computer-related hardware and software.
- 3.4-B Evaluate, test and construct, microprocessor or microcontroller-based systems.
- 3.5-B Resolve microprocessor or microcontroller-based system design and functionality issues.
- 3.6-B Design, code, and debug both high-level and assembly language programs for use in microprocessor or microcontroller applications using an appropriate debug and compile environment.
- 3.7-B Diagnose and characterize microprocessor and microcontroller-based systems using test or measurement instrumentation, including logic analyzers and oscilloscopes.
- 3.8-B Assess, design, and install interfaces, including A/D and D/A converters, between microprocessor and microcontroller-based systems and with supporting I/O devices.
- 3.9-B Model expected behaviour of microprocessor or microcontroller-based systems applying appropriate hardware emulation tools.

ELITY04-B Electrical Equipment

- Design, manufacture, and overhaul electrical equipment, including transformers and rotating electrical machines.

Learning Outcome Indicators include:

- 4.1-B Analyze application to determine operating and environmental requirements with consideration for ease of manufacture and cost effectiveness.
 - 4.1.2-B *Design equipment or machine to meet specified output, selecting the materials, component dimensions, cooling provisions, winding plans, conductor sizes, pole arrangements, and enclosures in accordance with standard handbook procedures and data tables.*
- 4.2-B Plan, execute, and document batteries of tests on manufactured or rebuilt electrical equipment and machines to determine their operating characteristics, compliance with specifications, codes and standards, and acceptability for intended applications.
- 4.3-B Plan and/or direct manufacture or re-manufacture of electrical equipment and machines, liaising with technologists and other specialists in mechanical and industrial engineering to develop procedures and quality management criteria.

- 4.4-B Plan, direct, and/or execute preventive and breakdown maintenance and repair of electrical equipment and machines, liaising with mechanics, electricians, and other specialists to develop appropriate procedures, schedules, performance, cost and mortality monitoring systems, and inventories of tools, spare parts, and supplies.

ELITY05-B Technical Support

- Create technical support, applications engineering, and technical sales solutions within electrical industry applying electrical engineering expertise.

Learning Outcome Indicators include:

- 5.1-B Specify electrical components, equipment, and software given technical requirements.
- 5.2-B Generate cost estimates and quotations for electrical engineering projects.
- 5.3-B Select and size electrical components and equipment.
- 5.4-B Produce technical product information, customer training, and education.
- 5.5-B Interpret and analyze technical literature, engineering specifications, applications data, and other technical documentation.
- 5.6-B Compose advice for customers on installation, configuration, programming, testing, and maintaining electrical equipment.
- 5.7-B Diagnose and troubleshoot electrical equipment installation and commissioning problems.
- 5.8-B Analyze customer applications and determine solutions utilizing electrical hardware and software products and services.

ELITY06-B Power Electronics

- Design, select, commission, and maintain power electronics equipment and systems.

Learning Outcome Indicators include:

- 6.1-B Design power converter circuits including rectifiers, choppers, inverters, and voltage controllers.
- 6.2-B Analyze, troubleshoot, and maintain power converter circuits in machine and process power supplies and control systems.
- 6.3-B Select, commission, and maintain electronic variable speed drives and soft starters.
- 6.4-B Select, commission, and maintain uninterruptible power supplies (UPS), backup and auxiliary power supplies and associated equipment.

ELITY07-B Industrial Data Communications Networks

- Test, design, commission, and maintain industrial data communications networks, equipment, media, and software.

Learning Outcome Indicators include:

- 7.1-B Select and specify data communications media including cables, couplers, terminations, support structures, enclosures, and junction boxes.
- 7.2-B Determine network topologies and configurations.
- 7.3-B Select and specify data communications equipment including communications adapters, bridges, gateways, switches, routers, modems, RTUs, and power supplies.
- 7.4-B Select, specify, and maintain data communications network software applications.
- 7.5-B Calculate maximum limits for data transfer rates, network, segment, and drop line lengths and power supply.
- 7.6-B Apply a variety of data communications protocols linking controllers with field devices, other controllers, and industrial data management systems.
- 7.7-B Select, specify, and apply data management software and equipment to collect plant floor data for analysis by business software systems.

ELITY08-B Computer Applications

- Employ advanced computer operations to support electrical environment.

Learning Outcome Indicators include:

- 8.1-B Resolve technical problems by applying computers.
- 8.2-B Resolve technical problems applying and creating appropriate software.
- 8.3-B Create select, install, and apply appropriate software.
- 8.4-B Plan and integrate control and data collection components and systems.
- 8.5-B Create, test, evaluate, simulate, and document electrical and electronic circuits using appropriate software.
- 8.6-B Analyze and solve complex engineering problems using appropriate software.

ELITY09-B Quality Control

- Plan and apply quality control and quality assurance procedures.

Learning Outcome Indicators include:

- 9.1-B Appraise and recommend modifications to specifications applicable to electrical circuits, equipment, and systems.
- 9.2-B Interpret, assess, monitor, and report test results in accordance with organizational quality assurance procedures and specifications.
- 9.3-B Plan and organize quality assurance testing by using appropriate equipment and apply the results to suggest modifications.
- 9.4-B Apply knowledge of relevant quality assurance programs to products and processes.

ELITY10-B Electrical Safety

- Apply knowledge of relevant safety procedures and standard practices to electrical workplaces.

Learning Outcome Indicators include:

- 10.1-B Select recommend, and apply protective equipment and clothing to ensure personal health and safety in the workplace.
- 10.2-B Select, operate, and maintain hand and power tools.
- 10.3-B Prepare common wire and cable lists and assemblies.
- 10.4-B Interpret and apply safety codes, policies and practices, and accident prevention procedures.
- 10.5-B Plan and organize safety inspections of shop environments to detect and correct hazardous conditions.
- 10.6-B Implement installation, maintenance, and repair of electrical equipment applying licensing and regulatory requirements when completing project.
- 10.7-B Create and apply procedures for the safe handling, storage, and disposal of hazardous materials such as Workplace Hazardous Materials Information System (WHMIS) and Transporting of Dangerous Goods (TDG).

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