POWER SYSTEMS – TECHNICIAN (PSTN 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 Power Systems CTS is relevant to programs including, but not limited to, electrical power generation, power transmission, electrical protection, power distribution and utilization, and electrical maintenance and installation at the at the technician level.

Learning Outcomes

This CTAC 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.

DLO and their LOI employ only cognitive domain verbs selected from a table of cognitive verbs modeled after a Bloom's cognitive domain table of verbs adapted specifically for engineering technology and applied science disciplines.

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 Power Systems Engineering Technology - Technician programs have career opportunities in such areas as: business, industry, construction, government, and public organizations. They may find employment in careers such as those relating to operating electrical power systems, planning, generation, transmission, sub-transmission, and distribution, and many other areas.

Discipline Learning Outcomes (DLOs)

PSTN01 Drawings & Graphics

- Communicate information effectively and accurately by analyzing, translating, and producing electrical drawings and other related documents and graphics.

Learning Outcome Indicators include:

1.1 Produce or reproduce drawings on CAD using appropriate tools and equipment.
1.2 Produce drawings applying standards and standard symbols.
1.3 Produce and modify drawings effectively using computers.
1.4 Communicate technical data using and producing graphics such as single line drawings, schematics, and assembly drawings.
1.5 Collaborate in the interpretation, preparation, and modification of electrical specifications and project-related documents.
1.6 Employ freehand sketching techniques.

PSTN02 Instrumentation

- Use instrumentation, station metering, and System Control and Data Acquisition (SCADA) analogs.

Learning Outcome Indicators include:

2.1 Collaborate to acquire and analyze/interpret analogs, including frequency, voltage, current, and real and reactive power values.
2.2 Perform basic measurements including power, voltage, resistance, and current.
2.3 Determine problems and initiate corrective action using SCADA analogs, equipment statuses, and field reported values of voltage, current, and power.
2.4 Collaborate in analyzing and troubleshooting circuits using SCADA analogs and statuses.
2.5 Test and troubleshoot transmission, sub-transmission, and distribution circuits using appropriate instrumentation.

PSTN03 Electrical Circuits & Equipment

- Implement established procedures to verify acceptable function of and use a variety of troubleshooting techniques to identify problems with electrical circuits, equipment, and systems.

Learning Outcome Indicators include:

3.1 Identify problems in circuits and equipment by using establishing practices.
3.2 Utilize standard electrical and electronic test equipment.
3.3 Utilize available resources such as the internet, manuals, and handbooks to complete troubleshooting.
3.4 Apply problem-solving techniques.
3.5 Test, maintain, and repair equipment.
3.6 Plan upgrade of equipment when appropriate.

3.7 Operate equipment according to job requirements and specifications.
3.8 Implement established service schedules.
3.9 Troubleshoot a variety of electrical systems.
3.10 Troubleshoot a variety of power supplies and sources.

PSTN04 Commission Equipment

- Collaborate to commission and assemble electrical circuits and equipment that fulfill job requirements and specifications.

Learning Outcome Indicators include:

4.1 Determine requirements and specifications of equipment.
4.2 Test and assemble equipment based on requirements and specifications.
4.3 Plan and organize the installation, testing, and configuring automation and control systems.
4.4 Plan and organize the installation of equipment protective devices such as fuses, circuit breakers, sensing current transformers, and relays.

PSTN05 Rotating Electrical Machines

- Collaborate to commission and troubleshoot rotating electrical machines.

Learning Outcome Indicators include:

5.1 Operate synchronized machines and their control systems for specified applications.
5.2 Monitor rotating electrical machines and equipment.
5.3 Verify safe operation of rotating electrical machines in a variety of environments.
5.4 Collaborate to select, specify, and commission electrical equipment based on knowledge of industrial standards.

PSTN06 Electrical and Electronic Circuits

- Collaborate to analyze and troubleshoot electrical and electronic circuits.

Learning Outcome Indicators include:

6.1 Collaborate to analyze AC and High Voltage Direct Current (HVDC) networks.
6.2 Collaborate to analyze AC circuits, RCL circuits, parallel and series DC circuits, and pulse circuit properties and characteristics.
6.3 Resolve problems relating to electrical circuits.
6.4 Apply inductors and capacitors for given applications.
6.5 Resolve impedance matching problems by determining transformer ratios and efficiencies.
6.6 Collaborate to analyze data from fault locators, protective relays, station metering, and other SCADA information to direct the sectionalizing, locating, and repair of defective sub-transmission circuits.

PSTN07 Electrical Design

- Contribute to the design of electrical circuits, equipment, components, and systems.

Learning Outcome Indicators include:

7.1 Apply knowledge of a variety of electrical circuits.
7.2 Apply test applications using Real Time Contingency Analysis.
7.3 Use computers to test system configurations, determine switching sequences for successful interruption of parallel current paths, de-energization of system equipment, and transfer of load.
7.4 Collaborate in assessing system reliability applying knowledge of a variety of system contingencies and contingency analysis tools to determine the effect of removing selected elements of the BES on electric motors, generators, synchronous condensors, transformers, and transmission lines.
7.5 Collaborate in advising planning and performance engineering staff on system upgrade/design requirements applying knowledge of BES, loading trends, circuit impedance, and equipment capabilities.

PSTN08 Control Systems

- Collaborate to analyze and troubleshoot a variety of control systems.

Learning Outcome Indicators include:

8.1 Collaborate to apply, install, test, and troubleshoot SCADA systems.
8.2 Collaborate to test HVDC controls, Joint Load Generator controls, Joint Var controllers, Automatic Generation Control (AGC), re-closer relays, and automatic voltage control of capacitor banks and reactors.
8.3 Collaborate to test and troubleshoot auto-sequence schemes and station auto transfers.
8.4 Collaborate to commission, troubleshoot, and verify safe operation of rotating electrical machine control systems, on load tap-changing voltage, and phase-shifting controls on transformers.

PSTN09 Computer Applications

- Support electrical environment utilizing computers.

Learning Outcome Indicators include:

9.1 Resolve technical problems using knowledge of computer systems and application software.
9.2 Access and share information using electronic communications.
9.3 Use appropriate application software.

PSTN10 Automated Processes

- Collaborate to analyze performance of automated processes/protection schemes, predict the response of processes to external stimuli, and troubleshoot various

industrial control configurations.

Learning Outcome Indicators include:
10.1 Collaborate to interpret instrumentation and automated control diagrams.
10.2 Collaborate to analyze and predict the automatic under-frequency load shedding applications.
10.3 Calculate and interpret the effect that over/under-frequency has on BES and its automated protection systems.
10.4 Collaborate to specify control modes and determine parameters to achieve good control for over/under-frequency protection.
10.5 Determine effects of automatic voltage controlled reactive resources such as automatic capacitor and reactor switching.
10.6 Collaborate to analyze operation of special protection schemes used on common process equipment.
10.7 Collaborate to interpret electrical control symbols commonly used in protection and instrumentation.

PSTN11 Quality Control

- Collaborate in conducting quality control and quality assurance procedures.

Learning Outcome Indicators include:
11.1 Review specifications applicable to electrical circuits, equipment, and systems.
11.2 Monitor and report test results in accordance with organizational quality assurance procedures and specifications.
11.3 Conduct quality control testing as directed.
11.4 Use appropriate measurement and testing equipment.
11.5 Apply knowledge of relevant quality assurance programs to industry.

PSTN12 Documentation Systems

- Prepare and maintain records and documentation systems.

Learning Outcome Indicators include:
12.1 Use electronic and/or paper-based systems to store and retrieve information.
12.2 Maintain current, clear, and accurate electrical engineering-related documents.
12.3 Prepare reports using electrical engineering-related records and inventories.
12.4 Implement established procedures of inventory control.
12.5 Document testing, modification, and implementation of electrical systems.

PSTN13 Safety Procedures

- Apply knowledge of appropriate safety procedures and standard shop practices to electrical engineering workplaces.

Learning Outcome Indicators include:
13.1 Use protective equipment and clothing to ensure personal health and safety in workplace.
13.2 Apply safety codes, policies, practices, and accident prevention procedures.
13.3 Conduct safety inspections of shop environments to detect and correct hazardous conditions.
13.4 Apply applicable Hydro Safety and Occupational Health requirements when completing switching sequences, commissioning procedures, and operating procedures.
13.5 Apply recommended procedures for safe handling, storage, and disposal of hazardous materials.

PSTN14 Supervisory Systems

- Collaborate to use System Control and Data Acquisition (SCADA) and supervisory control systems for control of BES equipment, interpretation of SCADA analogs and alarms for normal and emergency operations, and troubleshooting of station equipment faults.

Learning Outcome Indicators include:
14.1 Collaborate to analyze operation and function of various SCADA systems.
14.2 Collaborate to control all SCADA equipment including breakers, motor-operated disconnects, circuit switchers, transformer tap-changers, phase-shifters, capacitor banks, and reactor banks.
14.3 Collaborate to interpret SCADA alarm data to determine specific courses of action, activate standby personnel, and initiate troubleshooting plans.
14.4 Collaborate to analyze operation and function of the various components of a SCADA system.

PSTN15 Safety Systems

- Collaborate to design control and safety systems for industrial processes using basic engineering principles and knowledge of industrial control systems.

Learning Outcome Indicators include:
15.1 Develop engineering projects using engineering and project management software tools.
15.2 Collaborate to select electronic equipment, components, and systems by consulting manufacturers' specifications.
15.3 Prepare engineering drawings and supporting documentation.
15.4 Describe principles of project management, complete with related software.
15.5 Apply principles of team building in engineering project.
15.6 Apply established codes of professional ethics.
15.7 Apply environmental regulations and practices.

PSTN16 Reliability Standards

- Collaborate with team members to apply North American Reliability Council (NERC) reliability standards for planning and operating BES reliability.

Learning Outcome Indicators include:

16.1 Collaborate to apply NERC standards for Resource and Demand Balancing.
- 16.1.1 Collaborate to ensure utilization of contingency reserve to balance resources and demand to contribute to returning frequency within defined limits, determining frequency response and bias, proper use of time error corrections, AGC components and performance criteria.
- 16.1.2 Collaborate to monitor interchange between balancing authorities to meet inadvertent energy obligations.
- 16.1.3 Collaborate to ensure proper operating reserve requirements.
- 16.1.4 Collaborate to utilize VHF, PSTN, and dedicated dispatch lines for effective telecommunications that are staffed and available to address real-time emergency conditions.

16.2 Describe Critical Infrastructure Protection standards to protect cyber assets, including identification of cyber assets, sabotage reporting, training, and security management controls.

16.3 Collaborate to apply principles of Emergency Preparedness and Operations.
- 16.3.1 Collaborate to develop, maintain, and implement a set of plans to mitigate operating emergencies.
- 16.3.2 Describe procedures to mitigate energy and capacity emergencies.
- 16.3.3 Report disturbances properly and explain plans to restore system from partial or total shutdown.
- 16.3.4 Collaborate to establish Black start Capability Plans and testing.

16.4 Describe facilities design, connections, and maintenance in respect to connection and performance requirements of facilities, planning, and integration of new facilities; system operating limits; and transfer capability.

16.5 Collaborate to implement established Interchange Scheduling and Coordination standards to ensure balancing authorities and verify interchange schedules with adjacent balancing authorities.

16.6 Describe interconnection reliability operations and coordination.
- 16.6.1 Collaborate to implement Reliability Coordinator's recommendations in respect to their authority, plans, and agreements to direct reliability entities within their area to re-dispatch generation, reconfigure transmission, or reduce load to return a system to a reliable state.

16.7 Collaborate to implement modeling, data, and analysis to ensure accurate transfer capability and generation.
- 16.7.1 Describe transmission component capabilities, limits, and availability; effect of interruptible loads; data reporting requirements; and actual and forecast demands.
- 16.7.2 Collaborate to verify generator's real and reactive power capabilities.

16.8 Maintain personnel performance, training, and qualifications and minimum competencies to operate a reliable BES.

16.9 Collaborate in conducting protection and control commissioning, testing, and

documentation on special protection schemes, including under frequency, under voltage load shedding, and disturbance monitoring.

16.10 Collaborate to plan and coordinate generation and transmission outages, implement scheduled operating plans, and ensure transmission operations are carried out so that instability, uncontrolled separation, or cascading outages will not occur as result of the most severe single contingency.

16.11 Collaborate to perform studies and simulations to ensure present and future demands of the BES will be met.

16.12 Collaborate to monitor voltage and reactive resources; ensure voltage levels are maintained within limits in real time and protect equipment and the reliability of the BES.