



MECHANICAL - TECHNOLOGIST (METY 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 Mechanical CTS is relevant to programs including, but not limited to, manufacturing, industrial, HVAC, mechatronics and robotics, thermodynamics, biomechanics, marine, aerospace, and automotive 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 Mechanical 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 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; and supervision of manufacturing; supervision of projects; and training activities.

Discipline Learning Outcomes (DLOs)

METY01 Mechanical Component Design

- Design, analyze, specify, and manufacture mechanical components by applying fundamentals of mechanical engineering technology.

Learning Outcome Indicators include:

- 1.1 Design and analyse mechanical components applying manual methods, automated methods, and digital technology.
- 1.2 Design and manufacture mechanical components according to optimal tolerance specifications.
- 1.3 Evaluate strength and stability of components for reliability.
- 1.4 Identify safe operating limits of design.
- 1.5 Assess and Identify properties of materials in mechanical engineering environment.
- 1.6 Create mechanical components according to specifications by programming and applying computer-aided manufacturing (CAM).
- 1.7 Test design, analyse, and manufacture mechanical components applying fundamentals of mechanical engineering.
- 1.8 Analyze materials and mechanical components using appropriate testing and measurement equipment (e.g., non-destructive testing, mechanical testing, dimensional inspection, failure analysis, or specimen machining).
- 1.9 Assess ergonomic design of mechanical components.

METY02 Engineering Design & Drawings

- Evaluate, analyze, prepare and modify mechanical engineering drawings and other related technical documents.

Learning Outcome Indicators include:

- 2.1 Analyze, prepare, and modify mechanical engineering drawings and other related technical documents for the design of mechanical components, machines, processes, and systems.
- 2.2 Generate and apply geometric dimensions, tolerances, and materials specifications.
- 2.3 Evaluate, analyze, organize and prepare relevant information, data, materials, and documents in accordance with recognized standards (e.g., CSA, ISO).
- 2.4 Specify fits and finishes.
- 2.5 Create freehand mechanical engineering sketches.
- 2.6 Create and modify engineering drawings applying current and relevant computer- based drafting techniques (CAD).
- 2.7 Resolve technical problems using computer systems and application software.

- 2.8 Access, exchange, and store data electronically applying file management techniques.
- 2.9 Interpret and validate bills of materials and revision annotations.
- 2.10 Apply drawing revision system to drawings for engineering change control.
- 2.11 Compose engineering terminology correctly and accurately in written and oral communication.

METY03 Mechanical Systems

- Design, analyze, commission, and maintain mechanical systems for industrial, commercial, and institutional (ICI) buildings.

Learning Outcome Indicators include:

- 3.1 Design, analyze, commission, and maintain heating, ventilating, and air conditioning (HVAC) equipment and systems.
- 3.2 Design, analyze, commission, and maintain building fire protection systems and controls, including sprinklers and alarms.
- 3.3 Design, analyze, commission, and maintain building plumbing systems for water, air, and other services.
- 3.4 Generate calculations in accordance with design criteria and relevant codes and standards.
- 3.5 Generate preliminary and final designs.
- 3.6 Evaluate systems performance relative to design criteria.
- 3.7 Validate system compliance/non-compliance relative to design criteria.
- 3.8 Assess and report impact of non-conformance.
- 3.9 Critique and report possible causes and correction of problems.
- 3.10 Plan and organize support in review and preparation of building system operational reports.

METY04 Manufacturing Processes

- Produce components according to specifications applying knowledge of material and engineering principles to manufacturing operations and processes.

Learning Outcome Indicators include:

- 4.1 Critique and specify conventional machining processes such as milling, turning, sawing, drilling, grinding, and honing in producing mechanical components.
- 4.2 Critique and specify metal casting processes, such as sand casting, die-casting, and investment casting for preferred design use.
- 4.3 Critique and specify metals joining processes such as arc and gas welding, resistance, and laser welding for optimal application.
- 4.4 Critique and specify sheet metal fabrication processes for optimal application.
- 4.5 Critique and specify heavy metal fabrication processes for optimal application.

- 4.6 Critique and specify manufacturing methods for plastic components such as injection, blow and other molding techniques for optimal application.
- 4.7 Produce mechanical components to required tolerances using appropriate manufacturing practices and procedures.
- 4.8 Assess and analyze performance characteristics, limitations, and potential safety aspects of machinery, tools, and equipment.
- 4.9 Plan and select fabricating, joining, assembling, fusing, and finishing processes in production of mechanical components.
- 4.10 Create mechanical components according to required specifications programming and applying computer-aided manufacturing (CAM).
- 4.11 Assess and analyze manufacturing processes using computer-controlled equipment such as vibration analysis, magnetic-particle inspection, and ultrasonic testing.
- 4.12 Select, identify, and apply material testing methods.
- 4.13 Monitor and eliminate hazards associated with manufacturing processes or end product components.
- 4.14 Plan sourcing of tools, equipment, supplies, and services related to production of mechanical components.

METY05 Manufacturing Optimization

- Select analyze and specify requirements for product and manufacturing operations to optimize manufacturability.

Learning Outcome Indicators include:

- 5.1 Assess factors affecting industrial/manufacturing decision-making by applying knowledge of machinery, tools, and other equipment in manufacturing and assembling components.
- 5.2 Specify and program machines and manufacturing processes applying computer-aided manufacturing techniques such as Computer Numerical Control (CNC).
- 5.3 Select, justify and specify manufacturing materials, methods, operations, and processes for given applications.
- 5.4 Interpret drawings and specifications of given components to select and specify manufacturing equipment or process, sequence of operations, tooling, and fixtures required to produce component for economic production.
- 5.5 Evaluate manufacturing costs for each stage of production.
- 5.6 Create process plan for defined product, including all processes that might apply, such as casting, welding and fabrication, machining, heat treatment, finishing, assembly, and inspection.
- 5.7 Specify tolerances for manufacturing, precision measuring equipment and methods to ensure product conforms to design requirement.

- 5.8 Analyze relationship between product defects and equipment setting and alignment errors.
- 5.9 Diagnose anticipate and resolve limitations of equipment, technical problems, and potential safety problems in manufacture of components and systems using a systematic approach.
- 5.10 Assess vendor capabilities, lead times, and costs.

METY06 Manufacturing Automation

- Evaluate select, specify, program, and manage manufacturing automation systems.

Learning Outcome Indicators include:

- 6.1 Analyze and apply principles of mechatronics to design and implementation of automation systems.
- 6.2 Analyze and apply principles of industrial automation and control systems.
- 6.3 Analyze capabilities and applications of different control technologies.
- 6.3.1 *Select appropriate level of automation for an application.*
- 6.4 Design, commission, and maintain automated systems including drives, actuators, mechanical controls, and control systems.
- 6.5 Design and program control system interfaces, human machine interfaces (HMI), and graphical interfaces.
- 6.6 Select, diagnose program/configure, install, and commission PLC control systems.
- 6.7 Monitor and control machines and processes by selecting, configuring and installing applications software, and communication protocols.
- 6.8 Configure, program and install supervisory control and data acquisition systems.
- 6.9 Implement plant floor web-enabled application with dynamic data exchange (DDE) between plant floor processes and Microsoft applications.
- 6.10 Create graphical model of plant floor process and integrate with Supervisory Control and Data Acquisition (SCADA) system.
- 6.11 Select, apply, and program (offline/online) robotic system for given application.

METY07 Problem Solving

- Analyze and solve complex mechanical engineering problems by applying mathematics and fundamentals of mechanical engineering technology.

Learning Outcome Indicators include:

- 7.1 Analyze and solve complex technical problems applying mathematics, such as advanced algebra, trigonometry, geometry, differential and integral calculus, and statistics, as appropriate.

- 7.2 Analyze and solve complex technical problems applying fundamentals of physics and materials science.
- 7.3 Analyze properties of fluids and solve problems involving fluid pressures dynamics of fluid flow, friction losses, and fluid viscosity.
- 7.4 Assess and apply concepts of conduction, convection, radiation, and heat transfer to resolve heat transfer and heat exchanger problems.
- 7.5 Solve problems in design, operation and maintenance of prime mover engines applying principles of power engineering.
- 7.6 Analyze and resolve problems in design and/or failure of mechanical structures.
- 7.7 Diagnose analyse, design, and manufacture automated systems and processes applying principles of mechatronics.
- 7.8 Analyze joined materials and solve problems in specification and design in materials joining.

METY08 Quality Assurance

- Evaluate, plan, coordinate, and implement quality control and quality assurance procedures to meet organizational standards and requirements.

Learning Outcome Indicators include:

- 8.1 Generate production efficiency and effectiveness by implementing quality control systems (e.g., International Organization for Standardization [ISO] series systems—ISO 9000 series, Six Sigma, or continuous improvement [Kaizen] efforts).
- 8.2 Research and understand elements in quality assurance manual.
- 8.3 Analyze quality costs to develop and implement quality improvement strategies to reduce quality costs.
- 8.4 Evaluate engineering products or services to ensure they match intended purposes, including workplace and/or customer expectations.
- 8.5 Assess, document, and report compliance with appropriate procedures and specifications.
- 8.6 Apply principles of statistical process control to manufacturing process.
- 8.7 Design and analyze reports on quality assurance and quality control data for statistical process control and planning purposes.
- 8.8 Appraise specifications applicable to engineering project and develop procedures.
- 8.9 Identify root causes of quality, uncover defects and recommend corrective measures by inspecting, sampling, and evaluating.
- 8.10 Select, calibrate, and apply appropriate measuring instruments to inspect mechanical components.
- 8.11 Interpret and evaluate results of quality assurance sampling and testing to make adjustments or changes to manufacturing processes.
- 8.12 Manage programs for supplier approvals and supplier product acceptance.

- 8.13 Plan and organize the preparation and maintenance of project-related documents and progress reports in readily retrievable manner in accordance with organizational practices.

METY09 Project Management

- Apply current industry practices of project management and business principles.

Learning Outcome Indicators include:

- 9.1 Generate strategy for management of project, based on expected life cycle and role that project might play within industrial, manufacturing, environmental, laboratory, or similar setting.
- 9.2 Interpret interplay between time, costs, and quality elements of project.
- 9.3 Apply technology project elements such as integration, scope, time, cost, quality, communications, personnel, risk, and procurement in project of defined scope.
- 9.4 Demonstrate knowledge of processes associated with initiating project.
- 9.5 Generate project charter and define constraints.
- 9.6 Plan for project of defined scope for implementing various project elements.
- 9.7 Interpret measures to control changes to the scope, schedule, cost, and quality of project.
- 9.8 Research and document project activities and tasks.
- 9.9 Organize project schedule utilizing both manual method and computerized method, such as critical path and/or Gantt chart.
- 9.10 Interpret human resource requirements of project of defined scope.

METY10 Facilities Management /Engineering

- Critique and apply principles of Facilities Management (FM) for safe, efficient and economic operation.

Learning Outcome Indicators include:

- 10.1 Evaluate benefits of preventative and predictive maintenance.
- 10.2 Create and implement preventative/predictive maintenance programs.
- 10.3 Plan, track, and record equipment maintenance using computerized systems.
- 10.4 Apply computer software to manage physical assets.
- 10.5 Monitor and control maintenance program performance and effectiveness.
- 10.6 Assess service requirements to ensure reliable and adequate supplies such as plant compressed air, steam, natural gas, and electrical power.
- 10.7 Appraise and size heating, ventilation and air-conditioning (HVAC) systems design performance, maintenance and service procedures and ensure compliance with applicable codes and standards.

- 10.8 Appraise and design fire, security, and surveillance equipment incorporating emergency response plans.
- 10.9 Appraise building maintenance needs and coordinate required work.
 - 10.9.1 *Interpret layouts, assembly drawings, and schematics for equipment installations.*
- 10.10 Plan equipment installations incorporating safe work practices.
- 10.11 Identify and arrange for provision of services for new equipment and process installations.
- 10.12 Implement installation schedules and verify completion of installation plans and procedures.
- 10.13 Estimate and coordinate manpower, specific skills/trades, and equipment requirements.
- 10.14 Analyze need for and design of in-plant equipment and processes.
- 10.15 Plan for commission of equipment and process installations.
- 10.16 Evaluate systems performance relative to design criteria.
- 10.17 Appraise and report system compliance/non-compliance relative to design criteria, impact of non-conformance, and possible causes and correction.

METY11 Mechanical Design

- Design and analyze machines mechanical equipment, systems, and processes by applying fundamentals of mechanical engineering such as machine theory, fluid mechanics, hydraulics and pneumatics, thermodynamics, and mechatronics.

Learning Outcome Indicators include:

- 11.1 Validate design criteria such as mechanical strength and endurance, costs, weight, finish, maintainability, environment, and applicable codes and standards through analysis.
- 11.2 Select materials based on their properties to meet design criteria and evaluate their performance in engineering environment.
- 11.3 Plan fabricating, joining, assembling, fusing, and finishing processes in production of mechanical components.
- 11.4 Maintain a process variable at desired value or within desired range of values applying control system fundamentals.
- 11.5 Design and maintain mechanical components, processes, and systems applying electrical/electronic fundamentals.
- 11.6 Select and access relevant technical information from various sources (e.g., technical manuals, software and other media, the Internet, suppliers, or coworkers).
- 11.7 Design, implement, monitor, and report on experimental operations using advanced procedures.
- 11.8 Research and design assembly/disassembly instructions.

- 11.9 Analyze technical drawings and other technical documents used in design of components, processes, and systems.
- 11.10 Analyze and design components, machinery, processes, and systems applying principles such as mechanics and strength of materials, electrical and electronic control, hydraulics and pneumatics, and ergonometics.
- 11.11 Evaluate strength and stability of structures and components addressing stress factors such as fatigue, temperature, fluctuating and reversing loads, torque vibration energy, and other external and internal forces.
- 11.12 Generate basic stress analysis on designed parts using computer software programs.
- 11.13 Evaluate design alternative and justify preferred designs.
- 11.14 Analyze action of machines and machine elements with respect to work, energy, power, efficiency, safety, and liability.
- 11.15 Specify linear and geometric dimensions and tolerance for machine components, assemblies, and processes.

METY12 Bulk Material Processing and Handling Equipment

- Design, analyze, and specify bulk material processing and handling equipment. Prepare graphics, specifications, and technical documentation pertaining to equipment and plant layouts.

Learning Outcome Indicators include:

- 12.1 Apply appropriate physical science concepts and explain general bulk materials beneficiation processes (may include crushing, separation, settling, mixing, reactors [thermal, chemical or electrical], centrifuging, drying, shaping, and sizing).
- 12.2 Analyse process flow diagrams and generate them using industry-standard presentation procedures.
- 12.3 Identify and explain common processing equipment indication, monitoring, and control strategies, including inter-locking and start-up/shut-down sequencing.
- 12.4 Select, design, and specify dry bulk material conveying and handling equipment, using industry standard sizing/selection software where applicable (may include belt, screw, drag and chain conveyors/feeders, bucket elevators, chutes, and gates).
- 12.5 Select, design and specify wet bulk material conveying and handling equipment such as slurry pumps and piping systems, process tanks, and mixers and launders using industry-standard sizing/selection software
- 12.6 Interpret industrial building and safety codes and standards.
 - 12.6.1 *Apply the above to equipment layouts and fabrications.*
- 12.7 Design and prepare plant layouts, using accepted industry presentation techniques and adhering to process, safety, and personnel and maintenance access requirements.

- 12.8 Interpret vendor and manufacturer drawings, models, and specifications.
 - 12.8.1 *Evaluate equipment performance.*
- 12.9 Interpret stages of engineering projects and identify principles of construction management and process.
- 12.10 Estimate and schedule tasks using industry standard application software.

Copyright in the CTS are 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.