

# **Degree Level Expectations and Outcomes for Graduates Receiving the Degree of Bachelor of Applied Science in Engineering Science**

## **Faculty of Applied Science and Engineering University of Toronto**

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### **1 Executive Summary**

The degree level expectations for graduates of the Faculty of Applied Science and Engineering receiving the **Bachelor of Applied Science in Engineering Science** degree have been drafted by Professor Will Cluett (Chair), Professor Gabriele D'Eleuterio (past Associate Chair, Curriculum Matters) and Lisa Romkey (Lecturer, Curriculum, Teaching and Learning), all with the Division of Engineering Science. This document builds on the degree level expectations developed for the Bachelor of Applied Science that was created by a small working group under the direction of Professor Grant Allen, Vice Dean (Undergraduate).

The Faculty has previously approved two separate degree names, with one specifically for the Engineering Science program. The Engineering Science program shares elements of the core Engineering programs, but is distinct in many respects, as outlined in this document, with the key differences being:

- The Engineering Science program is designed and delivered at a level that is more academically demanding than the core Engineering programs;
- The Engineering Science program contains more mathematics, science and engineering science than the core Engineering programs, with greater focus on deriving results using a first principles approach;
- The Engineering Science program has a distinct “2+2” curriculum structure, namely a 2-year foundation curriculum followed by a 2-year specialization curriculum in a diverse range of fields or Options, many of which are unique to the Engineering Science program;
- The Engineering Science program requires that all students complete an independent research-based thesis project.

### **2 Program Objectives and Requirements**

#### **2.1 Program Objectives**

The Engineering Science program aims to provide all of its undergraduate students with an education that will encourage them to be responsible global citizens, future leaders in society, and leading practitioners of the engineering sciences.

The Engineering Science Program-Level Objectives Include:

- *To provide an academically enriched program for young men and women seeking a significant academic challenge;*
- *To produce engineering science graduates who have a deep understanding of mathematics, physics, chemistry, biology and the*

*engineering sciences, and can apply and integrate this knowledge to solve complex problems;*

- *To prepare men and women for careers in the engineering sciences within academia, industry and the public sector as well as careers in other professions;*
- *To produce engineering science graduates who have an understanding of the impact of technology on individuals, groups and society-at-large;*
- *To educate men and women as global citizens and leaders of the society in which they live and work.*

## **2.2 Requirements to Graduate**

In order to graduate with a Bachelor of Applied Science in Engineering Science, each student must complete a full undergraduate program in Engineering Science as outlined in the Faculty Calendar within nine calendar years of first registration, exclusive of mandatory absences from his/her program.

Students must satisfy both the requirements associated with being an accredited engineering program and the requirements associated with the degree program itself.

### **2.2.1 Accreditation Requirements**

The practice of engineering is regulated, by statute, in all Canadian provinces and territories. To become a Professional Engineer, an individual must satisfy the requirements of the licensing bodies. These requirements include a degree from an accredited program, successful completion of a professional practice examination in engineering law and ethics, and suitable experience. The Engineering Science program is an accredited engineering program and is evaluated regularly by the Canadian Engineering Accreditation Board (CEAB) of the Canadian Council of Professional Engineers.

The criteria set out by the CEAB are designed to ensure that each graduate has a foundation in Mathematics and Basic Sciences, a broad preparation in Engineering Sciences and Engineering Design and an exposure to non-technical subjects (Complementary Studies) that complement the technical aspects of the curriculum<sup>1</sup>.

### **2.2.2 Program-Level Requirements**

All students in the Engineering Science program are required to complete two foundation years and two specialization years. Specific outcomes for these components of the program will be described later in the document in Section 3.

There are a set of program-level requirements, described below, that apply to all Engineering Science students:

1. **Coursework:** Engineering Science students participate in a common foundation curriculum (years 1 & 2), designed for and delivered only to students in the Engineering Science program. Courses in the foundation curriculum are taught at an accelerated pace with a focus on developing the

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<sup>1</sup> Engineers Canada, “Accreditation Criteria and Procedures: Canadian Engineering Accreditation Board”, Canadian Council of Professional Engineers, ISSN 1708-8054 (2007)

students' ability to derive results using a first principles approach. Many of the courses in the specialization curriculum (years 3 & 4) are taught in a similar fashion and build on the unique background developed in the foundation curriculum.

- a. Foundation Curriculum (years 1&2):
    - Theoretical and Applied Physics, Chemistry & Applied Chemistry and Engineering Biology;
    - Pure and Applied Mathematics;
    - Engineering Science & Technology;
    - Engineering Design, Professional Practice & Issues-based Education.
  - b. Specialization Curriculum (years 3&4):
    - Courses in an area of specialization, several of which are offered only to Engineering Science students, building on their unique foundation experience;
    - Technical Electives, which provide students with choice;
    - Courses with substantial design content relevant to the area of specialization.
  - c. Complementary Studies Electives.
  - d. A basic knowledge of Engineering Economics.
  - e. Across all four years, sufficient opportunities for the development of professional awareness and practice.
2. **Research:** All students participate in an independent research thesis project in their fourth year.
  3. **Promotion:** Engineering Science consists of eight Fall (F) and Winter (W) Sessions taken in order.
    - a. A unique set of promotion rules exist in the first year for Engineering Science students to enable them to adapt to the rigors of the program:
      - i. Students must achieve a sessional average of 55% or greater to continue in Engineering Science after the 1F semester. Students with an average <55% must transfer to another engineering program.
      - ii. Students must achieve a sessional average of 65% or greater to continue in Engineering Science after the 1W semester. Students with an average <65% but must transfer to another engineering program.
    - b. To gain credit for a session a student must:
      - i. satisfy the academic regulations to proceed to the succeeding session as described in the Faculty Calendar, and
      - ii. not be subsequently required to repeat the session for which credit is to be gained, and

- iii. achieve a course mark of 50% or greater in every course taken as part of the academic load in a session, and
  - iv. not have any outstanding designations of 'standing deferred', 'incomplete' or 'No Grade Available' for any course in any session.
- c. To be eligible to graduate, each student must attain a weighted Session Average of 60% or greater in the final session of their program. Any student who does not achieve a weighted Session Average of 60% in their final session (4W), but has attained a weighted Session Average that allows them to proceed to the next session on probation, shall repeat the final session and achieve a weighted Session Average of 60% or greater to graduate.
- 4. **English Proficiency:** Each student must show an ability to write English coherently and correctly in all written work submitted for evaluation. Consequently, the Faculty reserves the right to ask each student to write a post-admission English Proficiency Assessment at the beginning of his or her first year of studies. Every student will also take at least one course that includes a written communication component within their curriculum. Satisfactory completion of the course or courses is required for graduation.
- 5. **Professional Experience:** The Faculty requires that all students complete a minimum of 600 hours of practical work before graduation.

### **3 Degree Level Expectations for the Bachelor of Applied Science in Engineering Science**

The Division of Engineering Science has adopted the six categories of degree level expectations outlined in the OCAV Guidelines. The following section describes how these expectations are met by students meeting the degree requirements outlined in Section 2.2.

#### **3.1 Depth and Breadth of Knowledge**

Students in the Engineering Science program participate in a comprehensive, two-year foundation curriculum. This foundation forms a common basis for study across various areas of specialization, as well as future study or work in engineering, mathematics or science, and also provides students with a developed knowledge and critical understanding of engineering, science and engineering science.

Specific outcomes include:

- An understanding of the formative theories that underlie the functioning of our universe;
- Knowledge of problems and challenges that sit at the intersection of science and engineering;
- A comprehensive understanding of science including biology, chemistry and physics;
- A comprehensive understanding of a broad range of the engineering sciences, including dynamics and mechanics, materials science, electric circuitry, thermodynamics, fluid mechanics, transport phenomena, digital and computer systems, chemical kinetics, and electromagnetism.

- A comprehensive understanding of mathematics in its pure and applied form;
- Knowledge and practice in engineering design, laboratory and communication;
- Knowledge of a breadth of design methodologies.

Upon completion of the two-year foundation curriculum, students participate in one of eight areas of specialization through years 3 and 4. Students develop depth of knowledge through outcomes that include:

- Ability to identify major research areas within an area of specialization;
- Demonstrate how their area of specialization intersects with other engineering science disciplines;
- Synthesize information and theories to conceptualize new engineering challenges;
- Carry out original research within their area of specialization;
- Demonstrate an awareness of new and emerging technologies;
- Apply fundamental knowledge from the foundation years.

The program consists of a complementary studies component that students participate in across all four years. This requirement allows students to develop critical thinking and analytical skills outside of engineering science.

### **3.2     *Knowledge of Methodologies***

Core methodologies within the Engineering Science program include engineering design and experimental science. Engineering Science students demonstrate the following outcomes:

Engineering Design:

- Identify and conceptualize engineering problems, including the identification of constraints;
- Analyze the design work of established engineers;
- Apply a deep understanding of pure math and science to engineering problems;
- Design a system, component or process to meet desired needs within economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability;
- Evaluate the appropriateness of various approaches to analyze and solve a design problem;
- Devise and sustain arguments for their design;
- Function as a member of a design team;
- Manage the design process and evaluate outcomes;
- Understand how technology impacts society at the individual, community and global level.

Experimental Science:

- Practice the scientific method;

- Practice research methodologies specific to one's area of specialization;
- Connect knowledge of pure math, science and engineering science to an experimental setting;
- Design and conduct experiments;
- Collect, analyze and interpret data;
- Conduct error analysis;
- Develop skills in research methodologies specific to one's area of specialization;
- Work as a member of a research team.

### **3.3 Application of Knowledge**

The application of engineering science to solve engineering problems is fundamental to the Engineering Science program. Students are also required to demonstrate an understanding of their professional and ethical responsibility to society, and apply this understanding to design projects. Specific outcomes include:

- Acquire knowledge necessary to complete research and design work;
- Apply established theoretical information and past research results to a scientific or engineering problem;
- Analyze the impact of engineering projects on the environment and society.

### **3.4 Communication Skills**

The Engineering Science Program requires students to demonstrate a number of outcomes related to communication skills, through a communication component placed within the design curriculum. Specific outcomes include:

- Understand that communication is integral to engineering practice;
- Communicate information to specialist and non-specialist audiences;
- Present outcomes of research and design through oral presentations;
- Present outcomes of research and design through technical writing;
- Present outcomes of research and design through visual communication;
- Demonstrate point of view through persuasive writing and debate;
- Comprehend and discuss the impact of the engineering profession in a global and societal context;
- Comprehend and discuss contemporary issues.

### **3.5 Awareness of Limits of Knowledge**

Engineering Science students in their chosen area of specialization develop a deep understanding of a discipline within engineering science as it is currently appreciated by educators, who are at the same time involved in original scholarship in the subject area. The course content is designed, in part, to provide students with an appreciation of the uncertainties, ambiguities and limitations of knowledge in the specific area. Specific outcomes include:

- An awareness of research within a particular discipline;

- An awareness of the questions that remain and the barriers that exist to answering these questions within a particular discipline;
- An appreciation of the limits of one's knowledge, and how the boundaries of knowledge limit action.

### ***3.6 Autonomy and Professional Capacity***

Engineering Science students are required to develop an awareness of the engineering profession and the skills and qualities of professional practice. Specific outcomes include:

- An ability to work in teams, recognizing the contributions of others and one's own responsibility in a team-based setting;
- Decision-making skills in engineering design and research;
- An understanding of the value of acknowledging the work of others;
- An understanding of ethical behaviour, particularly as it relates to engineering projects;
- An ability to manage one's learning and learning needs;
- Life-long learning skills.

### ***3.7 Other Degree Level Expectations***

The Engineering Science program requires all students to develop an advanced understanding of how to obtain, manipulate and evaluate information and bring diverse sources together to develop a comprehensive understanding of specific issues, solve problems or apply the scientific method to create further knowledge in the discipline.

## **4 Implementation**

The Faculty Council of the Faculty of Applied Science and Engineering has overall responsibility for ensuring that the degree level expectations are implemented consistently across the Faculty. All changes to curriculum are approved first through the Engineering Science Curriculum Committee, and then through the Faculty's Curriculum Committee.