

Graduate Attributes 101

July 9, 2026



ENGINEERING

Sarah Dickson-Anderson
Associate Dean (Undergraduate)

Shelir Ebrahimi
Associate Chair (Undergraduate), Department of Chemical Engineering

1. Some background on the CEAB
2. What are “Graduate Attributes”?
3. Curriculum mapping
4. Learning outcome statements
5. Indicator measurements
6. GA Documentation

1 - Some Background on the CEAB

A little context never hurts, right?



ENGINEERING

- **CEAB** - a standing committee to “Engineers Canada”
- **Engineers Canada** - a national federation of all the provincial licensing organizations (i.e., PEO)
- **Accreditation** - performed to ensure that graduates of an engineering program are academically qualified to be licensed as a professional engineer
- Accreditation is critical to our success!

What Does the CEAB Investigate? (Six key areas)

1. Graduate attributes - *we will come back to this*
2. Continuous improvement - *will come back to this*
3. Students - policies, procedures, quality, counselling, etc.
4. Curriculum content and quality - inputs-based assessment
 - AU - accreditation units
5. Program Environment (faculty, labs, libraries, financial resources ...)
6. Additional criteria (program options, weakest link, program name ...)

- Most recent review was November 2024
- iBioMed programs only (obtained the 6-year max)
- Next accreditation visit (10 B.Eng./B.Eng.BioEngineering + hopefully 8 iBioMed programs) scheduled for November 2027
- 2026-2027 is a “capture” year
- Graduate Attributes Continuous Improvement (GA/CI) is an ONGOING effort

2 - What are Graduate Attributes?

Lists are fun.



ENGINEERING

What are the 12 GAs?

Attributes/skills that graduates of a program must have include:

1. Knowledge base for engineering
2. Problem analysis
3. Investigation
4. Design
5. Use of engineering tools
6. Individual and team work
7. Communication skills
8. Professionalism
9. Impact on society and environment
10. Ethics and equity
11. Economics and project management
12. Life-long learning

- We need to some way to assess the degree to which our students have attained **attributes**
- We start by defining “**indicators**” of the attributes
- Each **attribute** has a number of “**indicators**” associated with it
- The indicators describe the various elements of an attribute
- Indicators must be “measurable”

Attribute: 1. A knowledge base for engineering

Description of the attribute (from CEAB):

Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.

Four Indicators for Attribute 1:

- 1.1 Competence in Mathematics
- 1.2 Competence in Natural Sciences
- 1.3 Competence in Engineering Fundamentals
- 1.4 Competence in Specialized Engineering knowledge

Attribute #6: Individual and team work

Description of the attribute (from CEAB):

An ability to work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.

Two Indicators for Attribute 6:

- 6.1 Actively contributes to the planning and execution of a team project
- 6.2 Manages interpersonal relationships, taking leadership responsibilities as needed

- We are measuring learning outcomes that relate to the indicators
- Graduate Attribute #1
 - Indicator 1.1
 - Indicator 1.2
 - ...
- Grad Attribute #2
 - Indicator 2.1
 - Indicator 2.2
 - Indicator 2.3
- ... *And so on...*
- Graduate Attribute #12
 - Indicator 12.1
 - Indicator 12.2

3 - Curriculum Mapping

It helps to have a map!



ENGINEERING

- Courses in each program have been mapped to relevant indicators
- Each course has a list of “**learning outcomes**”
- Relevant indicators map to the learning outcomes
- For each indicator, there are three levels:
 - I **I**ntroduced in your course
 - D **D**eveloped in your course
 - A **A**ppplied in your course

https://www.engineerscanada.ca/sites/default/files/draft_program_visitor_guide_v1.25.pdf

- **Introductory:** ... the students learn the working vocabulary of the area of content, along with some of the major underlying concepts. Many of the terms need defining and the ideas are often presented in a somewhat simplified way.
- **Development:** ...the students use their working vocabulary and major fundamental concepts to begin to probe more deeply, to read the literature, and to deepen their exploration into concepts. At this level, students can begin to appreciate that any field of study is a complex mixture of sub-disciplines with many different levels of organization and analysis.
- **Application:** ... the students approach mastery in the area of content.
They explore deeply into the discipline and experience the controversies, debate and uncertainties that characterize the leading edges of any field. An advanced student can be expected to be able to relate course material across different courses, to begin to synthesize and integrate and achieve fresh insights. Students at this level are working with the knowledge very differently, perhaps even creating new knowledge through independent investigation.

4 - Learning Outcomes

“I know nothing, except that I know nothing”



ENGINEERING

- Indicators can be **broad statements** that apply across departments.
- **Learning outcome** statements contain detailed information about what a student will know and be able to do at the end of the course.
- We are measuring how well the students mastered the learning outcomes.
- Good learning outcomes:
 1. Specify an ***action by the students*** that is **observable**.
 2. Specify an ***action by the students*** that is **measurable**.
 3. Specify an ***action*** that is **done by the students** (not the instructors).

- Must include verbs!
- Example of a bad learning outcome statement:
 - *Differential equations*
- Example of a good learning outcome statement:
 - Analytically solves a linear homogeneous differential equation with associated boundary conditions in 1 and 2 dimensions.

Four sin words in learning outcome statements: **know, understand, learn, appreciate**

Bloom's Taxonomy

Increasing Cognitive Load and Educational Fulfillment

Remember	Understand	Apply	Analyze	Evaluate	Create
Count Define Describe Draw Identify Label List Match Name Outline Point Quote Read Recall Recite Recognize Record Repeat Reproduce Select State Write	Associate Compute Convert Defend Discuss Distinguish Estimate Explain Extend Extrapolate Generalize Give examples Infer Paraphrase Predict Rewrite Summarize	Add Apply Calculate Change Classify Complete Compute Demonstrate Discover Divide Examine Graph Interpolate Manipulate Modify Operate Prepare Produce Show Solve Subtract Translate Use	Analyze Arrange Breakdown Combine Design Detect Develop Diagram Differentiate Discriminate Illustrate Infer Outline Point out Relate Select Separate Subdivide Utilize	Appraise Assess Compare Conclude Contrast Criticize Critique Determine Grade Interpret Judge Justify Measure Rank Rate Support Test	Categorize Combine Compile Compose Create Drive Design Devise Generate Group Integrate Modify Order Organize, Plan Prescribe Propose Rearrange Reconstruct Related Reorganize Revise, Rewrite Summarize Transform Specify

- Indicator:
 - 1.1 Competence in Mathematics
- Example of an associated learning outcome for a specific course:
 - Analytically solves a linear homogeneous differential equation with associated boundary conditions in 1 and 2 dimensions.
- Indicator:
 - 1.4 Competence in specialized engineering knowledge
- Example of an associated learning outcome for a specific course:
 - Describe the basis of the heat and momentum transfer analogy and perform heat transfer calculations on thermal boundary layers.

Learning Objectives

After completing this course, the student should be able to:

- L.1. Recognize when numerical methods should be applied as a part of a solution to a variety of chemical engineering (and other) problems or opportunities.
- L.2. Formulate mathematical models of common engineering unit operations and processes.
- L.3. Identify the appropriate algorithm or numerical method suitable for the solution.
- L.4. Break down how an algorithm works based on fundamental mathematical concepts.
- L.5. Implement algorithms using calculators and (more importantly) software tools.
- L.6. Derive algorithms for new problems based on a fundamental understanding of the objective.
- L.7. Use a numerical solution to help solve the original problem of interest.
- L.8. Identify the critical differences, advantages, and disadvantages of numerical versus analytical techniques.

- Certain courses collect indicator data on the development of attributes deemed critical for engineers by the CEAB. These indicators will be assessed throughout the course, and redacted samples of student work may be collected for submission to the CEAB during McMaster Engineering's accreditation cycle. The indicators assessed in ChE 2E04 are as follows:
 - 1.1 - Competence in mathematics.
 - 1.3 - Competence in engineering fundamentals.
 - 5.1 - Evaluates engineering tools, identifies their limitations, and selects, adapts, or extends them appropriately.
 - 5.2 - Successfully uses engineering tools.
 - 7.1 - Demonstrates comprehension of technical and non-technical instructions and questions.

- The CEAB indicators on slide 22 are mapped to the course learning outcomes, as shown in the table on the right.
- Note there may be additional indicators that are covered but not measured. They must also be included in the mapped learning outcomes
- The CEAB accreditation process is an important component to curriculum design in engineering.

Indicator	Mapped Learning Outcomes
1.1	L.2 L.4 L.5
1.3	L.1 L.2 L.3 L.7 L.8
5.1	L.3 L.4 L.6 L.8
5.2	L.3 L.5
7.1	L.1 L.7 L.8

- [Chemical Engineering GA Program Map](#)

5 - Indicator Measurements

Pass me the grade stick, will ya?



ENGINEERING

1. Determine the extent to which students are attaining specific *learning outcomes* associated with the indicator
2. Use this information to improve programs in subsequent years (as required by CEAB).

- We use tests, assignments, presentations, reports etc. in our measurement process.
- We use rubrics to measure the student learning outcomes demonstrated in those assessments.
- Four levels of performance are used:
 1. Does not meet expectations [BE]
 2. Marginal [MA]
 3. Meets expectations [ME]
 4. Exceeds expectations [XE]

1. Decide on which student work will be used for measurement (i.e., tests, exam, presentations, project reports...)
2. Develop a rubric to measure indicator performance based on the relevant learning outcome
3. Bin students according to rubric performance
4. Analyze results to provide information for continuous improvement (i.e., identify learning outcomes that the students are struggling with)
5. Document measurement results

Measurement of the Indicator 1.4: Competence in Specialized Engineering Knowledge

1. Student work used for measurement:
 - Final exam
2. Development of rubric (example to follow):
 - Think about what you wanted the students to learn
 - Link those learning outcomes to the exam questions
 - Decide on what the students needed to be able to do to demonstrate that they “met expectations”
 - Then define learning outcomes for “exceed expectations”, “marginal”, “does not meet expectations”

Example Rubric – MECH ENG 4S03 (Incompressible Flow)

Topic (exam questions used)	Below Expectations	Marginal	Meets Expectations	Exceeds Expectations
<u>Topic #1:</u> Heat and momentum transfer analogy (Question 4 of final exam)	-Does not understand the concept of the analogy	-Able to use the correlations. - Understands that there is an analogy, but cannot explain the math behind it.	- Can explain the math. basis of the analogy. - Can determine appropriate correlation to solve for heat transfer or drag	-“meets expectations” plus: - Can explain why analogy does not hold if there is pressure gradient
	Comments on Topic #1 performance:			

Example Rubric – MECH ENG 4S03 (Incompressible Flow)

Topic (exam questions used)	Below Expectations	Marginal	Meets Expectations	Exceeds Expectations
<u>Topic #2:</u> Boundary layers (Question 3 of final exam)	-Cannot use correlations correctly -Unable to explain separation	-Can draw velocity profile -Can calculate local shear and total drag -Doesn't understand separation	-Can draw boundary layer velocity profile - can calculate local shear and total drag -Can say whether flow will separate or not	-"meets expectations" plus: - Can explain (based on physics in near wall region) why sep. cannot occur for fav. pressure grad.
	Comments on Topic #2 performance:			

POOR Example Rubric

Topic (exam questions used)	Below Expectations	Marginal	Meets Expectations	Exceeds Expectations
<u>Topic #3:</u> (Question 4 of final exam)	Student does not answer question or does poorly on question 4 [< 4.5 / 10]	Student has problems with question 4. [4.5 – 6 / 10]	Is able to answer question 4 satisfactorily [6-8 / 10]	Does really well on question 4 [>8 / 10]
	Comments on Topic #3 performance:			

6 – Graduate Attribute Documentation

Home stretch



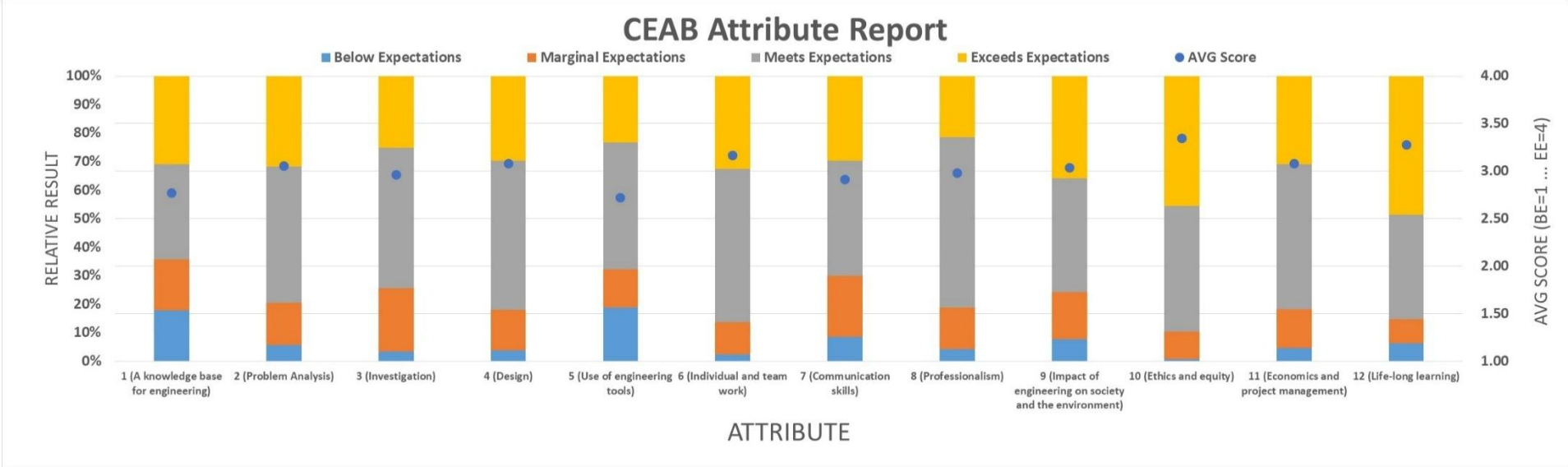
ENGINEERING

- Need to write a short document summarizing results. It should include:
 - Rubric used for measurement
 - Corresponding assessment (e.g., exam question)
 - Distributions for each indicator measurement
 - Identified areas for continuous improvement
 - Possibly examples of student performance in each area e.g., below expectations, marginal, ... (consult with your Associate Chair)
 - Suggestions for how to improve measurement procedure (if any)
- MESURE 2.0: Faculty of Engineering has invested in database software to store data

- Continuous Improvement:
 - Incorporate areas identified as needing improvement the next time you teach this course
 - This tracking ensures legacy for the next instructor of the course
- It is important to be accountable for your suggested improvements - they are recorded in GA reports and reported to the CEAB
- Subsequent measurement of the same learning outcomes should hopefully show improvement in those areas where we found the students were struggling.

- [Chemical Engineering Template](#)

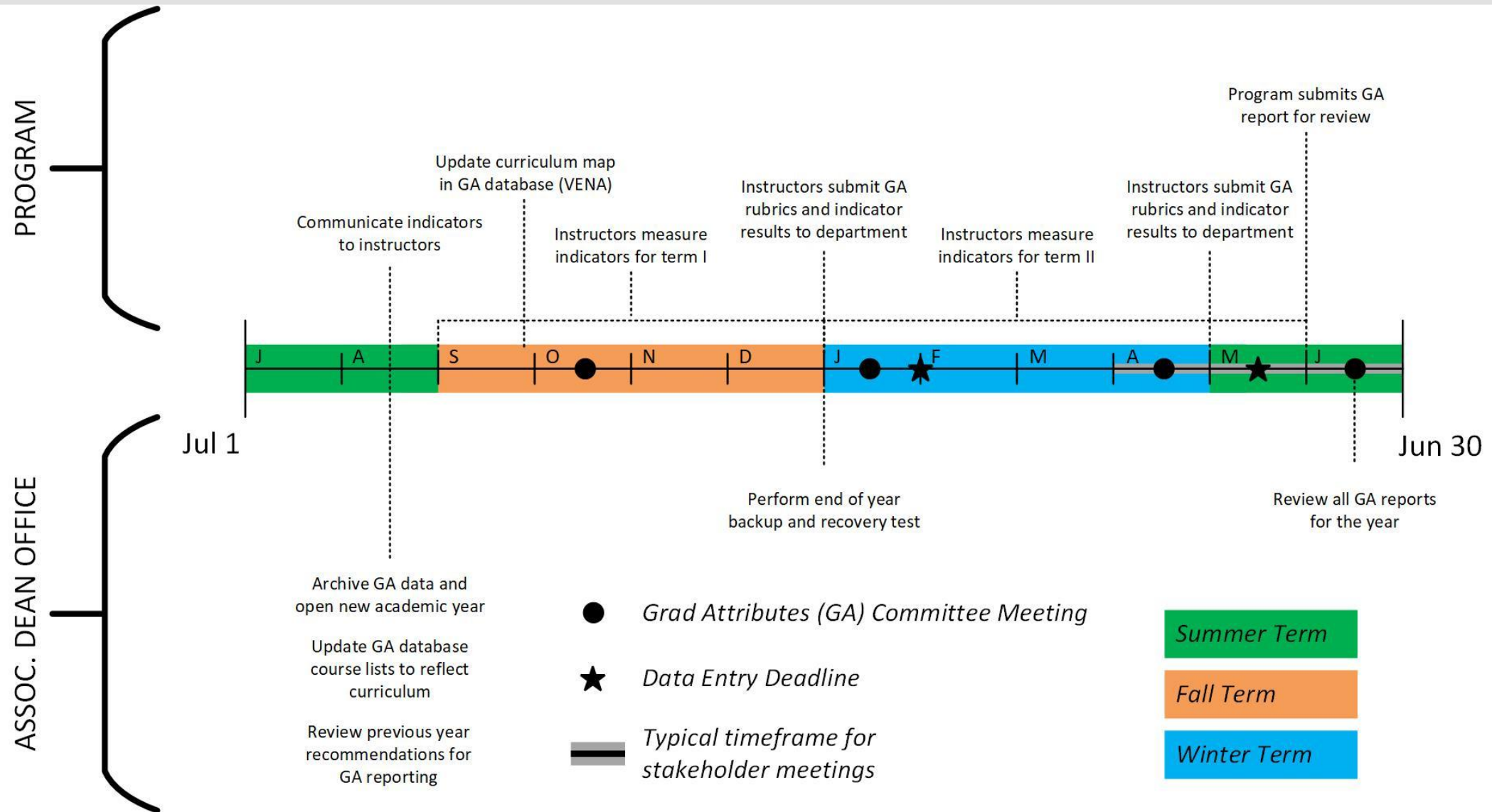
Program Outcome to Investigate (Chem Eng)



- At the program level, CEAB will be assessing:
 - Improvement process:
 - Suitable committee structure
 - Engagement of relevant stakeholders
 - Well-defined timetable
 - Stakeholder engagement:
 - Consultation with broadly-based set of stakeholders (internal and external to the program and institution)
 - Improvement Actions:
 - Expectation of curriculum or other program improvements
 - improved achievement of graduate attributes
 - Improvements in assessment process

^{*}From “Accreditation Criteria and Procedures 2022 - Appendix 10”

Annual GA/CI Cycle



- Each department has a graduate attributes (GA) committee (sometimes also the curriculum committee)
- GA Committee responsible for:
 - Developing a GA measurement plan for the department
 - Organizing stakeholder meetings
 - Communicating expectations to faculty members
 - Assisting faculty members with GA measurements
 - Reviewing GA measurement reports
 - Keeping track of continuous improvement at course level (via measurement reports)
 - Recommending program improvements based on program level GA measures
 - *e.g.*, which attributes do not meet the threshold or are not well represented in the curriculum.

Key Documents from CEAB website:

[Manual of Accreditation Procedures \(PDF\)](#) (updated June 2024)

[General Visitor Manual \(PDF\)](#) (updated July 2019)

See Appendix for Detailed List of Indicators

CEAB is Moving to a Competency-Based System

ENGINEERING

CEAB Graduate Attributes

A knowledge base for engineering
Problem analysis
Investigation
Design
Use of engineering tools
Individual and team work
Communication skills
Professionalism
Impacts of engineering on society and the environment
Ethics and equity
Economics and project management
Lifelong learning

Full Spectrum Competency Profile

Engineering knowledge
Problem solving and design
Protection of the public
Communication
Teamwork and collaboration
Lifelong learning

Pan-Canadian work experience competencies

Technical competence
Communication
Project and financial management
Team effectiveness
Professional accountability
Social, economic, environmental and sustainability
Personal continuing professional development

7 - Input-Based Accreditation Requirements

Home stretch



ENGINEERING

Key Area #1: Input-based Assessment

Key measure is: **AU – “Accreditation Unit”**

It is a way of measuring how much time we spend in lectures/tutorials/labs/ design projects

- One hour (50 min) of lecture = 1 AU
- One hour of lab or tutorial = 0.5 AU

At McMaster, **each term has 12.4 weeks**

How to Calculate AU?

Lecture-Based Courses:

# Lecture Hours/Week	# Tutorial Hours/Course	Calculation	AUs
3	0	$(3 \times 12.4 \times 1 \text{ AU}) + (0 \times 0.5 \text{ AU})$	37.2
3	24	$(3 \times 12.4 \times 1 \text{ AU}) + (24 \times 0.5 \text{ AU})$	49.6
2	24	$(2 \times 12.4 \times 1 \text{ AU}) + (24 \times 0.5 \text{ AU})$	37.2
3	12	$(3 \times 12.4 \times 1 \text{ AU}) + (12 \times 0.5 \text{ AU})$	43.4

How to Calculate AU?

Lab-Based Courses:

- They count the actual number of hours that the students spend on the labs in each course (including the pre-lab videos)
- Add them up and then multiply by 0.5

# Lecture Hours/ Week	# Tutorial Hours/ Course	# Labs Hours/ Course	Calculation	AUs
3	0	12	$(3 \times 12.4 \times 1 \text{ AU}) + (0 \times 0.5 \text{ AU}) + (12 \times 0.5 \text{ AU})$	43.2
3	24	0	$(3 \times 12.4 \times 1 \text{ AU}) + (24 \times 0.5 \text{ AU}) + (0 \times 0.5 \text{ AU})$	49.6
2	24	12	$(2 \times 12.4 \times 1 \text{ AU}) + (24 \times 0.5 \text{ AU}) + (12 \times 0.5 \text{ AU})$	42.8
3	12	16	$(3 \times 12.4 \times 1 \text{ AU}) + (12 \times 0.5 \text{ AU}) + (16 \times 0.5 \text{ AU})$	51.2

How to Calculate AU? Design Courses

Lecture hours don't really reflect the AUs since time is spent with supervisors outside of lectures.

Use “**k-factor**” (essentially it is a weight to relate units to AUs) and the number of units associated with the course to determine total AUs

Total AUs = k-factor * number of course units.

IBEHS used the lowest k-factor across all 8 programs (conservative method) which was determined as **12.93**

Within a Course Curriculum is Assessed

CEAB wants to know how well these areas are covered in our courses:

- Mathematics (example – statistics, linear algebra, ...)
- Natural Science (example – chemistry, physics, ...)
- Engineering Science
- Engineering Design
- Complementary studies (example – humanities, social science, art, management, engineering economics, impact of technology on society, communication, health and safety, ethics, equity, law)

For each course, we provide information on how much of these areas are covered:

Example Course: Math – 25%; Engineering Science – 75%

AU Program Requirements

Curriculum Area	Minimum AU
Total for entire program	1850
Math	225
Natural Science	195
Math + Natural Science	420
Engineering Science (ES)	225
Engineering Design (ED)	225
ES + ED	600
Engineering science + design	900
Complementary studies	225
Specific Requirements:	
ED: taught by P.Eng.	
ES: taught by P.Eng. or on the path to P.Eng.	

P.Eng. Requirements

- While this has not occurred in a while, in the 2009 accreditation, a program only got 3 years because the minimum requirements were not met for “Specific” requirements

APPENDIX

List of Indicators



ENGINEERING

1. A knowledge Base for Engineering

Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.

- 1.1 Competence in Mathematics
- 1.2 Competence in Natural Sciences
- 1.3 Competence in Engineering Fundamentals
- 1.4 Competence in Specialized Engineering knowledge

2. Problem Analysis

An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.

- 2.1 Identifies and states reasonable assumptions and suitable engineering fundamentals, before proposing a solution path to a problem.
- 2.2 Proposes problem solutions supported by substantiated reasoning, recognizing the limitations of the solutions

3. Investigation:

An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.

- 3.1 Selects appropriately from relevant knowledge base to plan appropriate data collection methods and analysis strategies.
- 3.2 Synthesizes the results of an investigation to reach valid conclusions.

4. Design

An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations.

- 4.1 Defines the problem by identifying relevant context, constraints, and prior approaches before exploring potential design solutions.
- 4.2 Explores a breadth of potential solutions, considering their benefits and trade-offs as they relate to the project requirements.
- 4.3 Develops models/prototypes; tests, evaluates, and iterates as appropriate.
- 4.4 Justifies and reflects on design decisions, giving consideration to limitations, assumptions, constraints and other relevant factors.

5. Use of Engineering Tools:

An ability to create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.

- 5.1 Evaluates engineering tools, identifies their limitations, and selects, adapts, or extends them appropriately.
- 5.2 Successfully uses engineering tools.

6. Individual and Teamwork

An ability to work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.

- 6.1 Actively contributes to the planning and execution of a team project.
- 6.2 Manages interpersonal relationships, taking leadership responsibilities as needed.

7. Communication Skills:

An ability to communicate complex engineering concepts within the profession and with society at large. Such ability includes reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.

- 7.1 Demonstrates comprehension of technical and non-technical instructions and questions.
- 7.2 Composes an effective written document for the intended audience.
- 7.3 Composes and delivers an effective oral presentation for the intended audience.

8. Professionalism

An understanding of the roles and responsibilities of the professional engineer in society, especially the primary role of protection of the public and the public interest.

- 8.1 Describes the duty of a Professional Engineer to the public, client, employer, and the profession.
- 8.2 Integrates appropriate standards, codes, legal and regulatory factors into decision making.

9. Impact of Engineering on Society and the Environment:

An ability to analyze social and environmental aspects of engineering activities. Such ability includes an understanding of the interactions that engineering has with the economic, social, health, safety, legal, and cultural aspects of society, the uncertainties in the prediction of such interactions; and the concepts of sustainable design and development and environmental stewardship.

- 9.1 Evaluates the environmental impact of engineering activities, identifies uncertainties in decisions, and promotes sustainable design.
- 9.2 Evaluates the social impact of engineering activities, including health, safety, legal, cultural, and other relevant factors, and identifies uncertainties in decisions.

10. Ethics and Equity

An ability to apply professional ethics, accountability, and equity.

- 10.1 Applies ethical frameworks and reasoning, including in situations where there are possible conflicting interests among the stakeholders.
- 10.2 Applies the principles of equity and universal design to ensure equitable treatment of all stakeholders.

11. Economics and Project Management:

An ability to appropriately incorporate economics and business practices including project, risk, and change management into the practice of engineering and to understand their limitations.

- 11.1 Applies economic principles in decision making.
- 11.2 Plans and effectively manages a project's time, resources, and scope, following business practices as appropriate.
- 11.3 Identifies, characterizes, assesses, and manages risks to project success.

12. Life-Long Learning

An ability to identify and to address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge.

- 12.1 Reflects on one's own educational needs and opportunities for growth.
- 12.2 Seeks and acquires appropriate external information as required, including showing awareness of sources of information and ability to critically evaluate them.