



CIVIL – TECHNOLOGIST (CVTY 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 Civil CTS is relevant to programs including, but not limited to, transportation, municipal, structural, environmental, geotechnical, hydrological and water resources, coastal, site engineering, construction and construction surveying 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 Civil Engineering Technology – Technologist programs have career opportunities in such areas as: business, industry, construction, government, and public organizations. They may find employment in careers such as: design of processes, infrastructure, or systems; interpretation or preparation of specifications, drawings, or instructions; quality management; construction management, construction contract inspection and administration; operations and maintenance; field and customer service; quantity surveying and estimating; engineering and construction survey layout; management and project management ; technical sales; supervision of projects; and training activities.

Discipline Learning Outcomes (PLOs)

CVTY01 Structural Design

- Design, analyze, and document structural steel, timber, concrete, and marine systems.

Learning Outcome Indicators include:

- 1.1 Evaluate, analyze, and design allowable loading combinations on civil related structures as identified by the National Building Code of Canada.
- 1.2 Analyze and resolve structural problems and design structural systems applying principles of Limit States Design.
- 1.3 Design and analyze structural elements (e.g., beams, columns, walls, and floor systems) in structural steel, timber, and reinforced concrete factoring in effects of flexural and axial loads applied in combination and the requirements for design of bolted or welded connections in steel and standard connections in timber.
- 1.4 Evaluate, analyze, and prepare plans and shop drawings for structural steel, timber, and concrete designs.
- 1.5 Interpret, analyze, and prepare construction drawings, including those for structural steel, steel connections, reinforcing steel layouts, and formwork/false work designs in conformance with design practices and applicable codes.
 - 1.5.1 *Interpret working drawings to assess construction activities and ensure compliance of work.*
- 1.6 Evaluate, design and analyze forms for concrete footings, walls, beams, slabs, and columns, including shoring and bracing.
- 1.7 Evaluate, design and analyze a reinforced concrete slab, a simple and a continuous beam, a cantilevered beam, and/or a slab, including selection and placement of reinforcing steel, cut-off distances, and anchorage requirements.
 - 1.7.1 *Evaluate, design, and analyze strength design concepts and procedures, including that of 'balanced design'.*
- 1.8 Evaluate design, and prepare placement drawings for reinforcing steel for reinforced concrete structures, and demonstrate the knowledge needed to verify steel placement.
- 1.9 Evaluate, design and analyze concrete foundations according to loading requirements and codes, taking into account the bearing capacity of soils.
- 1.10 Design and analyze marine structures, considering the effects of tides, currents, wind, waves, and ice taken from published data.
- 1.11 Calculate forces on vertical walls of marine structures due to breaking and non-breaking waves.
- 1.12 Evaluate impact of the environment on marine structures.

CVTY02 Construction

- Plan and organize construction of civil engineering projects, and evaluate materials, methods, and equipment used in construction.

Learning Outcome Indicators include:

- 2.1 Specify materials and equipment for civil projects, utilizing knowledge of specifications, performance properties, limitations, and safety considerations of equipment and materials.
- 2.2 Evaluate, analyze, and design technical criteria used in the design, layout, and construction of civil engineering projects.
- 2.3 Detect and, resolve technical problems in design, layout, and construction of civil engineering projects.
- 2.4 Select, evaluate, and apply appropriate project management principles and methods.
- 2.5 Evaluate and select financial resources, human resources, and timelines of civil engineering projects.
- 2.6 Evaluate and select the organizational and time-management strategies to support civil engineering projects.
- 2.7 Analyze failure and accident reports, and make appropriate recommendations.
- 2.8 Create deficiency lists, and recommend solutions.
- 2.9 Evaluate and select comprehensive job safety measures in compliance with provincial and federal health and safety acts, bylaws, etc.
- 2.10 Select and specify methods to be used in implementing and completing construction projects in a safe, effective, and efficient manner.
- 2.11 Plan and organize quality assurance inspection and testing of materials, methods, and equipment.
 - 2.11.1 *Interpret inspection and test results, and effect necessary adjustments or changes.*
- 2.12 Select and apply estimating and scheduling software.

CVTY03 Municipal Infrastructure

- Diagnose, design analyze, document, and inspect municipal and urban infrastructure.

Learning Outcome Indicators include:

- 3.1 Assess property's suitability for development through successful completion of concept and serviceability plans.
- 3.2 Plan and design urban road networks in accordance with best engineering practice and local regulations.
- 3.3 Create detailed design drawings for urban subdivisions, applying appropriate theory and design criteria and using engineering software.
 - 3.3.1 *Design urban subdivisions to consider economics, environmental, and engineering management.*

- 3.3.2 *Evaluate and document centerline chainage, roads, sidewalks, storm catchments, sanitary catchments, storm/sanitary/water main and profile plans, and other services.*
- 3.4 Plan and apply federal, provincial, and municipal acts, codes, regulations, and standards to minimize environmental impact caused by urbanization and related construction activities.
- 3.5 Evaluate requirements for and design water services, sanitary sewers, storm sewers, and storm water management systems in accordance with provincial and municipal standards.
- 3.6 Evaluate municipal requirements for water and waste water systems to meet regulatory agencies requirements and standards and to minimize environmental impact caused by urbanization and related construction activities.
- 3.7 Evaluate requirements for hydraulic structures (e.g., flumes and weirs) by applying the properties and characteristics of open channel flow.
- 3.7.1 *Assess and calculate flow rates, and recommend erosion control for various types of open channels based on hydraulic principles and conventions.*
- 3.8 Evaluate municipal requirements for a solid waste system, including factors and environmental conditions associated with the design, construction, and operation to meet regulatory agencies requirements.
- 3.9 Evaluate municipal requirements for air and noise systems to meet regulatory agencies requirements.
- 3.10 Plan and incorporate Leadership in Energy and Environmental Design (LEED) during design process.

CVTY04 Environmental Infrastructure Assessment and Remediation

- Diagnose, design, analyze, document, and inspect environmental infrastructure, including environmental monitoring, assessment, and remediation programs.

Learning Outcome Indicators include:

- 4.1 Evaluate and recommend implementation of engineering solutions to eliminate environmentally damaging activities.
- 4.1.2 *Demonstrate knowledge needed to implement 3R approaches to minimize wastes.*
- 4.2 Design, inspect, and supervise a project in compliance with provincial and federal environmental protection legislation and in conjunction with industry.
- 4.3 Evaluate potential environmental hazards, such as noise pollution; types of pollutants removed by primary, secondary, and tertiary treatments of effluents and waste; emission from landfills; and waste products from agricultural/ industrial/manufacturing processes.
- 4.4 Plan and organize preliminary site investigations following applicable regulatory criteria to assess background or natural conditions of the materials or natural environment to establish a statistically acceptable base-line condition, using computer modeling to simulate fate and transport of contaminants.
- 4.5 Create and implement environmental impact studies to assess effects of development on air, land, and water, as well as of biological, limnological,

- ecological, social, and economic factors and prepare environmental assessment reports.
- 4.5.1 *Create and recommend project alternative and revisions to reduce environmental impact for project for review with external stakeholders.*
 - 4.6 Create waste, site remediation, and decommissioning strategies, and conduct post remediation/decommissioning testing.
 - 4.7 Evaluate effectiveness of pollution control equipment intended to mitigate environmental impact of specific activities.
 - 4.8 Create and recommend prescriptive treatments for improving fish habitat deficiencies and production capabilities for a given set of conditions.
 - 4.9 Create and implement watershed and wetlands assessment using field procedures, such as data collection, scoring, and mapping, including delineation of riparian zones by plan interpretation, field marking, and compliance monitoring.
 - 4.10 Create environmental impact assessment reports.
 - 4.11 Plan and organize audit procedures for a facility and evaluate audit to ascertain that due diligence has been observed.

CVTY05 Hydrology

- Diagnose, design, analyze, document, inspect, and implement hydraulic infrastructure.

Learning Outcome Indicators include:

- 5.1 Analyze stream channels and drainage structures, documenting stream hydrology, channel morphology, sediment transport capability, and mass wasting processes, and impacts and methods to minimize wasting.
- 5.2 Classify stream sediment load, and calculate movement rates and sediment discharge.
- 5.3 Evaluate requirements for flow frequency analysis in river engineering project and its hydraulic structure design.
- 5.4 Evaluate criteria for dam design and its construction.
- 5.5 Assess hydraulic structures for maintenance and rehabilitation recommendations.
- 5.6 Interpret geologic, groundwater, and piezometric maps to identify potential aquifers and to determine aquifer characteristics.
- 5.6.1 *Monitor groundwater levels and movement to assess for containment and de-watering projects.*
- 5.7 Create water well design criteria based on given geological factors and demand requirements.
- 5.8 Analyze precipitation records to determine probable maximum precipitation events, frequency, and relationship between frequency, intensity, and duration.
- 5.9 Assess and predict net storm rain and infiltration rates.
- 5.10 Compile watershed boundaries and characteristics, drainage patterns, catchments area boundaries, and natural flow.
- 5.10.1 *Calculate design peak flows and estimate peak flows by flood routing techniques.*

- 5.10.2 *Estimate flood plain boundaries and recommend methods for flood damage mitigation.*
- 5.11 Determine catchment run-off, peak flow, snowmelt run-off, flood routing, and flood plains, and recommend mitigation measures.
- 5.12 Analyze how nature and humans interact with rivers, including how river geometry changes with changes in flow (e.g., erosion, sediment deposition, and transport).

CVTY06 Geotechnical Infrastructure

- Diagnose, design, analyze, document, inspect, and implement geotechnical infrastructure.

Learning Outcome Indicators include:

- 6.1 Implement and develop geotechnical site investigations, including bore drilling, geophysical, and other sampling methods and tests.
- 6.1.1 *Analyze laboratory and field test results (e.g. geological reports, subsurface investigations, and in-situ testing).*
- 6.2 Evaluate and specify land remediation techniques for contaminated soil, and assess their influences on groundwater control systems.
- 6.3 Classify soils and rocks using systems such as the Unified Soil Classification System, the Canadian System of Soils Classification, or a system approved by a given jurisdiction, and confirm classification using standard ASTM test methods.
- 6.4 Assess permeability, static water pressures, and effective stress for in-situ soil conditions and soil mass/volume relationships using piezometers and pump well techniques.
- 6.5 Assess soils reports for settlement, bearing capacity, and safety factor requirements for foundation designs.
- 6.6 Calculate relationships between soil conditions, foundation types, and loads to determine appropriate foundation design for the application.
- 6.6.1 *Design simple shallow spread footings for wall and column units.*
- 6.7 Analyze, monitor, and compare slope movement and causes of slope instability, including identification of potential slope hazards.
- 6.8 Resolve slope instability problems applying various standard slope stabilization techniques.
- 6.9 Analyse rock slope failures applying basic rock mechanics.
- 6.10 Design structures applying fundamental principles of earthquakes, including seismic hazards, structural behavior in earthquakes, and earthquake resistant design.
- 6.11 Assess and specify geo-materials, and their behavior under loading.
- 6.12 Analyze the design of marine structure foundations based on environmental considerations and breaking and non-breaking waves.

CVTY07 Surveying

- Verify and/or produce engineering and construction layouts using conventional survey instruments, GIS, and GPs systems.

Learning Outcome Indicators include:

- 7.1 Select standard survey instruments and GIS and GPS software and hardware.
- 7.2 Select and implement horizontal and vertical layouts and transition curves for transportation construction.
 - 7.2.1 *Generate calculations for transportation curves.*
- 7.3 Select and implement topographic surveys, take measurements, and do calculations required for the assignment.
- 7.4 Create and maintain monuments, and survey grid reference systems.
- 7.5 Select and implement culvert and bridge construction surveys to verify dimensions and vertical alignments.
- 7.6 Select and implement construction surveys and layouts, including line, site, elevations, and grade controls.
- 7.7 Select and implement methods of laying out a construction project using GIS data and a GPS satellite system.
- 7.8 Interpret aerial photographs and maps to calculate distance and to carry out field navigation and route planning.
- 7.9 Evaluate calculations and documentation of survey results.

CVTY08 Contracts

- Apply knowledge of ethics, sustainability, contract law, codes, standards, and management principles, to engineering technology or applied science applications consistent with the discipline requirements and program objectives.

Learning Outcome Indicators include:

- 8.1 Evaluate and prepare typical contracts for compliance with legal principles and the bidding processes.
- 8.2 Select and implement applicable environmental and health and safety-related legislation and practices.
- 8.3 Select and implement environmental sustainability issues resolution.
- 8.4 Select and implement equipment, materials, and practices that comply with relevant law, legislation, standards, codes, and bylaws.
- 8.5 Select and implement the CCDC documents.

CVTY09 Transportation Infrastructures

- Diagnose, design, analyze, document, inspect, and implement transportation infrastructure.

Learning Outcome Indicators include:

- 9.1 Evaluate and implement geotechnical assessment and terrain mapping of landform areas in order to recommend route locations.
- 9.2 Classify streets, roads, and highways in accordance with local, regional, and national standards and specifications.
- 9.3 Create complete set of topographic plans, layout plans, and specifications for streets, roads, and highways in accordance with Canadian geometric design standards.
- 9.4 Assess, calculate, and compile accumulated earthwork volumes based on provided highway design cross-sections, and use the accumulated volumes to prepare a mass haul diagram and determine the project overhaul quantity.
- 9.5 Design road drainage system, culvert, and drainage appurtenances, taking into consideration principles of self-maintenance and fail-safe, while minimizing environmental damage.
- 9.6 Evaluate potential environmental impacts of road construction practices, and specify required remedial and/or corrective actions.
- 9.7 Identify pavement distresses, relate these to the causes of pavement failure, and recommend remedial measures.
- 9.8 Analyze utility requirements for a proposed street and road development, and assess the potential environmental impact.
- 9.9 Select, design, and evaluate pavement structures in accordance with accepted standards.
- 9.10 Calculate pavement structure thicknesses for rigid and flexible materials based on application and foundation conditions.
- 9.11 Design, evaluate, and test asphalt cement and concrete cement mixes for given road and traffic conditions.

Copyright in the CTS is owned by Technology Accreditation Canada. Any person may, by acknowledging Technology Accreditation Canada as the source, use, reproduce, display, distribute, disseminate or otherwise make available to the public ("Use") the CTS on a royalty-free non-exclusive basis for any purpose, other than a commercial for-profit purpose primarily intended for or directed towards commercial advantage (a "Commercial Purpose"). Any person wishing to Use the CTS (or any excerpt thereof) for a Commercial Purpose requires the express consent of Technology Accreditation Canada.