
# Instrumentation and Control Engineering Technology Program Standard

**The approved program standard for Instrumentation and Control Engineering Technology program of instruction leading to an Ontario College Advanced Diploma delivered by Ontario Colleges of Applied Arts and Technology.**

**(MTCU funding code 61011)**

**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 Instrumentation and Control Engineering Technology programs offered by colleges of applied arts and technology in Ontario should be directed to the relevant college.



ISBN 978-1-4606-0366-6 (PDF)

# 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 Instrumentation and Control Engineering Technology Programs for their assistance throughout the project, the project officer who led the development of the vocational standard, Christine Foster, seconded faculty member from Algonquin College.

# Table of Contents

# I. Introduction

*This document is the Program Standard for the Instrumentation and Control Engineering Technology program of instruction leading to an Ontario College Advanced Diploma delivered by Ontario colleges of applied arts and technology (MTCU funding code 61011).*

## 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 Instrumentation and Control 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:

psu@ontario.ca

# II. Vocational Standard

*All graduates of the Instrumentation and Control Engineering Technology program of instruction have achieved the nine 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 Instrumentation and Control* Engineering Technology programs carry out instrumentation and control* engineering functions within a wide variety of private and public sector industries. Graduates have demonstrated achievement of vocational learning outcomes which relate to engineering in general and instrumentation and control* engineering in particular.

The vocational learning outcomes and their respective elements of performance are articulated to clearly define the range and level of skills, knowledge and attitudes required by graduates in order to be successful as entry-level instrumentation and control* engineering technologists.

Achievement of the vocational learning outcomes prepare the graduates of the Instrumentation and Control* Engineering Technology programs to select, install, calibrate*, troubleshoot*, analyze and modify equipment used in the measurement and control of process parameters. Graduates analyze and solve complex technical problems associated with wireless and wired control systems applying mathematical, scientific and digital* principles. Graduates contribute to the design, specification and modification of process control components and systems and to the modification of controllers* to optimize control systems.

As members of multidisciplinary project teams, graduates co-ordinate and supervise the installation and commissioning of control processes or systems. Graduates demonstrate leadership in project teams and support communication between trades, technical and professional personnel. Graduates analyze, prepare and present industry standard documentation, technical and technology reports and engineering drawings for instrumentation and process control* systems and work in compliance with relevant legislation, regulations, standards, codes, policies and procedures.

Graduates of Instrumentation and Control* Engineering Technology programs work in a broad range of employment settings, including general manufacturing, chemical industry, petroleum refining, agriculture, food processing, automobile manufacturing, steel production, pulp and paper, building automation, municipal waste and water utilities, and environmental and renewable energy industries. Graduates are typically employed in entry-level positions as instrumentation

control or process control technologists, control systems technologist or process analyzer specialists.

This program standard has identified a cluster of common skills, knowledge and attitudes essential to all entry-level technologists in the instrumentation and control* engineering field; however, individual colleges may choose to build on this standard by offering some degree of specialization.

There may be opportunities for graduates to pursue further educational qualifications through transfer pathways[1] between colleges and universities or occupational certifications through professional organizations. Graduates should contact individual colleges and professional associations, such as the Ontario Association of Certified Engineering Technicians and Technologists (OACETT).

**See Glossary*

[1] The Ontario Council on Articulation and Transfer (ONCAT) maintains the provincial postsecondary credit transfer portal, ONTransfer and the Ontario Postsecondary Transfer Guide (OPTG) at http://www.ocutg.on.ca/www/index_en.php?page=the_ontario_postsecondary_transfer_guide

## Synopsis of the Vocational Learning Outcomes
## Instrumentation and Control Engineering Technology
## (Ontario College Advanced Diploma)

*The graduate has reliably demonstrated the ability to*

1. **comply with and monitor health and safety practices and procedures in accordance with current legislation, regulations and organizational policy.**

2. **select, install, calibrate*, troubleshoot*, analyze and redefine equipment used in the measurement and control of process parameters.**

3. **contribute to the design and specification of process control components and systems, and select and install components to conform to system specifications and related safety requirements.**

4. **contribute to the design, configuration and modification of electronic and computer-based controllers* to optimize the performance of process control systems.**

5. **analyze and solve complex technical problems associated with wireless and wired control systems applying mathematical, scientific, electrical, electronic, and digital* principles.**

6. **co-ordinate and supervise the installation and commissioning of a control system as a member of a multi-disciplinary team.**

7. **work in compliance with relevant industry standards, codes, policies and procedures.**

8. **analyze, prepare and present documentation, technical and technology reports and engineering drawings for instrumentation and process control* systems that conform to industry standards.**

9. **develop strategies for ongoing professional development to enhance work performance as an instrumentation and control* engineering technologist.**

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

**See Glossary*

## The Vocational Learning Outcomes

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

**comply with and monitor health and safety practices and procedures in accordance with current legislation, regulations and organizational policy.**

### Elements of the Performance

- comply with all requirements of the current *Ontario Health and Safety Act,1990* and applicable sections of the *Technical Standards and Safety Authority (TSSA)* and the *Ontario Electrical Safety Code (OESC)*
- identify, interpret and apply safety codes, policies and practices, and accident prevention procedures
- maintain all required health and safety training and certification such as, Workplace Hazardous Materials Information System (WHMIS), Fall Arrest Protection and Confined Space Safety training
- recommend, select and use personal protective equipment* (PPE), footwear and clothing to promote worker safety
- handle, store and dispose hazardous materials safely in accordance with the Workplace Hazardous Materials Information System (WHMIS)
- identify various sources of potential and stored energy and the requirement for isolation and de-energization of those sources, i.e., pneumatic*, electrical, hydraulic*, gravity and mechanical
- work collaboratively with health and safety committees to develop, implement and monitor worksite policies and procedures related to safety including tag and lockout procedures
- plan and conduct safety inspections of all work environments to detect and correct hazardous conditions

**See Glossary*

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

**select, install, calibrate*, troubleshoot*, analyze and redefine equipment used in the measurement and control of process parameters.**

## Elements of the Performance

- use hand tools, measuring devices and test equipment
- identify, select and use a variety of calibration equipment
- analyze equipment performance and develop troubleshooting* techniques that conform to relevant standards and safety requirements
- mentor and guide team members with troubleshooting* and process recovery
- calibrate* process and product quality measurement devices such as temperature, pressure, level, flow, density, pH, etc.
- validate and test equipment according to manufacturer's specifications
- modify equipment parameters to improve efficiency
- read and interpret instrument loop and wiring diagrams, and calibration and data sheets
- check and tune control loops to verify loop performance within specifications
- set up, calibrate* and troubleshoot* control valves and positioners, actuators and other final control elements

**See Glossary*

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

**contribute to the design and specification of process control components and systems, and install components to conform to system specifications and related safety requirements.**

**Elements of the Performance**

- operate a process control system and comply with system specifications
- select, install and service components to conform to control system specifications and relevant safety requirements
- use standard communication protocols and devices, i.e., Open Systems Interconnection (OSI), Ethernet, Modbus, PROFIBUS, DNP3 and HART
- contribute to the design of a process control system to meet a specified requirement
- assess and recommend communication systems and interfaces, Programmable Electronic Systems (PES) and wireless controls
- identify needs and develop, configure, connect and apply operator interface(s) communication standards, i.e., GUI/HMI (Graphical User Interface/Human Machine Interface
- interpret system specifications and recommend components to form a process control system

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

**contribute to the design, configuration and modification of electronic and computer-based controllers* to optimize the performance of process control systems.**

## Elements of the Performance

- read and write applications and programs i.e. ladder logic, function block and structured text-based programming language
- operate and configure instruments to communicate with appropriate communication protocols
- use a variety of controllers* including Distributed Control Systems (DCS), Programmable Logic Controllers* (PLC) and Supervisory Control and Data Acquisition* (SCADA) to optimize the performance of control processes
- contribute to the design of programs to control machines and processes
- recommend modifications to control schemes to optimize processes
- compare and recommend appropriate control strategies for process systems
- analyze the performance of instrumentation and process control systems using application software
- apply the principles of process control to optimize systems

**See Glossary*

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

**analyze and solve complex technical problems associated with wireless and wired control systems applying mathematical, scientific, electrical, electronic and digital* principles.**

## Elements of the Performance

- review and analyze maintenance management system data, where available, and provide recommendations for equipment and control system performance and maintenance costs
- analyze and solve complex technical problems applying advanced mathematics and communication systems knowledge
- identify, assemble and integrate multiple devices to create a process control system
- consult manufacturer's manuals, circuit diagrams and Process and Instrumentation Diagrams* (P&IDs) to determine test and maintenance procedures
- complete testing and maintenance procedures on devices used for measuring and controlling flow, level, pressure, temperature, chemical composition or other variables
- inspect, repair and modify system components including sensors, transmitters, control elements, programmable logic controllers*(PLC) and computer-based control devices and communication systems
- test and troubleshoot* a range of electrical, electronic, and digital* circuits using appropriate equipment
- test and troubleshoot* motor speed control and servo drive systems

**See Glossary*

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

**co-ordinate and supervise the installation and commissioning of a control system as a member of a multidisciplinary team.**

## Elements of the Performance

- apply project management skills and communication processes to process control projects
- obtain and co-ordinate process control project documentation
- participate in process control project planning and co-ordination including personnel, resources, budgets and schedules
- support compliance with project specification and plans, site procedures and project deadlines as a member of the multidisciplinary team
- maintain ongoing communication with members of the multidisciplinary process control team, including but not limited to instrumentation and control* technologists, electricians and electrical technologists, mechanical technicians or technologists, pipefitters, millwrights, engineers, safety officers and information technology personnel
- recommend and justify solutions to technical problems encountered
- use current technologies to prepare project documentation
- complete and communicate all control project reports

**See Glossary*

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

**work in compliance with relevant industry standards, codes, policies and procedures.**

## Elements of the Performance

- interpret and comply with project specifications and drawings
- act in accordance with appropriate industry standards and codes i.e., Canadian Standards Association (CSA), Instrumentation Systems and Automation Society (ISA), International Electrotechnical Commission (IEC), Institute of Electrical and Electronics Engineers (IEEE) and International Organization for Standardization (ISO)
- select and use equipment and materials which adhere to best practices in conservation and sustainability*
- contribute to quality management and assurance practices in the lab and/or workplace setting
- identify procedures and practices that are non-compliant with legislation, standards, regulations and ethical principles
- adhere to professional codes of ethics

**See Glossary*

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

**analyze, prepare and present documentation, technical and technology reports and engineering drawings for instrumentation and process control* systems that conform to industry standards.**

### Elements of the Performance

- research and source technical information
- document instrumentation and control* systems to accurately depict control systems as designed
- analyze and draw complex process and instrument diagrams using Instrumentation Systems and Automation Society (ISA) symbols and schemata
- interpret and communicate instrumentation documents to technical and professional audiences
- prepare and modify technical documentation and reports
- present recommendations based on analysis and interpretation of instrumentation and control* documentation
- use industry standard terminology including Scientific Apparatus Makers Association (SAMA) and American National Standards Institute (ANSI)
- produce process control system documentation including Process and Instrumentation Diagrams* (P&ID), and Sequential Function Charts (SFC)
- prepare technical and technology reports using word processing and spreadsheets
- produce process and instrument diagrams using computer aided design (CAD)

**See Glossary*

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

**develop strategies for ongoing professional development to enhance work performance as an instrumentation and control* engineering technologist.**

## Elements of the Performance

- seek out and act upon constructive feedback to enhance work performance
- keep pace with, and adapt to, changing workforce demands and trends, as well as technological and scientific advances in the instrumentation and control* engineering field
- apply problem-solving techniques for specific knowledge acquisition and skill development
- take responsibility for one's job-related performance, as an individual and as a member or a leader of a team
- identify training courses, workshops and programs to enhance employment opportunities in the instrumentation and control* engineering field
- engage in activities that include critical thinking and self-evaluation to promote professionalism
- develop a plan that includes learning strategies and activities to improve one's skill level and to expand one's skill base
- develop a professional network and participate in instrumentation and control* engineering-based professional activities e.g., OACETT, IEEE, ISA and the College of Trades qualifications
- use effective time-management and organizational techniques to accomplish professional goals

**See Glossary*

## Glossary

**Calibrate** – To check and adjust the accuracy of the measurement of a measuring instrument against an accurate national standard, or if none exists, the Original Equipment Manufacturers (OEM) standards or specifications.

**Controller** – A device capable of receiving a signal from a process and regulating an output to that process in order to maintain a selected operating condition (set point) or control point.

**Digital** – A data parameter which varies by a discrete (discontinuous) value; 1-On or 2-Off.

**Hydraulic** – Describes scientific and engineering principles concerned with the use of non-compressible liquids to perform mechanical tasks.

**Instrumentation and Control** – A specialized branch of engineering based on applied mathematics, science and technologies, which is concerned with the measurement and control of automated processes with the goal of improving system productivity, reliability, safety and optimization. Instrumentation and control technicians and technologists work within a broad range of industrial, agricultural, environmental, biomedical, research, manufacturing, energy and resource fields.

**Personal Protective Equipment (PPE)** – Specialized clothing and equipment, e.g., boots, gloves, flame retardant clothing, goggles and masks, worn by workers in all work environments for their protection against health and safety hazards.

**Process and Instrumentation Diagram (P&ID)** – A schematic or illustration of functional relationships of piping, instrumentation and system equipment components that make up a process control system. Process and Instrumentation Diagrams (P&IDs) include process piping and instrumentation interfaces to process piping.

**Pneumatic** – Describes scientific and engineering principles concerned with the use of compressed air or gas to perform mechanical tasks or to transmit a signal value.

**Sustainability** - Calls for optimizing the long-term capacity and vitality of three interdependent systems – environmental, social and economic. In an industrial and manufacturing context, sustainability aims to improve the quality of human life, while protecting nature and while engaging in processes and systems that are non-polluting, conserve energy and resources and protect ecosystems; benefit employees, consumers and communities; and strengthen enterprises that foster economic growth and prosperity.

**Supervisory Control and Data Acquisition (SCADA) –** A version of telemetry commonly used in wide area industrial applications, such as electrical power

generation and distribution and water distribution, which includes supervisory control of remote stations as well as data acquisition from those stations over a bidirectional communications link (McGraw-Hill Dictionary of Scientific & Technical Terms, 6E, 2003).

**Troubleshoot/Troubleshooting** – Using a logical and systematic approach to determine why devices, electronic circuits, control systems or subsystems are malfunctioning or not operating per design or as expected, and recommending a course of action to correct the malfunction based on equipment operating parameters.

# III. Essential Employability Skills

*All graduates of the Instrumentation and Control 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.**<br><br>***The graduate has reliably demonstrated the ability to*:** |
|---|---|---|
| COMMUNICATION | • Reading<br>• Writing<br>• Speaking<br>• Listening<br>• Presenting<br>• 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.*<br>2. *respond to written, spoken, or visual messages in a manner that ensures effective communication.* |
| NUMERACY | • Understanding and applying mathematical concepts and reasoning<br>• Analyzing and using numerical data<br>• Conceptualizing | 3. *execute mathematical operations accurately.* |
| CRITICAL THINKING & PROBLEM SOLVING | • Analyzing<br>• Synthesizing<br>• Evaluating<br>• Decision making<br>• Creative and innovative thinking | 4. *apply a systematic approach to solve problems.*<br>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.<br><br>The graduate has reliably demonstrated the ability to: |
|---|---|---|
| INFORMATION MANAGEMENT | • Gathering and managing information<br>• Selecting and using appropriate tools and technology for a task or a project<br>• Computer literacy<br>• Internet skills | 6. *locate, select, organize, and document information using appropriate technology and information systems.*<br>7. *analyze, evaluate, and apply relevant information from a variety of sources.* |
| INTERPERSONAL | • Team work<br>• Relationship management<br>• Conflict resolution<br>• Leadership<br>• Networking | 8. *show respect for the diverse opinions, values, belief systems, and contributions of others.*<br>9. *interact with others in groups or teams in ways that contribute to effective working relationships and the achievement of goals.* |
| PERSONAL | • Managing self<br>• Managing change and being flexible and adaptable<br>• Engaging in reflective practices<br>• Demonstrating personal responsibility | 10. *manage the use of time and other resources to complete projects.*<br>11. *take responsibility for one's own actions, decisions, and consequences.* |

# IV. General Education Requirement

*All graduates of the Instrumentation and Control 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.