Ontario College of Teachers

Ordre des enseignantes et des enseignants de l'Ontario

Additional Qualification Course Guideline Teaching Manufacturing Technology - Robotics and Control System

Schedule F
Teachers' Qualifications Regulation

December 2014

Ce document est disponible en français sous le titre *Ligne directrice du cours menant à la qualification additionnelle Technologie des systèmes informatiques — Robotique et système de commande*, decembre 2014.

Additional Qualification Course Guideline

1. Introduction

The guideline for Teaching Manufacturing Technology - Robotics and Control System is organized using the following framework.

Diagram 1: Guideline Organization

Teachers are able to take the Additional Qualification course: Teaching Manufacturing Technology - Robotics and Control System if they hold a technological education qualification at Grades 9 and 10 or Grades 11 and 12 in the broad-based area of Teaching Manufacturing Technology.

The Additional Qualification Course: Teaching Manufacturing Technology - Robotics and Control System employs a critical, pedagogical lens to explore in holistic and integrated manner theoretical foundations, development of learners, program planning and implementation, instructional practices, assessment and evaluation, the learning environment and ethical considerations related to teaching and learning.

The Ontario College of Teachers recognizes that candidates working in the publicly funded school system, independent/private institutions or First Nations schools will have a need to explore topics and issues of particular relevance to the context in which they work or may work.

Critical to the implementation of this course is the creation of positive learning experiences that reflect care, diversity and equity. This course supports the enhancement of professional knowledge, ethical practice, leadership and ongoing learning.

The French language and the English language communities will also need to implement these guidelines to reflect the unique contextual dimensions and needs of each community. Each of these language communities will explore the guideline content from distinct perspectives and emphasis. This flexibility will enable both language communities to implement Teaching Manufacturing Technology - Robotics and Control System as understood from a variety of contexts.

The Teaching Manufacturing Technology - Robotics and Control System additional qualification course guideline provides a conceptual framework for providers and instructors to develop and facilitate the Teaching Manufacturing Technology - Robotics and Control System course. The guideline framework is intended to be a fluid, holistic and integrated representation of key concepts associated with Teaching Manufacturing Technology - Robotics and Control System.

2. Regulatory Context

The College is the self-regulating body for the teaching profession in Ontario. The College's responsibility related to courses leading to additional qualifications includes the following:

- to establish and enforce professional standards and ethical standards applicable to members of the College
- to provide for the ongoing education of members of the College
- to accredit additional qualification courses or programs and more specifically,

  The program content and expected achievement of persons enrolled in the program match the skills and knowledge reflected in the College's Standards

of Practice for the Teaching Profession and the Ethical Standards for the Teaching Profession and in the program guidelines issued by the College. (*Accreditation of Teacher Education Programs Regulation*, Part IV, Subsection 24).

Additional qualifications for teachers are identified in the *Teachers' Qualifications Regulation*. This regulation includes courses/programs that lead to Additional Qualifications, the Principal's Qualifications and the Supervisory Officer's Qualifications. A session of a course leading to an additional qualification shall consist of a minimum of 125 hours as approved by the Registrar. Accredited additional qualification courses reflect the *Ethical Standards for the Teaching Profession,* the *Standards of Practice for the Teaching Profession* and the *Professional Learning Framework for the Teaching Profession.*

The course developed from this guideline is open to candidates who meet the entry requirements identified in the *Teachers' Qualifications Regulation*.

Successful completion of the course leading to the Additional Qualification: Teaching Manufacturing Technology - Robotics and Control System, listed in Schedule F of the *Teachers' Qualifications Regulation* is recorded on the Certificate of Qualification and Registration. Successful completion of three schedule F courses within a specific broad-based technology area will be deemed to be equivalent to one specialist or honour specialist qualification for purposes of entry into the principal's qualification or the supervisory officer qualification. (O. Reg. 176/10 S.49 (4) and (5))

In this document, all references to candidates are to teachers enrolled in the additional qualification course. References to students indicate those enrolled in school programs.

3. Foundations of Professional Practice

The *Foundations of Professional Practice* conveys a provincial vision of what it means to be a teacher in Ontario. This vision lies at the core of teacher professionalism. The *Ethical Standards for the Teaching Profession* and the *Standards of Practice for the Teaching Profession* (Appendix 1) are the foundation for the development and in the realization of the Additional Qualification course. These nine standards, as principles of professional practice, provide the focus for ongoing professional learning and are the foundation for the

development and implementation of the Additional Qualification Course: Teaching Manufacturing Technology - Robotics and Control System. In addition, the *Professional Learning Framework for the Teaching Profession* is underpinned by the standards, articulates the principles on which effective teacher learning is based and acknowledges a range of options that promote continuous professional learning. The ongoing enhancement of informed professional judgment, which is acquired through the processes of lived experience, inquiry, and reflection, is central to the embodiment of the standards and the Professional Learning Framework within this AQ course and professional practice.

The *Ethical Standards of the Teaching Profession* and the *Standards of Practice for the Teaching Profession* serve as guiding frameworks that underpin professional knowledge, skills and experiences that teachers require in order to teach effectively within and contribute to an environment that fosters *respect, care, trust* and *integrity.*

Teacher-Education Resources

The College has developed resources to support the effective integration of the standards within Additional Qualification courses and programs. These teacher education resources explore the integration of the standards within professional practice through a variety of educative, research and inquiry-based processes. This guideline has been designed to reflect the *Ethical Standards for the Teaching Profession* and the *Standards of Practice for the Teaching Profession*and the *Professional Learning Framework for the Teaching Profession.*These resources can be found on the College web site (www.oct.ca). These resources support the development of professional knowledge and professional judgment through reflective practice. The lived experiences of Ontario educators are illuminated in the resources and serve as AQ course support for teacher education.

4. Conceptual Framework

The design, course content and implementation of the Additional Qualification Course Guideline: Teaching Manufacturing Technology - Robotics and Control System support effective teacher education practices. These course guideline components provide a conceptual framework for the development of a holistic, integrated, experiential and inquiry-based course. The following conceptual framework supports and informs professional knowledge, judgment and practices

within the Additional Qualification Course: Teaching Manufacturing Technology - Robotics and Control System.

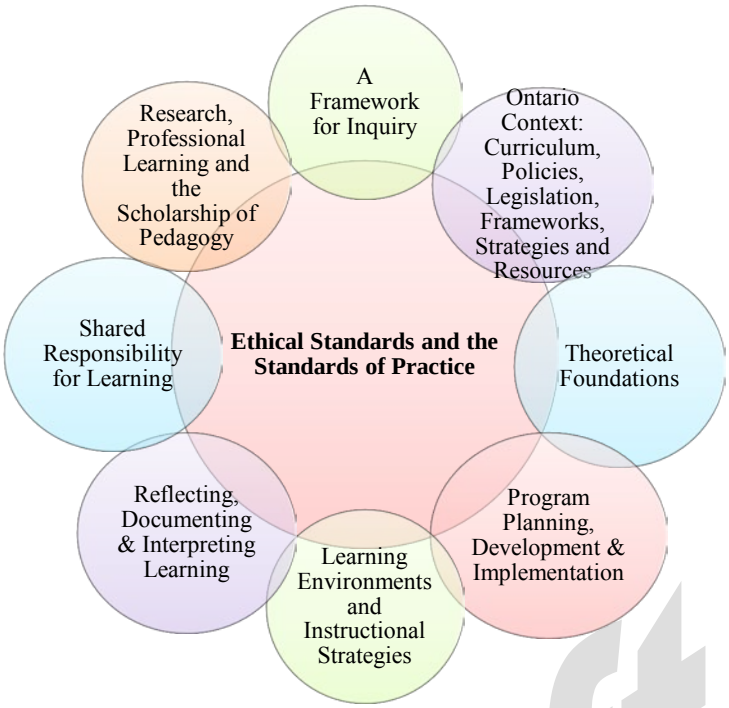

Diagram 2: Conceptual Framework for Teaching Manufacturing Technology - Robotics and Control System

A. The *Ethical Standards for the Teaching Profession* and the *Standards of Practice for the Teaching Profession*:

The *Ethical Standards for the Teaching Profession* and the *Standards of Practice for the Teaching Profession* represent a collective vision of professional practice. At the heart of a strong and effective teaching profession is a commitment to students and their learning. Members of the Ontario College of Teachers, in their position of trust, demonstrate responsibility in their relationships with students, parents, guardians, colleagues, educational partners, other professionals, the environment and the public.

The holistic integration of the standards within all course components supports the embodiment of the collective vision of the teaching profession that guides

professional knowledge, learning, and practice. The following principles and concepts support this holistic integration within the AQ course.

- understanding and embodying care, trust, respect and integrity
- fostering commitment to students and student learning
- integrating professional knowledge
- enriching and developing professional practice
- supporting leadership in learning communities
- engaging in ongoing professional learning.

Through professional dialogue, collaborative reflection and an ethical culture, course candidates will continue to critically inquire into and refine professional practice and ethical culture through the lens of the *Standards of Practice for the Teaching Profession*.

B. A Framework for Inquiry

The *Ethical Standards for the Teaching Profession* and the *Standards of Practice for the Teaching Profession* are embedded throughout the Additional Qualification course guideline.

This Additional Qualification course supports critical reflective inquiry and dialogue informed by the following:

- analyzing, interpreting and implementing Ontario's curriculum, district school board policies, frameworks, strategies and guidelines related to the Broad Based Technology
- developing awareness of First Nations, Métis and Inuit ways of knowing and perspectives
- extending theoretical understanding to design, implement and assess practices and/or programs
- implementing pedagogical strategies and assessment and evaluation practices that are linked to expectations, meet the individual needs of students, and promote student learning

- creating holistic learning environments conducive to the intellectual, social, emotional, physical, linguistic, cultural, spiritual and moral development of students
- working collaboratively with school personnel, parents/guardians, caregivers, the community, local business and industry as it relates to Teaching Manufacturing Technology - Robotics and Control System
- exercising leadership in accessing a variety of resources, including technological resources, within and beyond the educational system to enhance and support student learning
- refining professional practice through ongoing collaborative inquiry, dialogue and reflection
- modelling ethical practices and addressing ethical issues
- critically exploring and integrating environmentally sustainable practices
- fostering responsible, active environmental citizenship
- collaboratively developing and sustaining professional learning communities for enhancing professional knowledge and supporting student learning
- fostering leadership in the integration of information and communication technology to enhance teaching and learning
- critically exploring innovative strategies to create and sustain safe, healthy, equitable and inclusive learning environments that honour and respect diversity and foster student learning
- understanding the importance of critically examining qualitative and quantitative research related to professional practice
- critically exploring strategies to understand, gain insight into and support learners' well-being and mental health needs
- working collaboratively with interdisciplinary school teams to develop and implement Individual Education Plans (IEPs) of students
- exploring strategies that contribute to a culture that promotes openness to innovation and change
- demonstrating an awareness of emerging technologies related to Teaching Manufacturing Technology - Robotics and Control System
- demonstrating an awareness of health and safety risks associated with Teaching Manufacturing Technology - Robotics and Control System

- applying knowledge and skills to create and maintain a safe learning environment that addresses program needs: curriculum, material handling, tool handling and equipment storage, supervision, safety standards and practices that are respectful of the environment
- demonstrating technological literacy related to Teaching Manufacturing Technology - Robotics and Control System
- writing technical reports and creating and managing portfolios
- demonstrating mathematical literacy in Teaching Manufacturing Technology - Robotics and Control System
- demonstrating an understanding of business management and entrepreneurial practices related to Teaching Manufacturing Technology - Robotics and Control System
- inquiring into practice through reflection, active engagement and collaboration
- understanding the various professional practices and career opportunities in Teaching Manufacturing Technology - Robotics and Control System
- critically exploring the relationship between education, mental health and well-being
- identifying ways to modify expectations, instructional strategies and assessment practices in Teaching Manufacturing Technology - Robotics and Control System.

C. Ontario Context: Curriculum, Policies, Legislation, Frameworks, Strategies and Resources

The Additional Qualification Course: Teaching Manufacturing Technology - Robotics and Control System is aligned with current Ontario curriculum, relevant legislation, government policies, frameworks, strategies and resources. These documents inform and reflect the development and implementation of the Additional Qualification Course: Teaching Manufacturing Technology - Robotics and Control System and can be viewed at www.edu.gov.on.ca.

Course candidates are also encouraged to critically explore the policies, practices and resources available at school and board levels that inform teaching and learning related to Teaching Manufacturing Technology - Robotics and Control System.

D. Theoretical Foundations of Teaching Manufacturing Technology - Robotics and Control System

- understanding theories of student development (social, emotional, physical, intellectual, linguistic, cultural, spiritual and moral)
- understanding Ontario curriculum, resources and government policies, frameworks and strategies related to Teaching Manufacturing Technology - Robotics and Control System
- understanding learning theories and the particular learning needs of the adolescent in the Intermediate and Senior Divisions
- critically exploring a variety of conceptual frameworks related to Teaching Manufacturing Technology - Robotics and Control System
- reflecting on teaching practice and engaging in professional dialogue regarding the relationship between theory and practice
- integrating the *Ethical Standards for the Teaching Profession* and the *Standards of Practice for the Teaching Profession* as the foundation for teacher professionalism within the Additional Qualification Course: Teaching Manufacturing Technology - Robotics and Control System
- critically exploring the significance of relevant legislation including the Ontario Human Rights Code, Ontarians with Disabilities Act, and the Accessibility for Ontarians with Disabilities Act (AODA) and associated responsibilities within professional practice
- recognizing teachers' legal obligations and ethical responsibilities according to current provincial legislation
- critically inquiring into the dimensions associated with creating and sustaining safe learning environments
- critically exploring holistic and inclusive educational programs that build on learners' abilities and empower them to reach their learning goals
- critically exploring problem solving processes, methods and approaches as they relate to Teaching Manufacturing Technology - Robotics and Control System
- critically exploring the fundamental technological concepts in Teaching Manufacturing Technology - Robotics and Control System.

E. Program Planning, Development and Implementation

- applying the *Ethical Standards for the Teaching Profession* and the *Standards of Practice for the Teaching Profession* to inform a program planning framework
- critically exploring the influence of society's diverse and changing nature on student learning and well-being
- deepening understanding of program planning, development, implementation strategies and frameworks related to Teaching Manufacturing Technology - Robotics and Control System
- deepening understanding of differentiated instruction, universal design and the tiered approach in program planning, development and implementation
- critically exploring learning resources (for example, print, visual, digital) that support student learning
- understanding the types of secondary school pathways (including apprenticeship, college, university, workplace) and their relationship to students' post-secondary goals and career opportunities
- critically exploring how students' lived experiences, development, strengths, interests and needs can inform program planning, development and implementation
- integrating culturally responsive pedagogy within program planning and development
- critically exploring strategies that support learners' well-being and mental health needs
- planning instructional strategies that integrate students' learning styles, strengths and experiences
- demonstrating leadership in implementing local and provincial guidelines and policies that support safe and effective learning environments
- inspecting and reporting on the learning environment, facilities, equipment needs, resources and state of maintenance and repair for delivering Teaching Manufacturing Technology - Robotics and Control System
- applying the theoretical foundations of Teaching Manufacturing Technology - Robotics and Control System by incorporating the broad-based pedagogical approach that embeds problem solving and the fundamental technological concepts

- identifying the safe, ethical and legal use of technology in Teaching Manufacturing Technology - Robotics and Control System programs
- critically exploring and integrating multiple formal and informal assessment methods and data to inform program planning and support student learning.

F. Learning Environments and Instructional Strategies

- creating and sustaining positive, ethical, equitable, accepting and safe learning environments
- critically exploring strategies for fostering a collaborative community of empowered learners
- fostering engaging, trusting and inviting learning environments that promote student voice, leadership, critical inquiry and self-regulation
- critically exploring a variety of instructional strategies to support student learning
- developing strategies to create a positive and collaborative learning environment to support student learning
- cultivating safe, ethical and respectful practices in the use of technology in purposeful and legal ways
- integrating information and communication technologies that support student learning
- providing leadership in adapting instruction to meet the needs of all learners
- critically exploring strategies that engage students as active citizen in supporting environmental, social and economic sustainability
- using pedagogies that reflect the professional identity of educators as described in the *Ethical Standards for the Teaching Profession* and the *Standards of Practice for the Teaching Profession* and in the *Foundations of Professional Practice*
- creating inclusive learning environments that reflect the ethical standards and standards of practice
- implementing safe and effective management of a variety of technical learning environments

- planning, organizing and implementing effective health, safety, sanitation and environmental standards in the Teaching Manufacturing Technology - Robotics and Control System facility
- demonstrating an understanding of facility design and maintenance practices as per industry standards
- understanding and complying with workplace health and safety legislation and standards related to Teaching Manufacturing Technology - Robotics and Control System.

G. Reflecting, Documenting and Interpreting Learning

- collaboratively integrating fair and equitable, transparent, valid and reliable assessment and evaluation methods that honour the dignity, emotional wellness and cognitive development of all students
- critically exploring and collaboratively integrating assessment, evaluation and reporting practices that align with the principles and processes of Ontario's curriculum, frameworks and policy documents
- using assessment for the following three purposes: to provide feedback to students and to adjust instruction (assessment for learning); to develop students' capacity to be independent, autonomous learners (assessment as learning); to make informed judgements about the quality of student learning (assessment of learning)
- critically exploring the use of baseline data as well as current assessment data to reflect on how the students are progressing and the effectiveness of the learning strategies used.

H. Shared Responsibility for Learning

- critically exploring and collaboratively integrating a variety of effective communication and engagement strategies for authentic collaboration with parents/guardians, school/board personnel and community agencies
- critically exploring and engaging in strategies and opportunities for professional collaboration that supports student learning and well-being
- collaboratively designing programs that address biases, discrimination and systemic barriers in order to support student learning, well-being and inclusion

- fostering and sustaining a positive, inclusive educational culture in which all perspectives are encouraged, valued and heard
- understanding and respecting the importance of shared responsibility and partnership as conveyed in the standards and the Foundations of Professional Practice
- developing strategies to establish links between the school community, industry and the Teaching Manufacturing Technology - Robotics and Control System program
- critically exploring sector-specific learning opportunities in other curriculum areas
- critically exploring professional collaboration within interdisciplinary teams to support student learning, self-advocacy and transitions.

I. Research, Professional Learning and the Scholarship of Pedagogy

- critically exploring past, present and evolving practices in Teaching Manufacturing Technology - Robotics and Control System
- critically exploring professional practice through ongoing inquiry into theory and pedagogy/andragogy
- engaging in professional learning through research, scholarship and leadership
- integrating research and the scholarship of pedagogy/andragogy into teaching practice
- collaborating in research and the scholarship of pedagogy/andragogy
- critically exploring knowledge-creation and mobilization as professional practice.

5. Instructional Practice in the Additional Qualification Course: Teaching Manufacturing Technology - Robotics and Control System

Candidates will collaboratively develop with course instructors the specific learning inquiries, learning experiences, and forms of assessment and evaluation that will be used throughout the course.

In the implementation of this Additional Qualification course, instructors use strategies that are relevant, meaningful and practical in providing candidates with learning experiences about instruction, pedagogy and assessment and evaluation. These include but are not limited to: experiential learning, small group interaction; action research; presentations; independent inquiry; problem solving; collaborative learning and direct instruction.

Instructors model the *Ethical Standards of the Teaching Profession* and the *Standards of Practice for the Teaching Profession*, honour the principles of adult learning, recognize candidates' experience and prior learning and respond to individual needs. Important to the course are opportunities for candidates to create support networks and receive feedback from colleagues and instructors and share the products of their learning with others. Opportunities for professional reading, reflection, dialogue and expression are also integral parts of the course.

Instructors model effective instructional and assessment strategies that can be replicated or adapted in a variety of classroom settings.

A. Experiential Learning

Candidates will be provided with opportunities to engage in experiential learning related to key concepts and aspects of Teaching Manufacturing Technology - Robotics and Control System as collaboratively determined by both the instructor and course candidates. The intent of the experiential learning opportunities is to support the application and integration of practice and theory within the authentic context of teaching and learning. Candidates will also engage in critical reflection and analysis of their engagement in experiential learning opportunities related to Teaching Manufacturing Technology - Robotics and Control System. The professional judgment, knowledge and pedagogy of candidates will be enhanced and refined through experiential learning and inquiry.

The College's standards resources help to support experiential learning through various forms of professional inquiry.

6. Assessment and Evaluation of Candidates

At the beginning of the course, candidates will collaboratively develop with course instructors the specific learning inquiries, learning experiences, and forms of assessment and evaluation that will be used throughout the course. Instructors

will provide opportunities for regular feedback regarding candidates' progress throughout the course.

A balanced approach to candidate assessment and evaluation is used. It includes the combination of candidate self and peer assessment, as well as instructor evaluation. The assessment and evaluation strategies reflect effective, collaborative and inquiry-based practices. A variety of assessment approaches will be used that enable candidates to convey their learning related to course inquiries. The course provides opportunities for both formative and summative assessment and evaluation.

Central to candidates enrolled in Additional Qualification courses is the opportunity to be engaged in relevant and meaningful inquiries. Assignments, artefacts and projects enable candidates to make connections between theory and practice. At the same time, assignments must allow candidates flexibility, choice and individual inquiry opportunities.

Part of the evaluation process may include a major independent project or action research component over the duration of the course. This project is an opportunity for candidates to illustrate a high level of professional knowledge, communication skills, pedagogy, ethical practices and instructional leadership. Similarly, if a portfolio assignment is used it will also include reflections and analysis of a candidate's learning over time.

A final culminating experience in the course is recommended. This experience may take the form of a written assessment, a research paper, a performance, an inquiry project or a product that is original, meaningful and practical.

The following list of assessment strategies which are reflective of experiential learning is not exhaustive; it is intended to serve as a guide only.

a) Performance assessment: designing a sample unit which includes a culminating activity and appropriate assessment and evaluation tools, incorporates a variety of technologies and resources relevant to the study of Teaching Manufacturing Technology - Robotics and Control System, and is based on Ministry of Education expectations

b) Written assignment: reflecting critically on issues arising from articles, publications, research and/or other resources related to the teaching or

practice to Teaching Manufacturing Technology - Robotics and Control System

c) Presentation: developing a digital story, presenting an issue related to the teaching and learning related to Teaching Manufacturing Technology - Robotics and Control System

d) Portfolio: creating a portfolio of practical resources, artefacts, photographs and recording critical reflections for one or several components related to Teaching Manufacturing Technology - Robotics and Control System

e) Action research: engaging in action research by reflecting and acting upon a specific inquiry into teaching practice related to Teaching Manufacturing Technology - Robotics and Control System

f) Independent project: addressing any aspect of the course that is approved by the instructor

g) Instructional resource: developing a meaningful resource that will support instruction and pedagogy related to the teaching and learning of Teaching Manufacturing Technology - Robotics and Control System

h) Reflective writing: reflecting on professional practice through journal-writing, or writing a case or vignette that will support instruction and pedagogy related to the teaching and learning of Teaching Manufacturing Technology - Robotics and Control System

i) Case inquiry: writing or exploring a case related to collaboration and shared partnerships, with parents, colleagues, and community organizations

j) IEP development: collaboratively develop an IEP related to Teaching Manufacturing Technology - Robotics and Control System with the family, student and school team

k) Facilitating a Learning Experience: developing and implementing an engaging learning experience that reflects differentiated instruction and universal design and the tiered approach.

7. Demonstrated Knowledge and Skill in Teaching Manufacturing Technology - Robotics and Control System

Successful candidates will be able to demonstrate technical knowledge and skill in the following:

	Manufacturing Technology Fundamentals	Manufacturing Technology Skills
Manufacturing Business Operations	**Be able to demonstrate an understanding of:** ▪ secondary manufacturing industries and the processes and technologies related to them. **Be able to recognize and identify:** ▪ titles on a typical manufacturing organizational chart; ▪ titles in a typical engineering department. **Be able to identify and describe:** ▪ the roles and responsibilities of engineers and skills; ▪ trades within the organization related to robotics and controls engineering.	
Design Process	**Be able to demonstrate an understanding of:** ▪ the steps in the design process and how robotics and control Engineers make use of it; (for example, describing the situation, developing design criteria, generating solutions, research, communicating ideas,	**Be able to demonstrate proficiency in using:** ▪ the design process to plan and develop products or processes with a focus on robotics and control systems; ▪ critical thinking skills to design the most practical and efficient solution.

	evaluating solutions, using the critical analysis process, Design for Manufacture); ▪ the process of building a prototype based on conceptual design (for example, 3D modeling, 3D printing, scaled/simplified models); ▪ practical design considerations (for example, ergonomics, product life cycle, maintenance, assembly); ▪ reverse engineering and how it can assist in problem solving through the application of the technological concepts; ▪ mechanical and electrical engineering design and drawing standards. **Be able to list and describe:** ▪ the technological concepts and how important they are in the robotic design process; ▪ sources of technical and mechanical design information (for example, Machinery's Handbook, technical books and magazines, Internet); ▪ types of design models (for example, conceptual, physical, virtual, theoretical) typically used by Mechanical Engineers. **Be able to describe:** ▪ various forms of communication, technical drawings and design documentation that are	**Be able to use:** ▪ various research methods and strategies to gather, organize, and interpret engineering information from appropriate resources. **Be able to create and present:** ▪ research reports and design concepts; ▪ brainstormed design ideas graphically; ▪ technical reports. **Be able to create and evaluate:** ▪ process design control systems models (for example, process flow diagrams, schematics); ▪ robot prototypes using advanced engineering practices and design principals. **Be able to solve:** ▪ related challenges arising from the prototype production. **Be able to create, read and interpret:** ▪ engineering drawings along with product and process specifications to develop solutions to robotics challenges in manufacturing technology; ▪ orthographic, isometric, pictorial and schematic technical working drawings with the use of computer aided design using engineering standards (for example, geometric tolerancing, section views, symbols).

	used in the development of product and process ideas.	**Be able to design and assemble:** ▪ a robot prototype and analyze its functionality and efficiency.
Project Planning and Management	**Be able to demonstrate an understanding of:** ▪ production planning and control techniques; ▪ production optimization; ▪ project managerial control systems (for example, marketing, production tracking, routing, financial, budget control); ▪ time management (for example, project scheduling, resource allocation, process flow time, production efficiency, production, labour standard development critical path analysis, GANTT charts, time sheets); ▪ project management and process planning software. **Be able to identify and describe:** ▪ a robotic and control engineer's role in process planning including the design and engineering of production equipment and processes to optimize a manufacturing enterprise.	**Be able to plan, create and present:** ▪ a production process plan that includes material flow, production layout, quality control, facility layout, routing, appropriate control systems and cost analysis in the design and production of a robot or control system.
Control Systems	**Be able to identify and describe:** ▪ a variety of mechanical and control systems (for example, robotic arm, drive system, lifting device, electronic, pneumatic,	**Be able to design:** ▪ appropriate control systems for robotic functionality and control.

	hydraulic, mechanical, Programmable Logic Control (PLC), digital sensors, closed loop feedback control). **Be able to demonstrate an understanding of:** ▪ Computer Numerical Control (CNC) equipment; and associated programming; ▪ Computer Aided Manufacturing (CAM) ▪ Programmable Logic Controller (PLC); ▪ suitable robotic control systems (for example, electronic, pneumatic, hydraulic and mechanical); ▪ tele-operated control to control robot movement; ▪ autonomous control to control robot movement.	**Be able to safely and appropriately use/operate:** ▪ power control and automation systems; ▪ computers to operate and control systems; ▪ computer software/hardware to create, operate and control product/process design and production; ▪ suitable robotic control systems (for example, electronic, pneumatic, hydraulic and mechanical). **Be able to program and use:** ▪ teleoperated control to control robot movement; ▪ autonomous control to control robot movement; ▪ Programmable Logic Control (PLC); ▪ digital sensors and feedback in control systems.
Material Selection, Conversion and Preparation	**Be able to demonstrate an understanding of:** ▪ the processes for making material conversions (for example, joining, cutting, forming, fastening, changing structural properties); ▪ processes of converting the structure of a material (for example, heat treating, annealing, steaming, tempering) ▪ different type of ferrous and non-ferrous materials and their properties; ▪ the study of metallurgy in terms of mechanical properties and processes;	**Be able to list, evaluate, select and use:** ▪ suitable materials for fabricating products based on design specifications and the intended use of products based on material properties (for example, cost, strength, density, heat capacity, malleability, electrical properties, chemical properties, availability, machinability). **Be able to safely use:** ▪ a variety of tools and equipment for joining, cutting, separating, testing and forming materials.

	▪ destructive and non-destructive tests to evaluate material; ▪ material selection process as it relates to design specifications (for example, cost, strength, density, availability, electrical and chemical properties).	
Material Handling Systems	**Be able to demonstrate an understanding of:** ▪ different methods of handling/delivering materials (for example, hoist, carts, automated guided vehicles, manipulators, conveyors, fork trucks).	**Be able to evaluate, select and use:** ▪ appropriate material handling methods for various types of raw and finished materials.
Tools, Equipment and Materials	**Be able to demonstrate an understanding of:** ▪ the function, purpose, and operation of machine tools, equipment and technologies; ▪ layout and set-up tools; ▪ advanced measuring tools; ▪ computer numerical control equipment and conventional plasma cutting, engine lathes and milling machines; ▪ water jet and laser technology; ▪ 3D printing; ▪ material properties; ▪ tools and equipment selection process; ▪ fabrication processes; ▪ quality control tools (for example, Coordinate Measuring Machine (CMM), functional test equipment, radiography).	**Be able to safely and appropriately select and use/operate:** ▪ hand tools, machine tools and equipment; ▪ layout and set-up tools; ▪ advanced measuring and metrology tools; ▪ apply appropriate tools, machines and equipment to fabricate the final product; ▪ computers to operate and control manufacturing systems. (for example, robotics, Computer Numerical Control, Programmable Logic Control); ▪ a variety of appropriate hand and machine tools in the assembly or fabrication of a product or process; ▪ appropriate tools, machines, equipment and processes to fabricate the final product.

Quality Assurance	**Be able to identify and describe:** ▪ quality assurance standards with reference to governing organizations (for example, Canadian Standards Association (CSA), International Organization for Standardization (ISO), Canadian Chapter of the Society of Quality Assurance (CCSQA)); ▪ tolerancing methods for design and production processes. **Be able to describe:** ▪ quality control processes and systems (for example, statistical process control (SPC), International Organization for Standardization (ISO), inspections and test plans).	**Be able to apply:** ▪ quality inspection and testing procedures in accordance to design specifications; ▪ metrology skills to measure, lay out and inspect a product; ▪ be able to manage and control quality using industry standard techniques. **Be able to analyze and report:** ▪ production results in a manufacturing process. **Be able to use:** ▪ a quality control method (for example, statistical process control) to monitor and record the reliability of a manufacturing process.
Technological Literacy and Numeracy	**Be able to recognize and demonstrate an understanding of:** ▪ appropriate technical language and forms of communications; ▪ appropriate tools for documenting, reporting, and presenting ideas and results; ▪ the components of a technical report (for example, prepare and present proposals, specifications, flow charts, efficiency reports, cost analysis, designs, operations management).	**Be able to select and apply:** ▪ appropriate mathematic, scientific and technological concepts to produce a product or design. **Be able to select and use:** ▪ a variety of communications techniques and tools to present product and/or process designs; ▪ supporting documents including design layouts, presentation drawings, technical reports and cost analysis to present design. **Be able to interpret, prepare and present:** ▪ engineering reports using appropriate technical

	Be able to identify and describe: ▪ engineering reporting styles and formats.	language. **Be able to select and use:** ▪ a variety of communications techniques and tools to present product and/or process designs; ▪ supporting documents including design layouts, presentation drawings, technical reports and cost analysis to present design. **Be able to demonstrate and apply:** ▪ effective group work skills; ▪ problem solving skills; ▪ interpersonal communication skills; ▪ critical thinking and analysis skills.
Science Engineering Fundamentals	**Be able to understand:** ▪ properties of solids; ▪ properties of liquids; ▪ properties of gases; ▪ force and motion (for example, Newton's laws); ▪ simple machines; ▪ electricity and magnetism; ▪ design mechanics; ▪ gear ratio concepts and calculations; ▪ power, torque and efficiency calculations. **Be able to identify and describe:** ▪ mathematical, scientific and technological concepts.	**Be able to select and apply:** ▪ appropriate mathematic, scientific and technological concepts to produce and evaluate designs and products.

Technology and The Environment	**Be able to demonstrate an understanding of:** ▪ environmental impact (negative and positive) of manufacturing processes; ▪ mechanical/robotics engineer's ethical and professional standards; ▪ manufacturing/producing robotic components; ▪ industrial waste streams and methods of reducing and recycling. **Be able to identify and describe:** ▪ a variety of energy sources; ▪ carbon footprint of a manufactured product; ▪ modern energy sources and methods of improving sustainability.	**Be able to assess, compare, and select:** ▪ energy sources that minimize carbon footprints and improve efficiency and sustainability in robotic design and production. **Be able to advocate for, follow and model:** ▪ environmentally responsible practices throughout the design and manufacturing of a robot.
Technology and Society	**Be able to explain how:** ▪ globalization of the manufacturing and robotics industries and impacts jobs and job opportunities; ▪ the importance robotics and control systems play in manufacturing in today's workplace; ▪ emerging manufacturing technologies impact the local, provincial, and national economy . **Be able to describe:** ▪ the social and economic impact of technology and robotics related to manufacturing activities.	**Be able to research and report on:** ▪ political, economic, cultural and environmental issues and their impact on the manufacturing industry and the use of robotics and control systems; ▪ changing, evolving and future trends related to robotics in the local manufacturing sector.

Health and Safety	**Be able to demonstrate an understanding of:** ▪ specific components of legislation and standards related to workplace safety in the manufacturing industry; ▪ the Workplace Hazardous Material Information System; ▪ the importance of a safe work environment.	**Be able to promote and model:** ▪ safe and productive work practices (for example, general shop safety, WHMIS, fire safety); ▪ good housekeeping; ▪ specific robotic and control system related safety; ▪ specific machine and hand tool related safety. **Be able to demonstrate:** ▪ the skills required to safely operate machine tools.
Career Opportunities	**Be able to recognize and describe:** ▪ professional associations related to the manufacturing industry (for example, Engineers, Technicians and Technologists, Ontario College of Trades); ▪ the requirements for professional designations in the manufacturing and robotics industries (for example, Professional Engineer, Engineering Technologist). **Be able to identify and compare:** ▪ a variety of career opportunities related to manufacturing robotics and control systems (for example, technician, technologist, professional engineer, machinist, tool and die, industrial mechanic); ▪ post-secondary education pathways relating to robotics and control systems (for example, apprenticeship, college, university,	**Be able to create, assemble and present:** ▪ an up-to-date portfolio that may include pieces of work (for example, engineering logs, models/prototypes, drawings) and supporting documents (for example, time management charts, routing, cost analysis). **Be able to demonstrate and apply:** ▪ the essential workplace skills required to be successful in the manufacturing and robotics industry (for example, Ontario Skills Passport); ▪ the work habits required to be successful in the manufacturing and robotics industry (for example, working safely, team work, reliability, initiative, customer service and entrepreneurship and other work habits as found in the Ontario Skills Passport).

	specialized certification); ▪ secondary school opportunities and pathways (for example, OYAP, SHSM); ▪ personal skill sets, interests and goals and how they connect to careers in the manufacturing and robotics industries.	

Appendix 1

The *Ethical Standards for the Teaching Profession*

The *Ethical Standards for the Teaching Profession* represent a vision of professional practice. At the heart of a strong and effective teaching profession is a commitment to students and their learning. Members of the Ontario College of Teachers, in their position of trust, demonstrate responsibility in their relationships with students, parents, guardians, colleagues, educational partners, other professionals, the environment and the public.

The Purposes of the Ethical Standards for the Teaching Profession are:

- to inspire members to reflect and uphold the honour and dignity of the teaching profession
- to identify the ethical responsibilities and commitments in the teaching profession
- to guide ethical decisions and actions in the teaching profession
- to promote public trust and confidence in the teaching profession.

The Ethical Standards for the Teaching Profession are:

Care
The ethical standard of *Care* includes compassion, acceptance, interest and insight for developing students' potential. Members express their commitment to students' well-being and learning through positive influence, professional judgment and empathy in practice.

Respect
Intrinsic to the ethical standard of *Respect* are trust and fair-mindedness. Members honour human dignity, emotional wellness and cognitive development. In their professional practice, they model respect for spiritual and cultural values, social justice, confidentiality, freedom, democracy and the environment.

Trust
The ethical standard of *Trust* embodies fairness, openness and honesty. Members' professional relationships with students, colleagues, parents, guardians and the public are based on trust.

Integrity
Honesty, reliability and moral action are embodied in the ethical standard of *Integrity*. Continual reflection assists members in exercising integrity in their professional commitments and responsibilities.

The *Standards of Practice for the Teaching Profession*

The *Standards of Practice for the Teaching Profession* provide a framework of principles that describes the knowledge, skills, and values inherent in Ontario's teaching profession. These standards articulate the goals and aspirations of the profession. These standards convey a collective vision of professionalism that guides the daily practices of members of the Ontario College of Teachers.

The Purposes of the Standards of Practice for the Teaching Profession are:

- to inspire a shared vision for the teaching profession
- to identify the values, knowledge and skills that are distinctive to the teaching profession
- to guide the professional judgment and actions of the teaching profession
- to promote a common language that fosters an understanding of what it means to be a member of the teaching profession.

The Standards of Practice for the Teaching Profession are:

Commitment to Students and Student Learning
Members are dedicated in their care and commitment to students. They treat students equitably and with respect and are sensitive to factors that influence individual student learning. Members facilitate the development of students as contributing citizens of Canadian society.

Professional Knowledge
Members strive to be current in their professional knowledge and recognize its relationship to practice. They understand and reflect on student development, learning theory, pedagogy, curriculum, ethics, educational research and related policies and legislation to inform professional judgment in practice.

Professional Practice
Members apply professional knowledge and experience to promote student learning. They use appropriate pedagogy, assessment and evaluation, resources and technology in planning for and responding to the needs of individual students and learning communities. Members refine their professional practice through ongoing inquiry, dialogue and reflection.

Leadership in Learning Communities
Members promote and participate in the creation of collaborative, safe and supportive learning communities. They recognize their shared responsibilities and their leadership roles in order to facilitate student success. Members maintain and uphold the principles of the ethical standards in these learning communities.

Ongoing Professional Learning
Members recognize that a commitment to ongoing professional learning is integral to effective practice and to student learning. Professional practice and self-directed learning are informed by experience, research, collaboration and knowledge.