



Engineering Graduate Attribute Development Project



Engineering

The logo for the GA CIP Summit. It is contained within a light blue, double-bordered square frame. The text 'GA CIP' is in a large, bold, black, sans-serif font. To the right of 'CIP' is a stylized graphic of three overlapping mountain peaks with white snow-capped tops and dark grey bases. Below this, the word 'SUMMIT' is written in a smaller, black, serif font, with wide letter spacing.

Reconsidering Graduate Attribute Indicators

Appropriate, Effective, Practical?

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Engineering

1. Knowledge Base for Engineering



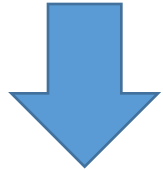
Engineering

Previous

Demonstrate competence in mathematics and modeling

Understand the natural sciences and engineering fundamentals

Possess specialized engineering knowledge appropriate to the program



New

Demonstrate competence in mathematics and modeling

Understand the natural sciences as applied to engineering

Understand engineering fundamentals

Possess specialized engineering knowledge appropriate to the program



Recall, describe and apply fundamental mathematical principles and concepts
Recall, describe and apply fundamental principles and concepts in natural science
Recall, describe and apply fundamental engineering principles and concepts
Recall, describe and apply program-specific engineering principles and concepts



Mathematical and Scientific Terms: Ability to interpret (understand and apply) mathematical and scientific terms.
Theory in Engineering Problems: Ability to understand and apply theory in engineering problems.
Mathematical Models: Ability to apply mathematical models to engineering problem and/or formulate engineering models.
Calculus and Linear Algebra: Ability to apply calculus and/or linear algebra to solve engineering problems.
Assumptions and Limitations: Ability to recognize essential/critical assumptions and limitations.
Calculations: Ability to carry out calculations and/or use mathematical software.
Statistical Analysis: Ability to use statistical concepts to analyze data.
Interpretation of Data: Ability to interpret mathematical and/or visual forms, including equations, diagrams, graphics, figures and tables.



Recalls and defines information and concepts in mathematics
Comprehends information and concepts in mathematics
Recalls and defines information, first principles and concepts in natural sciences
Comprehends information and concepts in natural sciences
Recalls and defines information, first principles and concepts in fundamental engineering sciences
Comprehends information and concepts in fundamental engineering sciences
Recalls and defines information, first principles and concepts in specialized engineering sciences
Comprehends information and concepts in specialized engineering sciences



Demonstrate competence in university-level mathematics.
Interpret natural phenomena and relationships through the use of analytical and/or experimental techniques.
Apply mathematics, natural science and engineering science to engineering problems.



Demonstrate understanding of concepts in mathematics
Demonstrate understanding of concepts in natural science
Demonstrate understanding of engineering fundamentals
Demonstrate understanding of specialized engineering knowledge



Engineering

Previous

- Identify and characterize an engineering problem
- Formulate a solution plan (methodology) for an engineering problem
- Formulate and interpret a model
- Execute solution process for an engineering problem



New

Understand the skill of engineering problem analysis

2. Problem Analysis



Formulate a problem statement in engineering and non-engineering terminology
Identify, organize and justify appropriate information, including assumptions
Construct a conceptual framework and select an appropriate solution approach
Execute an engineering solution
Critique and appraise solution approach and results



Identify/Define Problem: Ability to identify and/or articulate a problem.
Contextualize Problem: Ability to understand the problem within a larger context (problem within a problem).
Formulate Strategies for Solving a Problem: Ability to identify strategies for solving problems (brainstorming, research, trial and error).
Recognize and Consider Assumptions: Ability to recognize and consider assumptions when solving a problem.
Propose/Create Multiple Solutions: Ability to propose solutions to address the problem and/or create/play with solutions.
Analyze, Evaluate and Select Solutions: Ability to analyze, evaluate and select optimal/practical solution, including feasibility and impact.
Implement Solutions: Ability to implement a practical solution to address the problem.
Evaluate Solution Implementation: Ability to evaluate solution implementation and impact (performance, limitations, risk, cost (time and money), consequences of failure, risk).



Identifies and formulates complex engineering problems
Develops models from first principles to analyze complex engineering problems
Analyzes and solves complex engineering problems
Critically evaluates the validity and accuracy of existing solution methods



Characterize complex engineering problems.
Develop appropriate frameworks ¹ for solving complex engineering problems.
Implement solutions for complex engineering problems.
Analyze solutions to complex engineering problems to draw conclusions.



Formulate a problem statement
Develop models to solve engineering problems including identifying approximations, assumptions and constraints
Critically evaluate solutions of engineering problems

Reconsidering Graduate Attribute Indicators

Appropriate, Effective, Practical?

- Compilation of indicators for several universities available on websites
 - U of T and Queen's indicators are new, and in draft form; not yet approved
- Your tasks (without singling out specific institutions)
 - Identify commonalities and outliers among the indicators for each GA



- Consider if indicators:
 - Cover all aspects of the attribute, but don't extend beyond the attribute (Appropriate)
 - Are sufficiently specific to that attribute (Effective)
 - Can they be assessed? (Practical)
- Report back



Engineering

Previous

Define a problem

Devise and execute a plan to solve a problem

Use critical analysis to reach valid conclusions supported by the results of the plan



New

Design knowledge acquisition process (or experiment) to investigate engineering problem

Gather information from relevant sources to address problem

Synthesize information from multiple sources to reach valid conclusions

3. Investigation



Propose a working hypothesis

Design and apply an experimental plan/investigative approach (for example, to characterize, test or troubleshoot a system)

Analyze and interpret experimental data

Assess validity of conclusions within limitations of data and methodologies



Identifying Problems for Investigation: Ability to identify problems/issues/topics for investigation.

Collection of Background Information: Ability to gather background information (existing knowledge, research, and/or indications of the problem).

Procedure: Ability to select OR ability to develop a methodology or theoretical framework to investigate a problem.

Organizing Evidence: Ability to organize evidence to demonstrate patterns, and highlight differences and/or similarities.

Conclusions and Recommendations: Ability to state conclusions and make recommendations as a result of the investigation.

Limitations and Implications: Ability to identify limitations and implications.



Conducts planned activities (literature review, experiments, measurements, laboratories, etc.) and analyzes data

Interprets results and reaches valid conclusions regarding complex engineering problems

Formulates hypotheses and designs suitable investigative approaches and/or research methodologies

Understands and/or demonstrates appropriate safety protocols



Conduct investigations² to test hypotheses related to complex problems.

Analyze³ and interpret data using appropriate techniques and tools.

Synthesize information from investigations², considering sources of uncertainty and limitations to reach substantiated conclusions.

Adhere to appropriate workplace safety protocols in all work⁴ environments.



Design experiments to investigate complex engineering problems

Gather information from relevant sources³ to address complex engineering problems

Synthesize information from multiple sources to reach to reach valid conclusions



Engineering

Previous

Frame a complex, open-ended problem in engineering terms

Generate a diverse set of candidate engineering design solutions

Select candidate engineering design solutions for further development

Advance an engineering design to a defined end state



New

Frame a complex, open-ended problem in engineering terms

Generate a set of candidate solutions and critically appraise them to select best to take forward

Advance an engineering design to a defined end state

4. Design



Describe design process used to develop design solution
Construct design-specific problem statements including the definition of criteria and constraints
Create a variety of engineering design solutions
Evaluate alternative design solutions based on problem definition
Develop and refine an engineering design solution, through techniques such as iteration, simulation and/or prototyping



Understanding the Design Process: Ability to explain the design process including the importance of needs, specifications, concept generation, selection and evaluation.
Problem Solving: Considering Solutions: Ability to develop an approach to solve a problem.
Implementing Design Strategy: Ability to execute a solution to an open-ended problem taking into consideration design requirements and pertinent contextual elements.
Evaluating Final Design: Ability to evaluate/confirm the functioning of the final design.
Innovation: Ability to recognize and incorporate innovation when considering an idea.
Connecting and Integrating: Ability to connect, integrate and transform ideas into solutions.
Exploring New Directions: Ability to incorporate new ideas, ways or tactics (alternate, divergent, contradictory and/or potentially high risk perspectives or ideas) when developing a design/approaching an assignment.



Understands the problem and defines objectives and constraints
Develops a design process considering health and safety risks, applicable standards, economic, environmental, cultural and societal considerations.
Researches and develops possible solutions to a complex engineering problem and recommends a final design
Implements and evaluates a final design



Define problem, objectives and constraints ⁵ .
Compare multiple strategies for solving a problem.
Create a product, process or system to solve a problem, that meets specified needs ⁵ , and subject to appropriate iterations.
Evaluate performance of a design, using criteria that incorporates specifications, limitations, assumptions, constraints ⁵ , and other relevant factors.



Define design requirements and specifications for complex, open-ended engineering problems
Critically evaluate and compare design choices
Generate and refine potential solutions to complex, open-ended design problems



Engineering

Previous

Use fundamental modern techniques, resources and engineering tools

Use discipline-specific techniques, resources and engineering tools

Recognize limitations of the tools used



New

Demonstrate proficiency using current techniques, resources and engineering tools

Recognize limitations of the tools used

5. Use of Engineering Tools



- Select appropriate engineering tools from various alternatives
- Demonstrate proficiency in the application of selected engineering tools
- Recognize limitations of selected engineering tools



- Understand Tools: Ability to describe and explain the principles behind and applicability of engineering tools.
- Identify and Use Tools: Ability to identify and use relevant tools for an engineering activity.
- Create Tools: Ability to create engineering tools.
- Evaluate Tools: Ability to identify the limitations in the use of engineering tools, and their underlying assumptions.



- Selects and uses tools
- Evaluates tools and identifies their limitations
- Adapts, integrates and/or creates tools



- Develop, adapt and/or extend appropriate software, equipment, models, and simulations for a range of engineering activities.
- Apply and manage appropriate techniques, apparatus, databases, models, tools, and/or processes to accomplish a task.
- Evaluate limitations and errors of instrumentation/measurement techniques/models/simulations to assess appropriateness of the results.



- Select appropriate engineering tools, considering their limitations
- Modify and/or create appropriate engineering tools, identifying their limitations
- Use engineering tools appropriately

Previous

- Establish and monitor team organizational structure
- Promote team effectiveness through individual action
- Be successful in a team-based project



New

- Establish the team (e.g. vision, purpose, process, roles, and goals)
- Coordinate individual action towards the goal
- Works effectively with others

6. Individual & Team Work



Describe principles of team dynamics and leadership
Understand all members' roles and responsibilities within a team
Execute and adapt individual role to promote team success through, for example, timeliness, respect, positive attitude
Apply strategies to mitigate and/or resolve conflicts
Demonstrate leadership through, for example, influencing team vision and process, promoting a positive team culture, and inspiring team members to excel



Individual Idea Contributions: Ability to contribute useful ideas to advance work of team.
Individual Work Contributions: Ability to carry out individual responsibilities.
Individual Preparation and/or Contribution to Team Meetings: Ability to prepare and/or to contribute to team meetings.
Time Management: Ability to manage time (estimate, prioritize, establish deadlines/ milestones, follow timeline, plan for contingencies, adapt to change).
Credit and Accountability: Ability to share credit and accept accountability when working in a team.
Leadership Skills: Ability to lead a team. (i) Mentors and accepts mentoring from others. (ii) Demonstrates capacity for initiative while respecting others' roles. (iii) Facilitates others' involvement. (iv) Evaluates team effectiveness and plans for improvements.
Working with Others: Ability to listen to, collaborate with, and champion the efforts of others.
Promoting Positive Team Atmosphere: Ability to foster a positive and productive team atmosphere and keep team members working together. (i) Is courteous and respectful with team members; (ii) Demonstrates a positive attitude using verbal and non-verbal cues, and tone. (iii) Inspires team members; (iv) Helps and encourages team members.
Addresses Conflict: Ability to identify, respond to and resolve potentially damaging conflict among team members.
Management of Multidisciplinary Teams: Ability to appreciate, understand and work with multidisciplinary team members.



Participates actively
Shares workload
Displays good interpersonal skills
Develops leadership skills



Take initiative to plan, organize and complete tasks, as an individual and team member, in order to meet goals.
Seek and integrate diverse and alternative perspectives in decision-making.
Lead by example ⁶ by assuming responsibility for some aspect of the project ⁷ , seeking input from team members.
Share ideas and information by eliciting, giving and applying positive and effective feedback.



Contribute as an active team member or leader to complete individual tasks
Collaborate with others to complete tasks effectively as a team



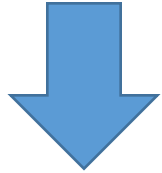
Engineering

Previous

Identify and credibly communicate engineering knowledge

Use different modes of communication

Develop communication through an iterative process



New

Representing: creation of written, oral, visual artifacts for communicating knowledge, decisions, processes, experiments, recommendations, and other elements of the profession.

Interpreting: understanding written, oral, visual representations of knowledge, decisions, processes, experiments, recommendations, and other elements of the profession.

TENTATIVE: (Translating? Use? Action related to/derived from/caused by: mapping between written, oral, visual representations and across levels of abstraction; take meaningful action toward an end goal)

7. Communication Skills



Identify key message(s) and intended audience in verbal or written communication as both sender and receiver
Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode
Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience
Substantiate claims by building evidence-based arguments and integrating effective figures, tables, equations, and/or references
Demonstrate ability to process oral and written communication by following instructions, actively listening, incorporating feedback, and formulating meaningful questions



Understands, interprets and/or assesses oral, written, graphical or visual communications
Produces written engineering reports and design documentation
Demonstrates competency in the oral communication of complex engineering concepts
Demonstrates an ability to give and effectively respond to clear instructions



Produce clear, concise, precise and well-organized written communication with language appropriate for the audience.
Deliver formal and informal oral presentations with suitable language, content, style, timing and flow, while adapting format, content and tone to audience and purpose.
Create figures, maps, tables and drawings to engineering report standards.
Interpret communication from a variety of sources ⁸ and respond to instructions and questions, displaying full understanding of the topic.
Generate a traceable and defensible record of a technical project using an appropriate records system.



Orally present information within the profession and to society at large
Communicate in a written format within the profession and to society at large
Interpret information, including instructions



Engineering

Previous

Describe engineering roles in a broader context (pertaining to the environment, health, safety and public welfare)

Recognize the impact of engineering within global society (the broader public interest)

Behave in a professional manner



New

Understands the roles and responsibilities of the Professional Engineer

Understands the regulation of the engineering profession

8. Professionalism



Demonstrate an understanding of what it means to be a professional engineer and distinguish between legislated and non-legislated professions

Effectively describe engineering law and its impact on professional engineering practice

Demonstrate professional behaviour



Behaviour and Responsibility: Ability to exhibit appropriate behaviour and assume responsibility for own actions.

APEGM Code of Ethics and Professional Engineering Act of Manitoba: Awareness and understanding of the APEGM Code of Ethics and the Professional Engineering Act of Manitoba, and the primary role of the engineer to protect the public and the public interest.

Manitoba Workplace Health and Safety Act: Awareness of the importance of, and demonstration of, the principles of personal and workplace health and safety.

Registration as a Professional Engineer: Understands the implications of, and the process for, becoming a Registered Professional Engineer.



Understands the role of engineering in society

Understands the responsibility of Professional Engineer in protection of the public and its interest

Knows pertinent codes, laws and regulations



Recognize that engineering is a regulated profession dedicated to serve and protect the public interest.

Integrate appropriate standards, codes, legal and regulatory factors into decision making.

Demonstrate professional conduct and integrity.



Articulate the roles and responsibilities of the professional engineer in society with reference to the protection of the public and its interest.

Describe the importance of codes, standards, best practices, laws, and regulations within engineering.

9. Impact of Engineering on Society & Environment



Engineering

Previous

Understand relationships among technology and the social, cultural, economic, and environmental conditions of society - both locally and globally, and in the short- and long-term

Identify and choose alternative ways to mitigate or prevent adverse social, environmental, health and safety impacts

Demonstrate awareness of legal issues relevant to an engineering activity



New

Appreciate the social impacts

Appreciate the environmental impacts and sustainability

Appreciate the regulatory and health and safety aspect



- Analyze the safety, social, environmental, and legal aspects of engineering activity
- Evaluate the uncertainties and risks associated with engineering activities
- Anticipate the positive and negative impacts of introducing innovative technologies to solve engineering problems



- Considers Diverse Perspectives: Ability to consider other cultural, disciplinary, and ethical perspectives when investigating engineering impact on society and environment.
- Considers Impact: Ability to consider the impact of engineering interventions (decisions and technology) on society and environment (historical and/or contemporary).
- Solutions for Societal and Environmental Challenges: Ability to identify solutions to challenges in society and the environment.
- Personal and Collective Responsibility: Ability to recognize the individual and collective responsibility of engineering and its interventions on society and the environment.



- Understands the social, environmental, economic, health, safety, legal and/or cultural aspects of engineering activities
- Able to analyze the uncertainties in the prediction of interactions between the different aspects of engineering activities
- Conducts social and/or environmental impact analyses
- Understands and/or applies the concepts of environmental stewardship, sustainable design and sustainable development



- Evaluate the environmental impact of engineering activities and promote environmental stewardship of the natural and built environments.
- Take appropriate action to mitigate risks associated with economic, health, safety and legal aspects of engineering activities.
- Evaluate cultural, societal, and technical norms while maintaining ethical position required for engineering practice in Canada.
- Incorporate concepts of sustainable design and development into engineering activities.



- Identify the relevance of and uncertainty associated with the different aspects (social, cultural, economic, health, safety, legal, environmental), of an engineering project.
- Analyze the social, health, safety, and environmental aspects of an engineering project, incorporating sustainability considerations in making decisions.

10. Ethics & Equity



Engineering

Previous

- Recognize ethical and equity-based dilemmas
- Apply the Code of Ethics and equity principles
- Act ethically and demonstrate individual accountability



New

- Understand and apply principles of professional ethics to individual actions and engineering problems
- Understand and apply principles of equity, diversity, and inclusion to individual actions and engineering problems



- Summarize ethical theories and equity, diversity, and inclusivity principles
- Determine an ethical course of action by applying ethical theories and the PEO Code of Ethics
- Demonstrate values consistent with good ethical practice, including equity, diversity, and inclusivity



- Ethical Issue Recognition and Behaviour: Ability to recognize and act on ethical issues (personal, professional and corporate).
- Equity: Ability to recognize equitable issues (ethnicity, gender, age, sexual orientation, faith, geography, socio-economic status, etc.), and acts/behaves with inclusivity.
- Accountability: Recognizes the need to assume responsibility for own actions.
- Proper Use of Others' Work: Ability to recognize, understand and apply proper ethical use of intellectual property, copyrighted materials, and research.



- Appreciates and articulates issues and dilemmas related to ethics and equity
- Demonstrates knowledge of ethical standards (i.e. Code of Ethics)
- Resolves ethical issues and/or issues of equity
- Demonstrates individual accountability



- Identify and resolve potential ethical issues using ethical principles and codes, demonstrating knowledge of professional accountability in engineering.
- Intentionally incorporate principles of fairness, access and opportunity into decision making.
- Adhere to guidelines regarding the fair use of intellectual property and contract guidelines.
- Incorporate concepts of sustainable design and development into engineering activities.



- Identify ethical and unethical behavior in professional situations
- Identify how an engineer is accountable to multiple stakeholders in engineering practice.
- Identify equitable and inequitable situations or behaviors

11. Economics & Project Management



Engineering

Previous

Estimate the life-cycle economic and financial costs and benefits for relevant engineering activities

Evaluate the economic and financial performance of an engineering activity and compare alternative proposals on the basis of these measures

Read and understand financial statements for engineering activities

Plan and manage engineering activities to be within time and budget constraints



New

Apply project management principles in engineering practice with attention to risk and change

Within identified constraints, perform economic analyses of engineering projects with attention to uncertainty and limitations



Apply project management techniques and manage resources within identified constraints
Identify risk and change management techniques, in the context of effective project management
Estimate economic impact and feasibility of an engineering project or design using techniques such as cost benefit analysis over the life of the project or design



Proposal: Ability to understand the problem, the client's needs, and propose a plan.
Budget: Ability to create and/or adhere to a budget
Risk Analysis: Ability to identify risks (physical, emotional, monetary, risks of repute, etc.) related to a project, consider the likelihood of the risks, and the gravity of their effects.
Time and Change Management: Ability to estimate time on task, establish deadlines/milestones, follow timeline, monitor and complete project. Ability to plan for contingencies and adapt to change.
Quality Assurance: Ability to understand and assure that work meets expectations/specifications/ standards (project, client/professor, industry, etc.).
Economics Principles: Ability to comprehend and employ economic principles of an engineering project, including short-term cost vs. long-term value.
Evaluation of Project Outcomes: Ability to evaluate the project and adapt for subsequent projects.



Understands economic concept in engineering context
Understands project management life cycle and its limitations
Critically applies business tools and economics principles in managing engineering projects (or the engineering practice)



Apply economic considerations, such as capital, operating, societal and life cycle costs, to design processes.
Effectively plan projects, including mitigating risk and managing change, to complete project on-time and on-budget



Apply project management techniques in engineering projects, with attention to risk and change.
Perform economic analyses of engineering projects with attention to uncertainty and limitations.



Engineering

Previous

Independently summarize, analyze, synthesize and evaluate information from a wide variety of sources
Develop a strategy to identify and address gaps in knowledge



New

Recognize and address limits in knowledge, skills and ability
Engage in self-direction and self-evaluation

12. Lifelong Learning



Table with 1 column and 3 rows: Identify personal career goals and opportunities for professional development; Self-assess skills relative to career goals and SOE defined learning outcomes; Demonstrate capability for continuous knowledge and skill development in a changing world

Table with 1 column and 13 rows: Interest and Curiosity: Inclination/ability to explore a subject/topic in the pursuit of knowledge; Initiative: Inclination/ability to explore additional opportunities for learning; Adaptability to New Situations: Ability to apply prior knowledge, skills and/or behaviours to new situations; Staying Current: Engaged in staying current in the chosen field; Asking Questions: Ability to recognize and/or construct meaningful and pertinent questions; Handling Constructive Criticism: Ability to accept and use constructive feedback; Reflection (Lessons Learned): Ability to reflect on (analyze and evaluate) experiences/situations; Formulate a Topic /Define Research Scope: Ability to frame a topic, determine research scope; Execute a Search Strategy and Retrieve Needed Information: Ability to use search strategies; Select and Evaluate Information and Sources Critically: Ability to use criteria to select and evaluate sources; Use Information to Realize an Objective: Ability to use information from a variety of sources; Legal and Ethical Use of Information: Ability to appropriately employ strategies to demonstrate an ability to recognize, understand and apply proper ethical and legal use of intellectual property



Table with 1 column and 5 rows: Sets goals; Applies appropriate knowledge and skills to learning activities; Engages in self-direction and self-evaluation; Locates required information; Adapts learning strategies to new conditions



Table with 1 column and 3 rows: Evaluate and reflect on own knowledge, skills and learning; Independently acquire new knowledge and skills for ongoing personal and professional development; Identify, organize, and critically evaluate information from an appropriate range of sources, to meet learning needs



Table with 1 column and 3 rows: Identify gaps in their knowledge, skills and abilities; Obtain and evaluate information or training from appropriate sources; Reflect on the use of information or training received