GENERAL PROGRAM CRITERIA FOR ALL DISCIPLINES

Scope

The National Technology Benchmarks **(NTB**) represent the program criteria used by the Canadian Technology Accreditation Board **(CTAB**) in the review and evaluation of applied science and engineering technology programs.

Accreditation of TECHNOLOGIST level programs by CTAB means that graduates have International Recognition of Academic Qualifications under the SYDNEY ACCORD (www.ieagreements.org).

Provincial Certification Boards may use the ***NTB*** in the evaluation of candidates for certification as an Applied Science or Engineering Technologist where students graduate from a non-accredited program in Canada or abroad.

The NTB are intended to establish a minimum level of achievement **at the time of graduation**.

National Technology Benchmarks Composition

The NTB comprise two sections:

Part 1 - Program Criteria - **General** for all disciplines
Part 2 - Program Criteria - **Discipline Specific**

Objectives

Educational

Technology programs will have educational objectives that are seen to be consistent with the CCTT profile for an applied science/engineering technologist (Appendix A). These educational objectives must be re-evaluated periodically based on industry needs. An educational program will also have a series of documented program outcomes, which are consistent with this general section and the appropriate discipline specific section of the NTB.

National Accreditation

Programs in Applied Science and Engineering Technology will prepare graduates with the technical, managerial and personal skills necessary to enter careers in a specific discipline. The Program Outcome Statements set out the culminating demonstration of learning that must be achieved by a graduate. Indicators of Performance* associated with each Program Outcome are to be considered ***"such as***" statements, providing a measure of the type of achievement anticipated in meeting the outcomes. A program may have greater or fewer performance indicators than those shown.

In order for a program to achieve National Accreditation status, the institution must clearly show that the graduates have demonstrated the ability to satisfy all of the outcomes in this general section, including an Applied Research/Technical Report and **at least five** of the Program Outcomes listed in Part 2.

General Requirements

An applied science/engineering technology program must demonstrate that graduates have:

a) acquired the skills needed to enter the workforce and can apply this knowledge to individual and team activities, as defined by the Conference Board of Canada in Appendix B;

b) competence in integrating and drawing together diverse knowledge to focus both technical and non-technical skills in solving problems;

c) the ability to be creative in the solution of problems and/or the design of systems, components, equipment or processes;

d) the ability to function effectively as an individual, and as a member or leader in diverse technical teams;

e) the ability to conduct, analyze and interpret experiments, and results to improve processes;

f) the ability to utilize the internet, technical literature and other means of professional development to keep current in their discipline; and

g) the ability to engage in independent and life-long learning.

Summary of General Program Outcome Statements

The graduate will have reliably demonstrated the ability to:

1. Research, analyze, prepare, document, submit and present a Technology Report (Capstone Project) relating to a significant technology-related issue.

2. Demonstrate capability *(in **one or more** of the following areas described below)* consistent with the discipline requirements and program objectives:

   2.1. Apply the basic knowledge of algebra, matrix manipulation, trigonometry and introductory calculus to resolve applied science and engineering technology problems; and/or

   2.2. Apply the knowledge of statistical processes; and/or

   2.3. Apply the knowledge of advanced algebra, integral and differential calculus methodologies; and/or

   2.4. Apply the knowledge of discrete/finite mathematics and logic systems

3. Apply the current practices of project management to applied science and engineering technology projects consistent with the discipline requirements.

4. Apply the principles of physical and natural science.

5. Apply the knowledge of business/management principles, ethics, sustainability, contract law, codes and standards.

6. Obtain and analyze data, and prepare and document data.

7. Utilize computer software, hardware and other technological tools appropriate and necessary to performance of tasks.

8. Apply knowledge of health and safety practices to minimize exposure to unsafe conditions and ensure a safe working environment for oneself and co-workers.

Program Outcomes

GC01 Research, analyze, prepare, document, submit, and defend a Technology Report (Capstone Project) relating to a significant technology-related issue.

Indicators of Performance, such as:

1.1. Define the scope or need of a practical investigation. Clearly identify the research question.

1.2. Investigate and document research using a wide range of resources, including published literature and online tools.

1.3. Apply formal problem solving techniques and design procedures, such as CAD and simulation software, to calculate and test solutions.

1.4. Apply scientific methods and mathematical tools to evaluate and/or predict the technological performance and appropriateness of processes, systems or components.

1.5. Derive evaluation criteria and techniques, and evaluate alternative solutions.

1.6. Create figures and tables to display data.

1.7. Draw conclusions and make recommendations.

1.8. Prepare the technology report in a professional format by applying knowledge of theoretical, practical or applied research, or a comprehensive literature review using accepted principles of documentation, grammar, writing style, electronic principles, graphics and design.

1.9. Present the Final Report, and respond effectively to questions defending project conclusions.

GC02

Educational Agencies must select one (or more) of the following outcome statements consistent with the discipline requirements. All Technology programs that include the word "Engineering" in their titles will require substantial coverage of 2.1, 2.2 and 2.3.

2.1 Apply the knowledge of algebra, matrix manipulation and introductory calculus to resolve applied science/engineering technology problems.

Indicators of Performance, such as:

2.1.1 Solve technical problems using algebraic equations, functions, factors, ratios and proportions, using trigonometry, using plane geometry, and using exponential and logarithmic functions.

2.1.2 Solve technical problems by plotting mathematical data, and by using graphs and standard equations.

2.1.3 Solve technical problems through fluency with electronic calculator functions and memories, or through fluency with mathematics computer software.

2.1.4 Solve technical problems using basic arithmetic operations on vectors. Evaluate scalar and vector products.

2.1.5 Calculate the derivative of a sum, product, quotient and composition of functions.

2.1.6 Use derivatives to evaluate slopes and to classify functions.

2.1.7 Solve technical problems through the application of differential calculus.

2.1.8 Solve technical problems such as the area under curves, volumes of revolution, length of paths, first moments of area and centres of gravity, through the application of integral calculus principles.

2.2 Apply the knowledge of statistical processes to resolve applied science or engineering technology problems.

Indicators of Performance, such as:

2.2.1 Specify and validate sampling methods, collect, organize and report statistical data. Evaluate data in terms of central tendency and dispersion.

2.2.2 Predict events using basic probability techniques. Calculate probabilities, experimental z and t values and correlation coefficients.

2.2.3 Use normal probability distribution, standard normal curve and central limit theorem to analyze sample distributions. Compare and analyze distribution and relative frequencies of discrete and continuous random variables.

2.2.4 Establish confidence intervals for population means; determine and/or use relationships with respect to sample size and population variability.

2.2.5 Determine differences between two population means, and between two population proportions using p values to indicate significance tests for population means.

2.2.6 Analyze and solve technical problems and linear relationships through the application of the principles of linear regression and correlation. Determine correlation coefficients.

2.2.7 Solve quality assurance problems through the application of techniques such as control charting and acceptance sampling.

2.2.8 Develop statistical experimental designs for methods of random sampling with selection of treatments and blocking.

2.2.9 Solve technical problems using chi-square tests, power and exponential regression, and by formulating and testing hypotheses for type I or type II errors.

2.3 Apply the knowledge of advanced algebra, matrix and calculus methodologies to resolve applied science/engineering technology problems.

Indicators of Performance, such as:

2.3.1 Solve technical problems using algebraic equations, functions, factors, ratios and proportions, using trigonometry, using plane geometry, and using exponential and logarithmic functions.

2.3.2 Solve technical problems by plotting mathematical data and by using graphs and standard equations.

2.3.3 Solve technical problems through fluency with electronic calculator functions and memories.

2.3.4 Solve technical problems by performing basic arithmetic operations on vectors. Evaluate scalar and vector products.

2.3.5 Determine the derivative of trigonometric and logarithmic functions. Calculate the derivative of a sum, product, quotient and composition of functions.

2.3.6 Solve technical problems through the application of differential calculus. Use derivatives to evaluate slopes and to classify functions. Solve first and second order differential equations. Apply La Place transforms. Apply Fourier transforms. Apply numerical methods to solve first and second order differential equations.

2.3.7 Solve technical problems using definite and indefinite integrals. Solve problems such as the area under curves, volumes of revolution, length of paths, first moments of area and centres of gravity, through the application of integral calculus principles. Apply trapezium or Simpson's rule.

2.3.8 Solve technical problems by solving simultaneous linear equations using determinants.

2.3.9 Solve technical problems through the application of complex numbers. Perform arithmetic operations on complex numbers. Convert a complex number between rectangular and polar form. Determine modulus, phase, real and imaginary parts of a complex number. Express complex numbers in exponent form and perform operations using this notation.

2.3.10 Solve technical problems using matrices. Perform arithmetic operations on matrices. Express and solve simultaneous equations as matrices.

2.3.11 Decompose partial fractions.

2.3.12 Solve technical problems through the application of linear programming.

2.3.13 Solve technical problems involving arithmetic, geometric and other series. Evaluate limits of a sequence or series. Apply Taylor's series.

2.3.14 Solve technical problems through the application of advanced techniques of integration by parts, trigonometric or algebraic substitution, partial fractions, or integral tables.

2.4 Apply the knowledge of discrete/finite mathematics and logic systems to solve applied science and engineering technology problems.

2.4.1 Solve technical problems using exponential and algorithmic functions.

2.4.2 Develop fluency with calculator functions.

2.4.3 Understand the basics of finite mathematics such as integers, finite graphs and formal languages.

2.4.4 Apply the concepts and notations from discrete mathematics to solve computer algorithmic problems and programming languages.

2.4.5 Express complex numbers in exponential form.

GC03 Apply current industry practices of project management that are consistent with the discipline requirements.

Indicators of Performance, such as:

3.1 Formulate a strategy for the management of a project based on expected life cycle and the role that the project might play within an industrial, manufacturing, environmental, laboratory or similar setting.

3.2 Recognize the interplay between time, costs and quality elements of a project.

3.3 Apply technology project elements, such as integration, scope, time, cost, quality, communications, personnel, risk and procurement in a project of defined scope.

3.4 Demonstrate knowledge of the processes associated with initiating a project, such as gaining authorization, defining project scope, developing product descriptions and strategic plans.

3.5 Generate a project charter and define the constraints and assumptions for a project of defined scope.

3.6 Develop a plan for a project of defined scope for implementing the various project elements, such as time, cost, quality, communications, personnel, risk and procurement.

3.7 Identify measures to control changes to the scope, schedule, cost and quality of the project.

3.8 Define and document project activities and tasks, such as time estimating, schedules and control mechanisms, and the close out process, including administrative closing and hand-offs, for a project of a given scope.

3.9 Develop a project schedule utilizing both a manual method and a computerized method, such as critical path and/or a Gantt chart.

3.10 Identify the human resource requirements of a project of defined scope, such as identifying personnel needs, acquiring staff, developing team competencies, monitoring the performance of project personnel and controlling risk factors of the project.

GC04 Apply the principles of physical and natural science.

Indicators of Performance, such as:

4.1 Apply the principles of physics (heat, light, sound and electricity).

4.2 Apply the principles of general, organic and inorganic chemistry.

4.3 Apply the principles of material science and/or physical chemistry.

4.4 Apply the principles of earth and life sciences.

4.5 Apply the principles of geomatic sciences.

4.6 Develop and demonstrate expertise in experimentation, observation, measurement, and documentation through laboratory experiences.

GC05 Understand the basic principles of ethics, sustainability, contracts, codes, and standards.

Indicators of Performance, such as:

5.1 Understand the professional code of ethics of the Provincial Association or Society.

5.2 Understanding of legal and professional accountabilities in the workplace.

5.3 Apply ethical reasoning to resolve social, contractual and environmental issues, with respect to a project.

5.4 Understand environmental sustainability issues with respect to a project.

5.5 Apply the principles of sustainability in an applied science or engineering technology project.

5.6 Demonstrate knowledge of codes and standards applicable to the discipline.

5.7 Demonstrate an understanding of contracts.

5.8 Demonstrate knowledge of confidentiality and privacy regulations, as well as other pertinent regulatory frameworks and/or compliancy requirements.

GC06 Obtain and analyze data. Prepare charts and reports and present to stakeholders.

Indicators of Performance, such as:

6.1 Determine the appropriate source and type of data required, and develop appropriate strategies for data collection.

6.2 Conduct and/or supervise the taking of measurements, their recording and evaluation.

6.3 Analyze and interpret data using systematic approaches to problem solving and decision-making.

6.4 Prepare sketches and/or drawings in accordance with discipline standards, formats, symbols and reference systems.

6.5 Prepare schematic diagrams appropriate for the discipline.

6.6 Produce plans, drawings, details and presentation graphics using computer-aided drafting software.

6.7 Evaluate data relationships for an applied science or engineering technology project's interface with its physical environment.

6.8 Prepare and present project-related documents, including reports in oral and written formats, as appropriate for the task and the discipline.

6.9 Present data reflective of work performed in the chosen field.

6.10 Report and communicate findings to a variety of audiences.

GC07 Utilize a variety of appropriate computer hardware and software necessary to the performance of tasks within the discipline.

Indicators of Performance, such as:

7.1 Determine when computers or other technology can enhance productivity, the completion of tasks, solving of problems, performing research or creating products.

7.2 Use basic computer operating systems and common application software competently.

7.3 Determine which tasks are best handled using computers or other technology.

7.4 Select, and effectively and ethically use suitable software, tools and equipment for the task.

7.5 Transfer data using electronic communication systems.

7.6 Manage computer file systems.

7.7 Solve technical problems using computer applications.

7.8 Use Internet technologies to transfer, research and retrieve information.

7.9 Demonstrate safe computing practices.

GC08 Apply knowledge of safe working practices, including Occupational Health & Safety Regulations.

Indicators of Performance, such as:

8.1 Demonstrate knowledge of health and safety legislation and apply this knowledge to practices applicable to a discipline.

8.2 Prepare site/project-specific Health and Safety Plans.

8.3 Demonstrate knowledge of provincially regulated first aid program.

8.4 Demonstrate knowledge of legislation with respect to designated substances.

8.5 Demonstrate knowledge of legislation with respect to the transportation of dangerous goods.

8.6 Demonstrate knowledge of, and apply health and safety legislation with respect to accident prevention.

8.7 Analyze a workplace area, and initiate action to handle unsafe or hazardous situations.

8.8 Perform prescribed safety and environmental inspections.

8.9 Demonstrate the knowledge of safe working practices and the ability to work safely in a lab or shop environment.

8.10 Operate workplace equipment safely.

APPENDIX A

Profile of a Certified Applied Science/Engineering Technologist

A Certified Applied Science or Engineering Technologist (hereinafter referred to as the technologist) is a professional who, through academic training and experience in the application of mathematics, engineering and scientific principles, is capable of assuming responsibility, and of exercising independent judgment.

Education and Training
The academic training for a technologist is based upon a core of applied mathematics and applied science/engineering fundamentals. The mathematics core would include topics such as differential equations, integration, linear algebra, analytical geometry, trigonometry, statistics and computer-related mathematics, permitting the technologist to use mathematics as a tool in the synthesis of designs or in the analysis of the technical problems. Programs that include "***Engineering***" in their title will require advanced mathematics.

Certification
An individual who successfully completes the examinations of a provincial association, or who graduates from an accredited technologist level program, or who otherwise meets the academic standards established by the certifying body, may on completion of at least two years of acceptable practical experience in an area of work directly related to the area of academic achievement, be certified as an Applied Science Technologist or Engineering Technologist.

Career Opportunities
The technologist may carry out a wide range of complex work processes. Career opportunities exist in most areas of: industry, consulting, business, government and public organizations. Typical areas would include design, marketing, sales, estimating, research and development, production control, purchasing, operations and production, testing, quality management, maintenance, customer and field service, management and supervision of projects and people, instruction and teaching.

Duties and Responsibilities
The technologist uses an applied approach based upon a comprehensive understanding of the field of technology in which certification was granted. The technologist evaluates assignments, establishes objectives, defines problems, and determines procedures and actions to resolve the problems.

The technologist may:

- design equipment, processes or systems; interpret and prepare specifications, technical drawings or instructions; prepare estimates and manage projects;
- conduct tests; develop prototypes; operate pilot plants; trouble-shoot complex equipment; resolve production or construction problems; compile experimental data, or prepare reports;
- supervise, train, coordinate and assume administrative responsibility for the work of others; and
- participate in short and long range planning
- carry out studies, prepare reports, develop programs, provide instructions and implement projects.

The Certified Applied Science or Engineering Technologist will assume responsibility for his/her work, and is at all times bound by a professional code of ethics. He/she will be identified by one of the following certification designations: AScT, CET, RET, TP or PTech.

Appendix B

Conference Board of Canada Employability Skills (2007)

The skills you need to enter and progress in the world of work - whether you work on your own or as a part of a team. These skills can also be used beyond the workplace in a range of daily activities.

Academic Skills

Those Skills, which provide the basic foundation to get, keep and progress on a job and to achieve the best results. Canadian employers need a person who can:

Communicate:

- understand and speak the languages in which business is conducted
- listen to, understand and learn
- read, comprehend and use written materials, including graphs, charts and displays
- write effectively in the languages in which business is conducted

Think:

- think critically and act logically to evaluate situations, solve problems and make decisions
- understand and solve problems involving mathematics, and use the results
- use technology, instruments, tools and information systems effectively
- access and apply specialized knowledge from various fields (e.g. skilled trades, technology, physical sciences, arts and social sciences

Learn:

- continue to learn for life

Personal Management Skills

The combination of skills, attitudes and behaviours required to get, keep and progress on a job and to achieve the best results. Canadian employers need a person who can demonstrate:

Positive attitudes and behaviours:

- self-esteem and confidence
- honesty, integrity and personal ethics
- a positive attitude toward learning, growth and personal health
- initiative, energy, and persistence to get the job done

Responsibility:

- the ability to set goals and priorities in work and personal life
- the ability to plan and manage time, money and other resources to achieve goals
- accountability for actions taken
- adaptability
- a positive attitude toward change
- the ability to identify and suggest new ideas to get the job done-----creativity

Teamwork Skills

Those skills needed to work with others on a job and to achieve the best results. Canadian employers need a person who can:

- work with others
- understand and contribute to the organization's goals
- understand and work within the culture of the group
- plan and make decisions with others and support the outcomes
- respect the thoughts and opinions of others in the group
- exercise "give and take" to achieve group results
- seek a team approach as appropriate
- lead where appropriate, mobilizing the group for high performance

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