Chemical Engineering Technology Program Standard

The approved program standard for Chemical Engineering Technology program of instruction leading to an Ontario College Advanced Diploma delivered by Ontario Colleges of Applied Arts and Technology.
(MTCU funding code 61301)

Ministry of Training, Colleges and Universities
December 2012

Permission to Reproduce

Ministry of Training, Colleges and Universities
Programs Branch, Program Standards and Evaluation Unit

psu@ontario.ca

Inquiries regarding specific Chemical Engineering Technology programs offered by colleges of applied arts and technology in Ontario should be directed to the relevant college.

ISBN 978-1-4606-0369-7 (PDF)

Ce document est disponible en français.

Acknowledgements

The Ministry of Training, Colleges and Universities acknowledges with thanks the significant contribution of the many individuals and organizations who participated in the development of this program standard. In particular, the Ministry of Training, Colleges and Universities would like to acknowledge the important roles of

- all individuals and organizations who participated in the consultations;

- the coordinators of Chemical Engineering Technology Programs for their assistance throughout the project, the project officer who led the development of the vocational standard, Francine Roach, seconded faculty member from Algonquin College, and Louise Campagna from La Cité Collégiale.

Table of Contents

I. Introduction

This document is the Program Standard for the Chemical Engineering Technology program of instruction leading to an Ontario College Advanced Diploma delivered by Ontario colleges of applied arts and technology (MTCU funding code 61301).

Development of System-Wide Program Standards

In 1993, the Government of Ontario initiated program standards development with the objectives of bringing a greater degree of consistency to college programming offered across the province, broadening the focus of college programs to ensure graduates have the skills to be flexible and to continue to learn and adapt, and providing public accountability for the quality and relevance of college programs.

The Program Standards and Evaluation Unit of the Ministry of Training, Colleges and Universities has responsibility for the development, review, and approval of system-wide standards for programs of instruction at Ontario colleges of applied arts and technology.

Program Standards

Program standards apply to all similar programs of instruction offered by colleges across the province. Each program standard for a postsecondary program includes the following elements:

- **Vocational standard** (the vocationally specific learning outcomes which apply to the program of instruction in question),
- **Essential employability skills** (the essential employability skills learning outcomes which apply to all programs of instruction); and
- **General education requirement** (the requirement for general education in postsecondary programs of instruction).

Collectively, these elements outline the essential skills and knowledge that a student must reliably demonstrate in order to graduate from the program.

Individual colleges of applied arts and technology offering the program of instruction determine the specific program structure, delivery methods, and other curriculum matters to be used in assisting students to achieve the outcomes articulated in the standard. Individual colleges also determine whether additional local learning outcomes will be required to reflect specific local needs and/or interests.

The Expression of Program Standards as Vocational Learning Outcomes

Vocational learning outcomes represent culminating demonstrations of learning and achievement. They are not simply a listing of discrete skills, nor broad statements of knowledge and comprehension. In addition, vocational learning outcomes are interrelated and cannot be viewed in isolation of one another. As such, they should be viewed as a comprehensive whole. They describe performances that demonstrate that significant integrated learning by graduates of the program has been achieved and verified.

Expressing standards as vocational learning outcomes ensures consistency in the outcomes for program graduates, while leaving to the discretion of individual colleges curriculum matters such as the specific program structure and delivery methods.

The Presentation of the Vocational Learning Outcomes

The **vocational learning outcome** statements set out the culminating demonstration of learning and achievement that the student must reliably demonstrate before graduation.

The **elements of the performance** for each outcome define and clarify the level and quality of performance necessary to meet the requirements of the vocational learning outcome. However, it is the performance of the vocational learning outcome itself on which students are evaluated. The elements of performance are indicators of the means by which the student may proceed to satisfactory performance of the vocational learning outcome. The elements of performance do not stand alone but rather in reference to the vocational learning outcome of which they form a part.

The Development of a Program Standard

In establishing the standards development initiative, the Government determined that all postsecondary programs of instruction should include vocational skills coupled with a broader set of essential skills. This combination is considered critical to ensuring that college graduates have the skills required to be successful both upon graduation from the college program and throughout their working and personal lives.

A program standard is developed through a broad consultation process involving a range of stakeholders with a direct interest in the program area, including employers, professional associations, universities, secondary schools, and program graduates working in the field, in addition to students, faculty, and administrators at the colleges themselves. It represents a consensus of

participating stakeholders on the essential learning that all program graduates should have achieved.

Updating the Program Standard

The Ministry of Training, Colleges and Universities will undertake regular reviews of the vocational learning outcomes for this program to ensure that the Chemical Engineering Technology Program Standard remains appropriate and relevant to the needs of students and employers across the Province of Ontario. To confirm that this document is the most up-to-date release, contact the Ministry of Training, Colleges and Universities.

II. Vocational Standard

All graduates of the Chemical Engineering Technology program of instruction have achieved the twelve vocational learning outcomes listed in the following pages, in addition to achieving the essential employability skills learning outcomes and meeting the general education requirement.

Preamble

Graduates of the Chemical Engineering Technology program carry out functions within a chemical engineering environment. Graduates have demonstrated achievement of vocational learning outcomes which relate to both chemical engineering and chemistry.

Upon successful completion of the Chemical Engineering Technology program graduates can carry out tasks in compliance with statutes, regulations, standards and procedures. They can interpret and present data, co-ordinate and perform quantitative and qualitative experiments, prepare compounds, maintain and control industrial chemical processes*, prepare and interpret technical documents, and co-ordinate quality control and quality assurance procedures to meet organizational requirements. They can also troubleshoot* industrial or chemical processes* and laboratory equipment. They can apply communication, teamwork, leadership, organizational and technology skills to support laboratory and engineering activities. They can also apply principles of ethics and sustainability* to the decision-making process.

Graduates of Chemical Engineering Technology programs are employed in a broad range of private and public engineering and chemical environments, including both large and small organizations, government departments, government agencies and regulatory bodies. They may work in both the production/industrial aspects of chemical and related industries and in laboratories. They are employed in many industrial sectors, including food and beverage production, pharmaceuticals, water and wastewater management, petrochemicals, energy, paints, plastics, pulp and paper, mining, metallurgy and nuclear energy. They can also work in technical sales. They have the potential to advance to supervisory or managerial positions in both laboratory and production facilities.

There are opportunities for graduates to pursue further educational or professional qualifications, and degree completion. Graduates should contact their respective colleges for further details.

**See Glossary*

Synopsis of the Vocational Learning Outcomes
Chemical Engineering Technology
(Ontario College Advanced Diploma)

The graduate has reliably demonstrated the ability to

1. **perform all work in compliance with relevant statutes, regulations, standards, practices and guidelines.**
2. **implement, co-ordinate and evaluate quality control and quality assurance procedures to meet organizational standards and requirements.**
3. **troubleshoot* industrial or chemical processes* and laboratory equipment.**
4. **solve complex problems and perform tasks by applying principles of mathematics, physics, chemistry and chemical engineering.**
5. **perform, co-ordinate, implement and validate laboratory procedures to conduct quantitative and qualitative analyses and tests.**
6. **prepare and purify compounds using standard synthesis* and purification procedures.**
7. **maintain and control industrial or chemical processes*and assist with their design using chemical engineering principles.**
8. **analyze and interpret data using statistical methods.**
9. **select and use current technologies in chemical engineering tasks and projects.**
10. **prepare, modify, interpret and present technical documents for chemical engineering applications.**
11. **apply best practices for sustainability*.**
12. **develop strategies for ongoing personal and professional development to enhance work performance in a multi-disciplinary workplace.**

**See Glossary*

Note: The learning outcomes have been numbered as a point of reference; numbering does not imply prioritization, sequencing, nor weighting of significance.

The Vocational Learning Outcomes

1. *The graduate has reliably demonstrated the ability to*

perform all work in compliance with relevant statutes, regulations, standards, practices and guidelines.

Elements of the Performance

- promote the safety of self and others by adhering to organizational practices and procedures, and complying with environmental and health and safety legislation (e.g*.,* the Occupational Health and Safety Act, 1990 (OHSA) and the Workplace Hazardous Materials Information System (WHMIS))
- comply with industrial practices, standards and regulations as required (e.g., Good Manufacturing Practice (GMP)*, Good Laboratory Practice (GLP)*, International Organization for Standardization (ISO) and the American Society for Testing and Materials International (ASTM International))
- use the proper care, handling, storage, segmentation and disposal procedures for organic and inorganic waste
- adhere to safety codes, policies and practices, and accident prevention procedures
- monitor the workplace for hazards and take appropriate action to promote a safe working environment
- respond appropriately to emergency situations according to organizational practices and procedures
- adhere to organizational policies that strengthen an inclusive, equitable, respectful, safe and co-operative workplace environment

**See Glossary*

2. *The graduate has reliably demonstrated the ability to*

implement, co-ordinate and evaluate quality control and quality assurance procedures to meet organizational standards and requirements.

Elements of the Performance

- assess the importance of quality control and quality assurance programs to an organization's products and/or services
- use quality assurance and quality control terminology effectively in written and oral communications
- comply with quality assurance procedures
- design and conduct programs of sampling and analysis to maintain quality standards of raw materials, chemical intermediates and products
- design and co-ordinate quality assurance inspections, sampling, testing or audits that ensure chemical materials and products are manufactured according to required specifications
- determine measurable standards to assess quality assurance sampling and testing
- promote production efficiency and effectiveness by implementing quality control systems (e.g., International Organization for Standardization (ISO) series systems—ISO 9001, ISO 14001, ISO 17025 and Six Sigma or Lean Six Sigma)
- inspect, sample, test and evaluate for quality control against established standards to uncover anomalies, identify root causes of quality problems and recommend or carry out the needed corrective measures
- prepare, interpret, manage and present reports on quality assurance and quality control data for established statistical process control and planning purpose
- determine method detection limits and system suitability for analytical procedures in accordance with current organizational practices
- select, calibrate*, use and maintain appropriate measuring instruments to inspect mechanical components
- prepare, maintain and manage clear and accurate standard operating procedures (SOP) and other process documents in accordance with current organizational practices

**See Glossary*

3. *The graduate has reliably demonstrated the ability to*

troubleshoot* industrial or chemical processes* and laboratory equipment.

Elements of the Performance

- troubleshoot* analytical and process equipment
- monitor and troubleshoot* chemical processes* and instrumentation procedures and make recommendations related to these processes to optimize output and/or mitigate environmental impact
- clean, maintain and calibrate* laboratory instruments and equipment
- recommend preventive maintenance protocols and maintenance equipment
- use standard testing equipment to support troubleshooting* activities
- evaluate performance of equipment by applying mathematical and scientific principles
- take a scientific approach to problem solving by identifying the problem, determining the problem-solving sequence, searching for relevant information, recognizing limitations, troubleshooting* and recommending appropriate action
- conduct research independently to resolve problems (e.g., professional literature on topic, technical writings)

**See Glossary*

4. *The graduate has reliably demonstrated the ability to*

solve complex problems and perform tasks by applying principles of mathematics, physics, chemistry and chemical engineering.

Elements of the Performance

- perform chemical analyses, prepare standard solutions and complete other assigned tasks applying concepts of mathematics, including but not limited to, algebraic equations, functions, factors, ratios, conversions and fundamental calculus
- solve complex problems applying concepts of physics, including but not limited to, thermodynamics, fluid mechanics**,** sound, light, electricity and mechanics
- solve complex problems applying concepts of chemistry, including but not limited to, organic chemistry, inorganic chemistry, physical chemistry, analytical chemistry, electrochemistry and radiochemistry
- use mathematical and scientific terminology accurately (e.g., chemical nomenclature)
- access and select relevant technical information from various sources (e.g., technical manuals, the Internet, suppliers and coworkers)
- design, execute and evaluate chemical processes* and experiments using scientific methods
- collect and organize data, and summarize and analyze results
- interpret findings to make valid and reliable conclusions and predictions, and present the results, conclusions and recommendations

**See Glossary*

5. *The graduate has reliably demonstrated the ability to*

perform, co-ordinate, implement and validate laboratory procedures to conduct quantitative and qualitative analyses and tests.

Elements of the Performance

- collect, handle, log, preserve, track, prepare and analyze samples using appropriate techniques (e.g., air, water and soil samples)
- co-ordinate the sampling processes that ensure appropriate techniques are used and quality controls are respected
- use, or organize and monitor the proper use of, laboratory equipment and/or performance of chemical techniques to identify the quality and quantity of analyte (e.g., titration, mass spectroscopy, spectrometric, electrometric, and chromatographic instrumental techniques and their associated data reduction systems)
- analyze the physical properties of chemicals and materials efficiently, using standard operating procedures
- prepare solutions and dilutions using established protocols, and determine appropriate concentration units and conversions
- anticipate the outcomes of a chemical reaction, and recognize and interpret unexpected results
- perform pipetting to transfer exact quantities of a liquid during chemical sampling, tests and processes
- use analytical balances and weighing techniques to measure mass accurately and precisely
- perform procedural and analytical calculations, and interpret the results
- document, interpret and report quantitative and qualitative experimental results in the required format
- select and operate analysis equipment taking into account the cost of materials and lab equipment
- assist with ordering laboratory and field supplies

6. *The graduate has reliably demonstrated the ability to*

prepare and purify compounds using standard synthesis* and purification procedures.

Elements of the Performance

- use industrial chemicals safely
- identify major industrial synthesis processes (e.g., caustic soda, soda ash, sulfuric acid, esters and preparation of medicinal products)
- synthesize chemical compounds using standard operating procedures and following safety protocols
- perform purification methods that separate a targeted chemical substance from other contaminants
- select and perform standard purification methods including, but not limited to, filtration, evaporation, extraction, crystallization and adsorption
- calculate the chemical yield of a process and, if need be, recommend corrective action for improvement

**See Glossary*

7. *The graduate has reliably demonstrated the ability to*

maintain and control industrial or chemical processes*and assist with their design using chemical engineering principles.

Elements of the Performance

- assist in the development of a chemical engineering process
- assist in the selection of equipment for the handling of liquids and solids (e.g., compressors, pumps, valves and pipes)
- interpret and assist in the development of Process Operating Instructions (POIs), Piping and Instrumentation Diagrams (P&IDs), Block Flow Diagrams (BFD) and Flowsheets or Process Flow Diagrams (PFD)
- start up, operate and shutdown analytical and simple chemical process equipment*
- maintain and monitor analytical and chemical process equipment*
- collect, maintain and analyze operational data relating to an industrial or chemical process* (e.g., perform mass and energy balances)
- assess and monitor costs and waste products related to an industrial or chemical process*
- assist in the selection of equipment for process control and common unit operations (e.g., equilibrium contacting, mixing, heat transfer, phase separation, evaporation and chemical reactors)
- analyze process and instrumentation diagrams to identify process failure points
- identify symptoms of systematic failure of industrial chemical processes* or systems
- recommend process controls that improve efficiency and that minimize waste by-products and energy consumption
- outline the importance of valving operations in industrial chemical applications and chemical manufacturing
- analyze process scaling factors and related safety implications
- analyze bulk chemical material handling processes, including but not limited to, dispensing systems, transfers methods and weighing systems for raw materials
- analyze the advantages and disadvantages of using batch production and continuous processes

**See Glossary*

8. *The graduate has reliably demonstrated the ability to*

analyze and interpret data using statistical methods.

Elements of the Performance

- calculate and interpret measures of central tendency and dispersion (e.g., mean, median, mode, standard deviation, and the coefficient of variation)
- perform and interpret comparative analysis statistical tests (e.g., T-test, F-test and Q-test)
- perform calculations using measurement system analysis to ensure the integrity of data used for analysis (e.g., calibration, test method, sampling plan)
- predict and forecast results using linear regression and analysis
- identify and interpret potential causes for outlier results excluded from the statistical analysis using standard tests such as the Dixon test
- apply statistical process control (SPC), including control charts, continuous improvement process and design of experiment (DOE), to produce meaningful and measurable data

9. *The graduate has reliably demonstrated the ability to*

select and use current technologies in chemical engineering tasks and projects.

Elements of the Performance

- select and use current technologies to analyze and solve complex technical problems related to chemical engineering
- select and use current technologies to enable and support quantitative and qualitative analyses and tests
- select and use current technologies to compile, manage, process, interpret, report and present data (e.g., word processing software, Excel spreadsheets, data management software, presentation software)
- outline the importance of using a laboratory information management system (LIMS)
- apply process control software to monitor, manage and improve process performance
- select and use current technologies to prepare and modify technical documents for chemical engineering applications
- discuss the importance of ensuring proper storage, backup and naming of digital files

10. *The graduate has reliably demonstrated the ability to*

prepare, modify, interpret and present technical documents for chemical engineering applications.

Elements of the Performance

- prepare, modify and interpret technical documents related to the design of chemical processes*, equipment and systems
- collect, prepare and organize relevant information data, materials, literature and documents in accordance with recognized standards (e.g., ISO and the Canadian Standards Association - CSA)
- search for information and determine criteria, specifications and materials relevant to the chemical engineering process, equipment or system
- present clear, concise and complete information that targets the intended audience and meets predetermined objectives
- use engineering terminology correctly and accurately in written and oral communications

**See Glossary*

11. *The graduate has reliably demonstrated the ability to*

apply best practices for sustainability*.

Elements of the Performance

- apply best practices for reducing waste, conserving energy and water consumption and reducing emissions to bring about effective and efficient use of resources
- apply sustainability* practices when selecting and using materials (e.g., life cycle analysis)
- make decisions based on ethical principles
- gather and analyze pertinent information to assess the business rationale behind corporate sustainability* initiatives
- describe the potential impact of sustainability* indicators (SDI) on chemical engineering practices

**See Glossary*

12. *The graduate has reliably demonstrated the ability to:*

develop strategies for ongoing personal and professional development to enhance work performance in a multi-disciplinary workplace.

Elements of the Performance

- seek out and act upon constructive feedback to enhance work performance
- develop a plan to keep pace with, and adapt to changing workforce demands and trends, as well as technological advances in the chemical engineering field
- take responsibility for one's job related performance, as an individual and as a member of a multidisciplinary team
- identify training courses, workshops and programs to enhance employment opportunities in the chemical engineering field
- develop a plan that identifies one's strengths and weaknesses, and proposes a strategy for improved skills to meet future goals
- identify the roles and benefits of professional organizations and certification (e.g., Ontario Association of Certified Engineering Technicians and Technologists (OACETT), Association of the Chemical Profession of Ontario (ACPO), Ontario Water Wastewater Certification (OWWC) stationary engineering certification)
- develop a plan for building a professional network and for participating in chemical engineering professional associations and activities
- identify workplace opportunities and challenges in the chemical engineering field, including different work schedules (e.g., shift work) and different workplaces (e.g., remote workplace locations, chemical-based manufacturing environments, and large scale or specialized industrial or chemical processing plants)

Glossary

Calibrate – To compare the accuracy of the measurement, reading or output of a measuring instrument to a standard of known accuracy and to adjust the instrument if the measurement, reading or output is found to differ from the standard.

Chemical process equipment – Various types of process equipment for carrying out chemical processes, including, but not limited to, distillation columns, heat exchangers, filters, evaporators, extractors, chemical mixers, solid liquid separators and instrumentation and control systems.

Chemical processes – Various types of processes, including but not limited to, chemical reactions, chemical purification, distillation, chemical and physical separation, and mixing.

Good Laboratory Practice (GLP) – A quality system concerned with the organizational process and the conditions under which laboratory studies and activities are planned, performed, monitored, recorded, archived and reported.

Good Manufacturing Practices (GMP) – A system governing consistency, quality control and risk management in the testing, manufacturing, processing, packaging, labeling, storing, and distributing of products and devices, so that they comply with applicable requirements, specifications and regulations.

Sustainability – Sustainability encompasses the ethical ideal that calls for optimizing the long-term carrying capacity and vitality of three interdependent systems – environmental, social and economic. In a chemical engineering environment, sustainability aims to improve the quality of human life, while protecting nature, by engaging in industrial or chemical processes that are non-polluting, conserve energy and resources and protect ecosystems, that benefit employees, consumers and communities, and that strengthen enterprises that foster economic growth and prosperity.

Synthesis procedures – A procedure whereby a molecule is "constructed" or synthesized from precursors, creating a new substance.

Troubleshoot (troubleshooting) – To diagnose equipment and process problems, and propose solutions.

III. Essential Employability Skills

All graduates of the Chemical Engineering Technology program of instruction have reliably demonstrated the essential employability skills learning outcomes listed on the following pages, in addition to achieving the vocational learning outcomes and meeting the general education requirement.

Context

Essential Employability Skills (EES) are skills that, regardless of a student's program or discipline, are critical for success in the workplace, in day-to-day living, and for lifelong learning.

The teaching and attainment of these EES for students in, and graduates from, Ontario's colleges of applied arts and technology are anchored in a set of three fundamental assumptions:

- these skills are important for every adult to function successfully in society today;
- our colleges are well equipped and well positioned to prepare graduates with these skills;
- these skills are equally valuable for all graduates, regardless of the level of their credential, whether they pursue a career path, or they pursue further education.

Skill Categories

To capture these skills, the following six categories define the essential areas where graduates must demonstrate skills and knowledge.

- Communication
- Numeracy
- Critical Thinking & Problem Solving
- Information Management
- Interpersonal
- Personal

Application and Implementation

In each of the six skill categories, there are a number of defining skills, or sub skills, identified to further articulate the requisite skills identified in the main skill categories. The following chart illustrates the relationship between the skill categories, the defining skills within the categories, and learning outcomes to be achieved by graduates from all postsecondary programs of instruction that lead

to an Ontario College credential.

EES may be embedded in General Education or vocational courses, or developed through discrete courses. However these skills are developed, all graduates with Ontario College credentials must be able to reliably demonstrate the essential skills required in each of the six categories.

SKILL CATEGORY	**DEFINING SKILLS: Skill areas to be demonstrated by graduates:**	**LEARNING OUTCOMES: The levels of achievement required by graduates.** ***The graduate has reliably demonstrated the ability to*:**
COMMUNICATION	• Reading • Writing • Speaking • Listening • Presenting • Visual literacy	1. *communicate clearly, concisely and correctly in the written, spoken, and visual form that fulfills the purpose and meets the needs of the audience.* 2. *respond to written, spoken, or visual messages in a manner that ensures effective communication.*
NUMERACY	• Understanding and applying mathematical concepts and reasoning • Analyzing and using numerical data • Conceptualizing	3. *execute mathematical operations accurately.*
CRITICAL THINKING & PROBLEM SOLVING	• Analyzing • Synthesizing • Evaluating • Decision making • Creative and innovative thinking	4. *apply a systematic approach to solve problems.* 5. *use a variety of thinking skills to anticipate and solve problems.*

SKILL CATEGORY	DEFINING SKILLS: Skill areas to be demonstrated by graduates:	LEARNING OUTCOMES: The levels of achievement required by graduates. The graduate has reliably demonstrated the ability to:
INFORMATION MANAGEMENT	• Gathering and managing information • Selecting and using appropriate tools and technology for a task or a project • Computer literacy • Internet skills	6. *locate, select, organize, and document information using appropriate technology and information systems.* 7. *analyze, evaluate, and apply relevant information from a variety of sources.*
INTERPERSONAL	• Team work • Relationship management • Conflict resolution • Leadership • Networking	8. *show respect for the diverse opinions, values, belief systems, and contributions of others.* 9. *interact with others in groups or teams in ways that contribute to effective working relationships and the achievement of goals.*
PERSONAL	• Managing self • Managing change and being flexible and adaptable • Engaging in reflective practices • Demonstrating personal responsibility	10. *manage the use of time and other resources to complete projects.* 11. *take responsibility for one's own actions, decisions, and consequences.*

IV. General Education Requirement

All graduates of the Chemical Engineering Technology program have met the general education requirement described on the following pages, in addition to achieving the vocational and essential employability skills learning outcomes.

Requirement

The General Education Requirement for programs of instruction is stipulated in the Credentials Framework (Appendix A in the Minister's Binding Policy Directive *Framework for Programs of Instruction*).

For certificate programs: While the inclusion of General Education is locally determined for programs of instruction leading to either a college certificate or on Ontario College Certificate, it is recommended that graduate of the Ontario College Certificate programs have been engaged in learning that incorporates some breadth beyond the vocational field of study.

In programs of instruction leading to either an Ontario College Diploma or an Ontario College Advanced Diploma, it is required that graduates have been engaged in learning that exposes them to at least one discipline outside their main field of study and increases their awareness of the society and culture in which they live and work. This will typically be accomplished by students taking 3 to 5 courses (or the equivalent) designed discretely and separately from vocational learning opportunities.

This general education learning would normally be delivered using a combination of required and elective processes.

Purpose

The purpose of General Education in the Ontario college system is to contribute to the development of citizens who are conscious of the diversity, complexity, and richness of the human experience; who are able to establish meaning through this consciousness; and, who, as a result, are able to contribute thoughtfully, creatively, and positively to the society in which they live and work.

General Education strengthens student's essential employability skills, such as critical analysis, problem solving, and communication, in the context of an exploration of topics with broad-based personal and/or societal importance.

Themes

The themes listed below will be used to provide direction to colleges in the development and identification of courses that are designed to fulfill the General Education Requirement for programs of instructions.

Each theme provides a statement of Rationale and offers suggestions related to more specific topic areas that could be explored within each area. These suggestions are neither prescriptive nor exhaustive. They are included to provide guidance regarding the nature and scope of content that would be judged as meeting the intent and overall goals of General Education.

1. Arts in Society:

Rationale:
The capacity of a person to recognize and evaluate artistic and creative achievements is useful in many aspects of his/her life. Since artistic expression is a fundamentally human activity, which both reflects and anticipates developments in the larger culture, its study will enhance the student's cultural and self-awareness.

Content:
Courses in this area should provide students with an understanding of the importance of visual and creative arts in human affairs, of the artist's and writer's perceptions of the world and the means by which those perceptions are translated into the language of literature and artistic expression. They will also provide an appreciation of the aesthetic values used in examining works of art and possibly, a direct experience in expressing perceptions in an artistic medium.

2. Civic Life:

Rationale:
In order for individuals to live responsibly and to reach their potential as individuals and as citizens of society, they need to understand the patterns of human relationships that underlie the orderly interactions of a society's various structural units. Informed people will have knowledge of the meaning of civic life in relation to diverse communities at the local, national, and global level, and an awareness of international issues and the effects of these on Canada, and Canada's place in the international community.

Content:
Courses in this area should provide students with an understanding of the meaning of freedoms, rights, and participation in community and public life, in addition to a working knowledge of the structure and function of various levels of government (municipal, provincial, national) in Canada and/or in an international context. They may also provide an historical understanding of major political

issues affecting relations between the various levels of government in Canada and their constituents.

3. Social and Cultural Understanding:

Rationale:
Knowledge of the patterns and precedents of the past provide the means for a person to gain an awareness of his or her place in contemporary culture and society. In addition to this awareness, students will acquire a sense of the main currents of their culture and that of other cultures over an extended period of time in order to link personal history to the broader study of culture.

Content:
Courses in this area are those that deal broadly with major social and cultural themes. These courses may also stress the nature and validity of historical evidence and the variety of historical interpretation of events. Courses will provide the students with a view and understanding of the impact of cultural, social, ethnic, or linguistic characteristics.

4. Personal Understanding:

Rationale:
Educated people are equipped for life-long understanding and development of themselves as integrated physiological and psychological entities. They are aware of the ideal need to be fully functioning persons: mentally, physically, emotionally, socially, spiritually, and vocationally.

Content:
Courses in this area will focus on understanding the individual: his or her evolution; situation; relationship with others; place in the environment and universe; achievements and problems; and his or her meaning and purpose. They will also allow students the opportunity to study institutionalized human social behaviour in a systematic way. Courses fulfilling this requirement may be oriented to the study of the individual within a variety of contexts.

5. Science and Technology:

Rationale:
Matter and energy are universal concepts in science, forming a basis for understanding the interactions that occur in living and non-living systems in our universe. Study in this area provides an understanding of the behaviour of matter that provides a foundation for further scientific study and the creation of broader understanding about natural phenomena

Similarly, the various applications and developments in the area of technology have an increasing impact on all aspects of human endeavour and have numerous social, economic, and philosophical implications. For example, the operation of computers to process data at high speed has invoked an interaction between machines and the human mind that is unique in human history. This development and other technological developments have a powerful impact on how we deal with many of the complex questions in our society.

Content:

Courses in this area should stress scientific inquiry and deal with basic or fundamental questions of science rather than applied ones. They may be formulated from traditional basic courses in such areas of study as biology, chemistry, physics, astronomy, geology, or agriculture. As well, courses related to understanding the role and functions of computers (e.g., data management and information processing), and assorted computer-related technologies, should be offered in a non-applied manner to provide students with an opportunity to explore the impact of these concepts and practices on their lives.