ENVIRONMENTAL – TECHNOLOGIST (ENTY 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 Environmental CTS is relevant to programs including, but not limited to, water and waste water treatment, waste management, air/water/ soil pollution, environmental impact assessment and mitigation, environmental law, industrial hygiene, ecological resources, and environmental sustainability 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 Environmental 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 (DLOs)

ENTY01   Analysis
➢ Interpret, evaluate, and report on sample collection and quantitative and qualitative analysis.

Learning Outcome Indicators include:
1.1   Implement accepted scientific method in obtaining samples.
1.2   Create sampling safety protocol.
1.3   Validate and maintain chain of custody for samples.
1.4   Assess background or natural environment to determine a statistically acceptable 'base line' condition.
1.5   Select and implement principals of solution chemistry in sample preparation.
1.6   Assess the physical and chemical properties of a material in a lab or field setting selecting and implementing appropriate analytical techniques, equipment and, tests.
1.7   Select and implement processes to maintain and preserve plant, animal, and microbial cultures and, when appropriate, safely dispose of the culture media.
1.8   Identify cell cultures selecting and applying appropriate microscopic, biochemical, culture, and immunological techniques.

ENTY02   Instruments and Equipment
➢ Diagnose, select, test, operate, calibrate, and maintain instrumentation and analytical equipment common to the discipline.

Learning Outcome Indicators include:
2.1   Implement procedures to troubleshoot, test, and maintain instrumentation and analytical equipment.
2.2   Implement procedures to calibrate instruments and equipment to manufacturers' specifications.
2.3   Validate the accuracy of analytical instruments by developing and applying appropriate quality control procedures.
2.4   Create calibration standards and samples for instrumental analysis.
2.5   Interpret and perform infrared (IR), ultraviolet (UV), visible, atomic absorption, optical emission, atomic spectrometry, and nuclear magnetic resonance spectroscopy (NMR) analyses.
2.6   Interpret and perform analyses using electrochemical methods, including titrations and ion selective electrodes.
2.7   Analyze, develop, and apply analytical instruments and analyzers such as: gas chromatographs, dissolved oxygen, humidity, ultraviolet, infrared, pH, turbidity, and environmental analyzers.

ENTY03   Environmental Systems Management
➢ Develop, maintain, and apply the principles of an environmental management system.

Learning Outcome Indicators include:
3.1   Develop an environmental management system that is consistent with corporate strategic plans and regulatory requirements and considers aspects of environmental liability, reasonable care, due diligence, and risk management.
3.2   Evaluate and recommend implementation of engineering solutions in accordance with ISO standards to eliminate environmentally-damaging activities.
3.3   Design effective environmental management system (ISO 14000s).
3.4   Evaluate industry stewardship, accountability, and due diligence to minimize environmental liability.
3.5   Evaluate Occupational Health and Safety (OH&S) program for compliance with OH&S Legislation.
3.6   Interpret, analyze and perform analyses made using infrared (IR), ultraviolet (UV), visible, atomic absorption, optical emission, atomic spectrometry, and nuclear magnetic resonance spectroscopy (NMR).
3.7   Interpret and perform analyses using electrochemical methods, including titrations and ion selective electrodes.
3.8   Analyze, develop, and apply various analytical instruments and analyzers such as: gas chromatographs, dissolved oxygen, humidity, ultraviolet, infrared, pH, turbidity, and environmental analyzers.
3.9   Design an environmental management system for a specific application (e.g., hazardous waste management system or wastewater treatment management system).
3.10   Design an environmental monitoring program for a specific application, showing what is required for a successful monitoring application.
3.11   Apply good laboratory practices in accordance with accepted principles of quality assurance.

ENTY04   Aquatic Ecosystem Studies
➢ Identify and differentiate the evolutionary stages in aquatic ecosystems and resulting water quality.

Learning Outcome Indicators include:
4.1   Plan, organize and assess limnology studies.
4.2   Interpret principles of a bottom fauna life cycle.
4.3   Interpret stages of plant and animal primary succession.
4.4   Interpret principles and factors affecting lake and water flow evolution.
4.5   Interpret and determine water quality and quantity impact.
4.6   Assess and interpret different types of water pollution, including physical, biological, and chemical.
4.7   Assess and interpret importance of dissolved oxygen in surface water and the limits of dissolved oxygen for aquatic life.

4.8   Identify and apply basic concepts of ecosystems in analysis of environmental studies.
4.9   Interpret and analyze field reports for sustainable development of renewable resources.
4.10   Interpret and recommend treatment options for any natural water for use as aquatic habitat, or as drinking, agricultural, recreational, or industrial process water based upon quantitative and qualitative analyses using appropriate laboratory and/or field procedures.
4.11   Select, apply, evaluate, and modify, as necessary, environmental management options consistent with environmental project outcomes.

ENTY05   Air and Water Pollution
➢ Interpret and apply environmental procedures for air and water pollution control.

Learning Outcome Indicators include:
5.1   Identify sources of air and water pollution.
5.2   Appraise permitted emission/effluent levels as defined in government legislation.
5.3   Interpret, compute, and record meteorological data.
5.4   Select emission-monitoring instrumentation.
5.5   Create procedures to calibrate, operate, and maintain test-monitoring equipment.
5.6   Process, collect, transport, and store air and water samples in accordance with established procedures.
5.7   Analyse pollution levels by applying and interpreting biological procedures and tests of air and water samples.
5.8   Appraise and interpret bacterial and other contaminant counts.
5.9   Create procedures to record and document data.

ENTY06   Quality Assurance and Quality Control
➢ Implement relevant quality assurance and quality control procedures in accordance with appropriate health, occupational safety, and environmental regulations.

Learning Outcome Indicators include:
6.1   Create processes to communicate effectively using quality assurance and quality control terminology.
6.2   Interpret and assess accuracy and precision of statistical data.
6.3   Interpret and evaluate analytical data and intra-laboratory proficiency results.
6.4   Interpret and assess legal and professional ramifications of reporting inaccurate results from analytical data analysis.
6.5   Differentiate between accuracy, precision, and bias.
6.6   Differentiate between chronic and sporadic types of quality problems.
6.7   Create and manage quality assurance records and procedures.
6.7.1   *Audit laboratory applications and procedures.*
6.8   Assess, and report compliance with appropriate laboratory and field procedures and standards.

6.9   Create chain of custody forms for sample and data traceability.

ENTY07   Environmental Processes
 ➢ Apply basic principles of science and engineering to environmental processes.

Learning Outcome Indicators include:
7.1   Demonstrate knowledge of unit operations, industrial processes, and physical, biological, and chemical control.
7.2   Interpret and apply the principles of sampling, analysis, and process monitoring to environmental projects.
7.3   Evaluate gaseous, liquid, and solid waste management systems, as well as methods of operation of such processes.
7.4   Evaluate, analyze, and design water supply and treatment systems.
7.5   Evaluate, analyze, and design wastewater collection, treatment, and sludge handling systems.
7.6   Interpret and analyze fluid flow applying fundamental knowledge of fluid flow measurement.
7.7   Evaluate, analyze, and design emission control technologies for air.
7.8   Interpret hydrologic and hydraulic principles.
7.9   Analyze, design, and develop operations for industrial processes and waste treatment equipment to comply with environmental regulations.
7.10   Implement environmental audits and relate the recommendations to the operation of industrial processes and waste treatment systems.
7.11   Evaluate detailed physical, chemical, and biological water and wastewater treatment processes, incorporating regulatory guidelines and industry standards.
7.12   Evaluate municipal requirements for air and noise systems to meet regulatory agencies requirements.

ENTY08   Environmental Impact, Assessment, and Remediation
 ➢ Plan, design, and implement environmental impact, assessment, and remediation programs.

Learning Outcome Indicators include:
8.1   Evaluate and recommend the implementation of engineering solutions to eliminate environmentally-damaging activities.
8.1.1   Demonstrate the knowledge needed to implement 3R approaches to minimize wastes.
8.2   Evaluate the potential environmental impacts of a project on the air, land, water resources, and ecological components in the project area.
8.3   Create environmental impact assessment reports, which could include research results, proposed activity, and general mitigation measures.
8.4   Assess the effects of engineering projects and human activities on the biophysical and human environment and recommend measures to mitigate these.

8.5   Evaluate potential environmental hazards, such as: noise pollution; the 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.

8.6   Compile preliminary site investigations following applicable regulatory criteria to assess background or natural conditions of the materials or natural environment in order to establish a statistically acceptable 'base line' condition, using computer modeling to simulate the fate and transport of contaminants.

8.7   Differentiate and recommend project alternatives and revisions to reduce environmental impact for the project.

8.8   Interpret and review proposals with external stakeholders.

8.9   Create waste, site remediation, and decommissioning strategies, and conduct post remediation/decommissioning testing.

8.10   Evaluate effectiveness of pollution control equipment intended to mitigate environmental impact of specific activities.

8.11   Recommend prescriptive treatments for improving fish habitat deficiencies and production capabilities for a given set of conditions.

8.12   Compile watershed and wetlands assessment using field procedures, such as data collection, scoring, and mapping, including the delineation of riparian zones by plan interpretation, field marking, and compliance monitoring.

ENTY09   Geotechnical Infrastructure

➢ Diagnose, appraise, analyze, document, inspect, and implement geotechnical infrastructure.

Learning Outcome Indicators include:

9.1   Create and implement geotechnical site investigations, including bore drilling, geophysical, and other sampling methods and tests.

9.2   Analyze laboratory and field test results, such as geological reports, subsurface investigations, and in-situ testing.

9.3   Specify land remediation techniques for contaminated soil, and assess its influences on groundwater control systems.

9.4   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.

9.5   Assess permeability, static water pressures, effective stress for in-situ soil conditions, and soil mass/volume relationships using piezometers and pump well techniques.

9.6   Analyze, monitor, and compare slope movement and causes of slope instability, including identification of potential slope hazards.

9.7   Resolve slope instability problems applying various standard slope stabilization techniques.

9.8   Analyse rock slope failures applying basic rock mechanics.

9.9   Assess and specify geo-materials and their behaviour under loading.

ENTY10   Survey
- Create procedures for survey layouts using conventional survey instruments, GIS, and GPS systems.

Learning Outcome Indicators include:
10.1   Select standard survey instruments and GIS and GPS software and hardware.
10.2   Create procedures for topographic surveys, take measurements, and do calculations.
10.3   Create and maintain monuments, and produce survey grid reference systems.
10.4   Compute distances and carry out field navigation and route planning applying aerial photographs and maps.
10.5   Analyze and interpret calculations, and document survey results.
10.6   Select and implement horizontal and vertical layouts and transition curves.
10.7   Plan, organize, and maintain interface with computer-aided drafting system.
10.8   Plan, organize, and maintain effective survey database with system of archives and records.

ENTY11   Hydrology
- Analyze surface and groundwater hydrology, rivers, and watersheds.

Learning Outcome Indicators include:
11.1   Plan and implement a program to collect, monitor, interpret, and analyze atmospheric and hydrometric data to estimate precipitation depth, precipation area, precipitation duration, evaporation, evapotranspiration, and infiltration.
11.2   Classify stream sediment load, and calculate movement rates and sediment discharge.
11.3   Evaluate the requirement for flow frequency analysis in river engineering.
11.4   Determine watershed boundaries and characteristics, drainage patterns, catchments area boundaries, and natural flow.
11.4.1 Calculate design peak flows, and estimate peak flows by flood routing techniques.
11.4.2 Identify flood plains, and recommend methods for flood damage mitigation.
11.5   Determine predicted catchment runoff, peak flows, snowmelt run-off, flood routing, and flood plains.
11.5.1 Recommend flood mitigation methods.
11.6   Analyze how nature and humans interact with rivers, including how river geometry changes with changes in flow (e.g., erosion, sediment deposition, and transport).
11.7   Analyze stream channels and drainage structures.
11.8   Evaluate criteria for hydraulic structures design, construction, maintenance, and rehabilitation.
11.9   Identify potential aquifers and aquifer characteristics by interpreting geologic, groundwater, and piezometric maps.

11.9.1 Assess groundwater levels and movement for containment and de-watering projects.
11.10   Create water well design criteria based on given geological factors and demand requirements.
11.11   Analyze precipitation records to determine probable maximum precipitation events, frequency, and relationships between frequency, intensity, and duration.
11.12   Compute and predict infiltration rates, and net storm rain and infiltration rates.
11.13   Analyze ground water hydrology and potential aquifer formations, and map water tables.

ENTY12   Waste Management
➢ Interpret and evaluate waste sources and manage waste disposal systems.

Learning Outcome Indicators include:
12.1   Classify the phases of a waste management system (generation, treatment, and disposal).
12.1.1 Identify waste sources and waste generators.
12.2   Classify waste as flammable, combustible, reactive, corrosive, toxic, or biologic.
12.3   Create a protocol to categorize and characterize typical wastes from point sources such as mineral extraction, industrial processing, agricultural land use, or municipal waste.
12.4   Create a management protocol for treating solid waste prior to disposal such as physical, chemical, biological, immobilization, chemical fixation, physical fixation, and electromagnetic separation.
12.5   Create a protocol for safe waste storage, such as deep wells and underground storage.
12.6   Create a protocol for safe storage and transport of hazardous waste in accordance with Transport Canada and provincial guidelines.
12.7   Create and apply emergency response plan for spills.
12.8   Create a protocol to manage solid, liquid, sanitary, and hazardous waste in landfills.
12.9   Create a protocol to manage incinerable wastes.
12.10 Create and manage monitoring systems for landfills and incinerator emissions.
12.11 Interpret and employ environmental auditing methods.
12.12 Create and implement concepts of risk management.
12.13 Create and implement plans for emergencies and respond effectively.