First-Year Common Engineering Curriculum for the BC Post-Secondary Sector
- Implementation Phase

FINAL REPORT

Prepared for and funded by:

The British Columbia Council on Admissions and Transfer

NOV - 2018

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MEMBERS OF THE FIRST-YEAR COMMON CURRICULUM STEERING COMMITTEE

The work contained in this report has been driven by a steering committee consisting of a broad institutional membership including public/private, sending/receiving, and urban/rural representation:

Brian Dick (Chair)	Vancouver Island University
Yang Cao	University of British Columbia - Okanagan
Margaret Gwyn	University of Victoria
Jennifer Kirkey	Douglas College
Barbara Rudecki	College of New Caledonia
Elroy Switlishoff	Selkirk College
Tara Todoruk	Columbia College

SPECIAL RECOGNITION

The committee would like to specifically thank the following individuals for their engagement and facilitating the movement of this initiative through their respective engineering schools.

LillAnne Jackson, Associate Dean Undergraduate Studies	University of Victoria
Carol Jaeger, Associate Dean Academic	University of British Columbia
Todd Whitcombe, Chair, Chemistry, Environmental Science & Environmental Engineering	University of Northern BC
Atousa Hajshirmohammadi, Senior Lecturer, School of Engineering Science	Simon Fraser University

1.0 PROJECT SCOPE

Support for *First-Year Core Engineering Curriculum for the BC Post-Secondary Sector - Implementation (Part I)* was sought and obtained from BCCAT in the form of a Transfer Innovation project grant.

The primary goal of this project is to design and implement a common first-year engineering curriculum for members of the BC Transfer system. Deliverables supporting this goal include:

1. Finalize learning outcomes/expectations for Design I/II in the common curriculum
2. Prepare a memorandum of understanding (MOU) / common transfer agreement that any and all primarily receiving post-secondary institutions may sign if consistent with their needs and requirements.

2.0 BACKGROUND

The BCCAT Engineering Articulation Committee currently has representation from 6 accredited research institutions[1], 17 teaching institutions and colleges, and the province's engineering professional association (EGBC). Interest in engineering education has been growing, in recognition of its importance to the provincial economy. In 2014, this committee requested and received funding through BCCAT to determine the feasibility of building a common first-year engineering curriculum acceptable at all accredited receiving institutions in the province. Over the next eighteen months, we conducted an inclusive consultative process towards this goal.

This study[2] found that, although there exists diversity within the first-year engineering programs offered at different institutions, there is sufficient overlap to suggest a sector-wide common first-year curriculum could be developed. In 2017, the BCCAT Engineering Articulation Committee formed a steering committee to move forward with implementing the findings of the feasibility study.

3.0 BENEFITS

A first-year core curriculum, if clearly articulated and regulated, can:

- Improve **access** and **opportunity** for success in engineering education for BC's diverse post-secondary students;
- Create opportunities for regional **community engagement** and **partnerships** within the engineering sector, encouraging graduates to return to employment in smaller, non-urban communities;
- Enhance the student learning environment and improve **retention** and **achievement** in engineering across the province through maximizing use of student supports, class size, and regional diversity;

[1]For the purposes of this proposal, the term *research institutions* refer to UBC-Vancouver, UBC-Okanagan, SFU-Burnaby, SFU-Surrey, University of Northern BC, and the University of Victoria.
[2]*First-Year Core Engineering Curriculum for the BC Post-Secondary Sector,* http://www.bccat.ca/pubs/Engineering Final Report v121.pdf (Fetched 13.Jun.2018)

- Enhance **quality** reporting for accreditation processes;
- Improve overall **efficiencies** within the post-secondary system.

Expanding access to engineering education is both timely and urgent, and these goals are consistent with the stated priorities of both the **BC Tech Strategy** and the **BC Ministry of Advanced Education, Skills & Training Service Plan**; namely,

- Increasing the number of tech graduates
- Expand work-integrating learning in existing programs
- Ensure affordable access to post-secondary education and skills training
- Respond and adapt to the diverse and changing needs of learning
- Ensure a high quality, relevant post-secondary education and skills training system that provides services people count on for good-paying jobs and opportunities to reach their full potential.

4.0 CONSULTATIVE PROCESS

This common transfer agreement was developed through an inclusive consultative process involving all members of the BCCAT Engineering Articulation committee, particularly those post-secondary institutions identifying as primarily receiving schools. Engagement has ranged from broad discussions (e.g. annual articulation committee meetings) to one-on-one sessions with individual post-secondary institutions. The framework for the common transfer agreement, including the number of accreditation units delivered and how they were to be allocated, was developed during a day-long session hosted by the University of British Columbia (Vancouver campus) with representation from that institution as well as the University of Northern British Columbia, the University of Victoria, and Simon Fraser University. A sample of the meetings undertaken within this project's mandate are shown in Table 1.

Table 1. Selected Meeting Schedule

Date	*Location*	*With*	*Representing*
04.May.2017	UVic	Engineering Articulation Committee	
08.Dec.2017	UBC-Vancouver	Castro, Jan	SFU-Burnaby
		Hajshirmohammadi, Atousa	
		Jaeger, Carol	UBC-Vancouver
		Ostafichuk, Peter	
		Gwyn, Margaret	UVic
		Whitcombe, Todd	UNBC
02.Feb.2018	VCC	Karavas, Costa	VCC
		Todoruk, Tara	Columbia College
02.Feb.2018	Douglas College	Majdanac, Allan	Douglas College
		Kirkey, Jennifer	
21.Mar.2018	VIU (call-in)	Ahmed, Faheem	TRU
26.Mar.2018	UBC-Vancouver	Jaeger, Carol	UBC-Vancouver
17.Apr.2018	BCIT	Wood, Renata	BCIT

18.Apr.2018	UBC-Okanagan	Cao, Yang UBC-O Curriculum Committee	UBC-Okanagan
30.Apr.2018	MacEwan University	ACAT Engineering Articulation Meeting	
03.May.2018	Douglas College	Engineering Articulation Committee	
04.May.2018	UBC-Vancouver	Canadian Engineering Education Association AGM (Poster Presentation)	
07.Aug.2018	SFU-Burnaby	Chapman, Glenn Hajshirmohammadi, Atousa	SFU-Burnaby
07.Aug.2018	UBC-Vancouver	Jaeger, Carol	UBC-V/O
08.Aug.2018	UVic	Jackson, LillAnne	UVic

5.0 DELIVERABLES

By 31.Aug.2018, signatures providing faculty-level approval of the common transfer agreement have been obtained from the **University of British Columbia** (both the Vancouver and Okanagan campuses), as well as the **University of Victoria**. Institutional approval through required governance procedures will take place over the coming year. The common curriculum has also received departmental approval from both **Simon Fraser University (School of Engineering Science)** and the **University of Northern British Columbia**; institutional approval is anticipated in the near future. Further, discussions with **Thompson Rivers University** were initiated after the announcement of their program expansion to a full degree in software engineering. This conversation is on-going.

Other deliverables of this project outside of its scope include:

- Presentation of this work at the Canadian Engineering Education Association conference held at the University of British Columbia (Vancouver campus)
- Presentation of this work at the Alberta Council on Admissions and Transfer (ACAT) Engineering Articulation committee meeting held at MacEwan University.
- Proposal submission to BC Ministry of Advanced Education, Skills & Training for capacity building funds to implement proposed common curriculum at signatory sending institutions.

6.0 COMMON TRANSFER AGREEMENT

6.1 Oversight

The common transfer agreement is a living document; the BCCAT Engineering Articulation committee will facilitate conversations to ensure that the on-going needs of all signatory members are met. Review of the agreement will take place **annually** at the BCCAT Engineering Articulation committee meeting.

6.1.1 Change requests

Change requests must be made through the annual BCCAT Engineering Articulation Committee and approved by **all** the signatory receiving institutions and a **2/3** majority of signatory sending institutions. Such change requests ought not be unreasonably refused, and will typically be effective no less than **18 months** from the date of that meeting.

6.1.2 Notice of Withdrawal

Signatory institutions may give notice that they wish to withdraw from the agreement at any time; this notice must be served to the BCCAT Engineering Articulation Committee chair, who is responsible for communicating the intent to agreement signatories. The withdrawal will be effective no less than two years from the date the notice is served.

6.2 Agreement Terms

6.2.1 General

All signatory institutions have agreed to the following general terms:

- Course-by-course articulation (via the BC Council on Admissions and Transfer - BCCAT) informs the curriculum contained in this agreement.
- The terms of this agreement apply to those students who have completed fully and successfully the common first-year engineering curriculum at one of the signatory institutions.

6.2.2 Receiving Institutions

Primarily receiving institutions have agreed to the following:

- Accept, as equivalent to its first-year engineering curriculum, the curriculum described in the engineering common agreement (see later in this document) stated in Section 6.3, including the appropriate Appendix.
- Post information on its website regarding common first year engineering curriculum (CFYEC) and its signatory sending institutions, and promote the CFYEC option when meeting with high schools.
- Endeavour to provide access to information regarding the CFYEC and its signatory sending institutions to any applicant denied direct entry into an engineering program or school. Such data to be provided in compliance with the BC Freedom of Information and Privacy Act (FOIPA) and other relevant statues.
- On an annual basis, endeavour to provide details (in comparison to direct-entry students) on progression and academic success for students from a sending institution to that sending institution. Such data to be provided in compliance with FOIPA and other relevant statutes.
- Facilitate course-by-course articulation of the CFYEC through BCCAT for each signatory sending institution upon request by said sending institution.

6.2.3 Sending Institutions

Sending institutions will need to agree to the following:

- Encapsulate the CFYEC as a recognized credential (e.g., a certificate)

- Provide information on its website regarding the CFYEC and its signatory receiving institutions, and promote the CFYEC option when meeting with high schools.

- Ensure that instructors for designated engineering content within the CFYEC (typically those covering engineering science, engineering design, project work, and/or an introduction to the engineering profession) have a professional engineering credential (e.g., P. Eng, Eng. L) allowing for practice of engineering in Canada.

- Articulate course-by-course transfer of the CFYEC through BCCAT.

- Reasonably accommodate a request by receiving institutions to participate in at least one university transfer information session to provide details about their engineering programs.

- Reasonably accommodate requests by receiving institutions to document accreditation unit counts and topics in CEAB workbooks or equivalent, and collect a limited amount of graduate attribute data

- Ensure students within the CFYEC program are aware that they must follow all application procedures and policies of the receiving institution, including applying for admission and submitting post-secondary and/or high school academic transcripts.

6.3 Curriculum

The first-year common engineering curriculum consists of eleven common course units, with, typically, one additional course specific to each receiving institution (see relevant Appendix). Upon completion of this curriculum, students are expected to have the required skills and knowledge to transfer to second year engineering at the receiving institution and be successful.

6.3.1 General Learning Outcomes:

- Demonstrate an understanding of the scientific method and apply it to critically solve problems;
- Demonstrate proper laboratory techniques, including the use of appropriate equipment and instrumentation;
- Develop original designs to solve engineering problems;
- Collect, analyze, and interpret laboratory data, and draw sound conclusions;
- Effectively communicate ideas and project results;
- Demonstrate an ability to work well independently and in groups;
- Engage in informed debate on topics related to technology; and

- Effectively apply scientific/engineering concepts towards subsequent coursework.

To add clarity, the learning outcomes from the certificate have been packaged in course units. Sending institutions need not organize these learning outcomes exactly as specified, although to aid course-by-course articulation between sending and receiving institutions, it is recommended that these course packages be maintained as much as possible.

6.3.2 Course Units

Course units are presented in terms of hours of instruction (lecture:lab) per week over a standard term length of 12 weeks. This term length describes the effective instructional time, and excludes statutory holidays and any relevant final exam period. Terms that differ from this standard ought to be pro-rated to ensure that same minimum coverage (both in terms of learning outcomes and time) is maintained. Learning outcomes are elaborated for each course package in Appendix A, while the approximate course-by-course transferability of these units to each institution is shown in their appropriate appendix.

Differential Calculus - CALC I (4:0)
Limits, continuity, intermediate value theorem; differentiation; Taylor polynomials and special Taylor series; curve sketching

Integral Calculus - CALC II (4:0)
Integration; numerical integration (including the Trapezoidal Rule); improper integrals: evaluation and convergence estimates; differential equations (first-order linear) with applications.

Engineering Chemistry - CHEM I* (4:3)
A survey of general first year chemistry. Topics include thermochemistry, atomic and molecular structure, chemical bonding, solution and phase equilibria, equilibrium, chemical thermodynamics, and electrochemistry.

For those institutions not offering CHEM I*, the following combinations would be acceptable:

- CHEM I and CHEM II (BSc standard first-year chemistry curriculum)
- CHEM I and a one-credit course such that the latter course includes the topics of thermochemistry, thermodynamics, and electrochemistry

Computer Science I - CSCI I (4:2)
A first-year course in computer science using the 'C' programming language. Topics include structured programming, top-down program design, procedures, and an introduction to dynamic data structures.

University Writing - ENGL I (3:0)

An introduction to critical thinking and reasoning, academic writing, and research skills, consistent with the conditions and expectations students encounter as readers and writers at university.

Technical Writing - ENGL II (3:0)
An introduction to business and technical communication skills with a focus on documents (such as letters and reports) and presentations. Topics may include planning, outlining, summarizing, presenting data, handling references, and editing. The course comprises several practical assignments, including a formal report and an oral presentation.

Engineering Design I - ENGR I (2:2)
An introduction to the principles of engineering design, engineering drawing and sustainable practice. This knowledge will be applied to practical projects to be undertaken by teams of students. ENGR I is to be instructed by a P.Eng, Eng.L., or equivalent designations in other Canadian professional engineering associations.

Engineering Design II - ENGR II (2:2)
Principles and applications of engineering design, engineering drawing, and sustainable practice. This knowledge will be applied to practical projects to be undertaken by teams of students. ENGR II is to be instructed by a P.Eng, Eng.L., or equivalent designations in other Canadian professional engineering associations.

Matrix Algebra - LALG I (4:0)
An examination of vectors, matrices and their operations, linear systems, determinants, linear dependence and independence, eigenvalues, and eigenvectors, and applications.

Fundamental Physics I - PHYS I (4:3)
A calculus-based course. Topics such as kinematics and dynamics of particles, energy and momentum, rotational and periodic motion.

Fundamental Physics II - PHYS II (4:3)
A calculus-based course. Topics include waves, electricity and magnetism, geometrical and physical optics, quantization and nuclear processes.

6.4 Admissions and Transfer:

There are differences between admission requirements at each receiving institution: This agreement is not intended to supersede those requirements. In general, however, the following admission guidance for sending institutions can be provided:

- English 12 with a minimum grade of B
- Physics 12 with a minimum grade of C+; outstanding candidates missing Physics 12 or equivalent are encouraged to apply and will be reviewed on a case-by-case basis.

- Chemistry 12 with a minimum grade of C+; Outstanding candidates missing Chemistry 12 or equivalent are encouraged to apply and will be reviewed on a case-by-case basis.
- Pre-Calculus 12 with a minimum grade of B
- Recommended: Calculus 12 (if available); Programming 12 (if available)

6.5 Minimum AU/GA Delivery Requirements

Accreditation Units (AU) and Graduate Attributes (GA) are two of the means by which engineering schools in Canada are evaluated by the national regulatory body. The common engineering transfer agreement provides a **minimum** delivery AU/GA outcome from the CFYEC, based on 12 weeks of instruction with 10-weeks of labs, and shown in Table 2. The AU/GA total has been broken down into lecture and lab hours per week, as well as hour counts in the areas of math (M), natural science (NS), complementary studies (CS), engineering science (ES), and engineering design (ED). Definitions for each of these areas can be found in Appendix D.

Table 2. Prescribed AU Outcomes claimed by the Common First-Year Engineering Curriculum

Course	Cred.	Lec (hr/wk)	Lab/Tut (hr/wk)	Total AU	M	NS	M+NS	CS	ES	ED	ES+ED
CALC I	3	4	-	48	48		48	-	-	-	-
CALC II	3	4	-	48	48	-	48	-	-	-	-
CHEM I	4	4	3	63	-	63	63	-	-	-	-
CSCI I	4	4	2	58	-	-	-	-	58	-	58
ENGL I	3	3	-	36	-	-	-	36	-	-	-
ENGL II	3	3	-	36	-	-	-	36	-	-	-
ENGR I	3	2	2	34	-	-	-	8.5	8.5	17	25.5
ENGR II	3	2	2	34	-	-	-	8.5	8.5	17	25.5
LALG I	3	4	-	48	48	-	48	-	-	-	-
PHYS I	4	4	3	63	-	63	63	-	-	-	-
PHYS II	4	4	3	63	-	63	63	-	-	-	-
Total				**531**	**144**	**189**	**333**	**89**	**75**	**34**	**109**

Although Graduate Attributes are not prescribed by the Canadian Engineering Accreditation Board (CEAB) at a first-year level, it does consider progression of each attribute through a students' academic studies. The CFYEC claims the following Graduate Attributes, *each at an introductory level*:

Table 2. Prescribed GA Outcomes claimed by the Common First-Year Engineering Curriculum

1. A Knowledge Base of 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 of Engineering on Society and the Environment
10. Ethics and Equality
12. Life-long Learning

Each signatory receiving institution may require additional AU/GA credits, as identified in the relevant Appendix.

7.0 NEXT STEPS

The primary goal of this project was to have primary receiving institutions accept as equivalent to their first-year programs, a first-year common engineering curriculum. To date, institutions representing approximately 75% of available first-year seats in the province have agreed to accept this curriculum, and it is expected that this will increase to 95% of all available seats within the next couple of months.

The following steps are now required:

1. Work with UNBC and SFU to secure their signatures on the common transfer agreement. To date, only department-level approval of the agreement has been received and Faculty-level approval is needed to implement its terms.
2. Work with TRU to evaluate if and how the common transfer agreement can facilitate transfer into their new software engineering degree.
3. Work with BCIT to evaluate if the common transfer agreement can facilitate transfers into their various credentials.
4. Building of example course outlines for specific engineering design and (likely) physics courses within the common curriculum.
5. Development of common and shareable teaching and learning tools
6. Acceptance of the first-year common engineering curriculum by primarily sending institutions
7. Formal acceptance of the first-year common engineering curriculum by primarily receiving institutions through their appropriate governance process.

TRANSFER INNOVATIONS PROJECT RECOMMENDATIONS

The Implementation Phase (Part I) to launch a first-year common engineering curriculum has been successful. It is recommended to the BCCAT Engineering Articulation Committee (or its representative) that a proposal for the second phase of this implementation be submitted to BCCAT under its Transfer Innovations program.

APPENDIX A: Required Learning Topics/Outcomes

The learning topics and outcomes for the common transfer agreement are shown below, and are based on conversations within the BCCAT Engineering Articulation committee membership using its recent publication[3] "First-year Core Engineering Curriculum for the BC Post-Secondary Sector" as a guide.

CALC I/II

CALC I (Differentiation) and CALC II (Integration) have been standardized for the science stream across all BC post-secondary institutions under a BCCAT TI project entitled *First-year Core Calculus*[4] (updated in 2013[5]) and the BC Transfer Guide shows the equivalent of CALC I and II are articulated across all receiving institutions on a course-by-course basis.

Required Learning Topics - CALC I/II
The first-year Core Calculus - Science Stream prescribes the following core content, which shall be the equivalent of 75% of a standard one-year calculus experience:

- Limits, continuity, intermedia value theorem
- Differentiation
    - First and second derivatives with geometric and physical interpretation
    - Mean value theorem
    - Derivatives of exp and log functions, exponential growth and decay
    - Derivatives of trigonometric functions and their inverses
    - Differentiation rules (including chain rule, implicit differentiation)
    - Linear approximation and Newton's Method
    - Optimization - local and absolute extrema and applications
- Taylor polynomials and special Taylor series (sin, cos, exp, 1/(1-x)), plus enough sequences and series to understand the radius of convergence; in particular the concept of series and convergence, the ratio test, and how to find the radius of convergence.
- Curve Sketching
- Integration
    - Definition of the definite integral
    - Areas of plane regions
    - Average value of a function
    - Fundamental Theorem of Calculus
    - Integration techniques: Substitution (including trig substitutions), parts, tables, partial fractions
    - At least one more application of integration

[3]http://www.bccat.ca/pubs/engineering-final-report-v121
[4]http://www.bccat.ca/pubs/calculus.pdf (as of 16.Jul.2016) - pg 10
[5]http://www.bccat.ca/pubs/CoreCalcUpdate2013.pdf (as of 12.Jun.2018)

- Improper integrals: Evaluation and Convergence estimates
- Separable differential equations

The first-year Core Calculus - Science Stream suggests several additional topics to cover the remaining 25% of a standard one-year calculus experience. The CFYEC suggests the additional topics to best prepare students for success in second year:

- Sequences and Series; for example, the following tests: integral, comparison, alternating series, root, and limit ratio
- Polar coordinates and parametric equations (with calculus applications)
- Complex numbers

CHEM I[6]*

Chemistry I* is a single course which combines the learning outcomes from both Chemistry I (CHEM I) and Chemistry II (CHEM II), the two standard chemistry courses within the first year of a Bachelor of Science program at most institutions.

Recommended Learning Outcomes:

- Understand the present model of atomic structure, and how it influences the periodic properties of the elements
- Understand present models of chemical bonding
- Understand how intermolecular interactions determine the properties and phases of matter
- Understand the principles of chemical thermodynamics, and how they relate to the spontaneity of chemical processes
- Know and practice proper laboratory procedures of safety and cleanliness
- Know and be proficient with basic techniques in quantitative and volumetric analysis, and spectrophotometry
- Be able to produce a properly structured laboratory report

For those institutions not offering CHEM I*, the following combinations would be acceptable:

- CHEM I and CHEM II (Standard BSc first-year Chemistry curriculum)
- CHEM I and a one-credit course such that the latter course includes the topics of thermochemistry, thermodynamics, and electrochemistry

CSCI I[7]

An introduction to programming is a required course by all receiving institutions although emphasis on practical applications of programming may vary. The programming language must be C or C++ and include:

Recommended Learning Outcomes

[6] Example from D. Friesen, CHEM 150 (VIU)
[7] Example from S. Carruthers, CSCI 160 (VIU)

Program Comprehension

- Analyze and explain the behaviour of simple programs involving the fundamental programming constructs variables, expressions, assignments, I/O, control constructs, functions, parameter passing, and recursion.

Program Design and Implementation

- Design, implement, test, and debug a program that uses each of the following fundamental programming constructs: basic computation, simple I/O, standard conditional and iterative structures, the definition of functions, parameter passing, constants, and enumerated types.

Primitive Data Types

- Identify and describe the appropriate use of primitive data types
- Write programs that use primitive data types

Conditional and Iterative Constructs

- Choose appropriate conditional and iteration constructs for a given programming task
- Modify and expand short programs that use standard conditional and iterative control structures and functions.

Functions

- Describe the purpose of function definitions
- Describe the importance of modularization when solving problems
- Break problems up into sub-problems using functions, when writing programs

Advanced Data Structures

- Write programs that use each of the following data structures: arrays, structs, strings.
- Write programs that use pointers for dynamic memory allocation and release
- Describe the concept of dynamic data structures and their uses
- Recognize the risks of pointers.

Code Quality

- Apply consistent documentation and program style standards
- Describe the importance of consistent documentation and program style standards
- Create readable and maintainable software using conventions like documentation and program style standards

ENGL I[8]

ENGL I is a standard university academic writing course historically required by all sending and receiving institutions. It typically consists of an introduction to critical thinking and reading, academic writing, and research skills consistent with the expectations of university. Within the common core context, it is *recommended* that this course be offered as a collaborative effort with ENGR I.

Recommended Learning Outcomes

- Analyze the rhetorical situation

[8] Example from J. Eikenaar APSC 176 (UBC-O)

- Explore technical and scientific topics
- Create effective persuasive documents
- Write effective academic prose
- Implement a structured writing process
- Create effective arguments, using appropriate evidence
- Practice the problem-solving process to develop creative and innovative solutions
- Collaborate on oral and written communication projects

ENGL II[9]

ENGL II focusses on communicating technical information clearly and concisely, managing issues of persuasion when communicating with diverse audiences, presentation skills, and teamwork. Within the common core context, it is *recommended* that this course be offered as a collaborative effort with ENGR II.

Recommended Learning Outcomes

- Understand and apply the key concepts of organizational communication and the writing process
- Establish the purpose(s) of a written or spoken discourse
- Analyze the target audience
- Apply the various strategies and general formats used to produce appropriate business correspondence (e.g. letters, memos & e-mails)
- Describe a variety of employment search skills and prepare an effective letter of application and a functional or targeted resume
- Apply the skills of document design (e.g. effective use of layout, headings, graphics, etc.)
- Develop effective descriptive writing skills frequently used to produce lengthy documents such as process descriptions or formal reports
- Research, plan, organize and prepare formal reports. (Table of Contents, List of Figures, Executive Summary, Body [i.e. effective layout, headings and subheadings], and APA documentation and with the appropriate in-text citations)
- Research, plan, and organize information to prepare unsolicited proposals
- Prepare and deliver effective presentations

ENGR I/II

An effective engineer requires a broad understanding of a large body of expertise, separate from and independent of the sciences. The increasing emphasis of the Canadian Engineering Accreditation Board (CEAB) on graduate attributes encourages developing students' understanding of engineering design, the engineering profession, and engineers' roles in society at a much earlier point in their academic career. Estimated coverage time

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[9]Example from Distant Education, ENG 160 (NIC)

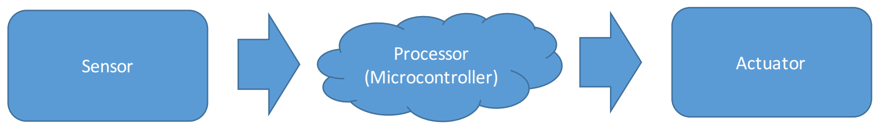
for each topic is indicated in brackets in terms of instruction lecture and lab hours (lecture:lab).

Recommended Learning Outcomes

Engineering Design (20:20 hrs)	• Describe/identify tools within each Engineering Design Process step • Identify and engaging stakeholders • Identify project scope (function/constraints) • Integrate design considerations (e.g. environment, safety) • Identify and consider risks and hazards • Use brainstorming and creative tools • Apply formal decision processes (e.g., Pugh, weighted decision matrix) • Build/test prototypes
Sustainability (8:8 hrs)	• Understand the three pillars of sustainability • Compare traditional vs. sustainable design criteria • Apply life cycle assessment to a product • Describe the impact of human activity on health, safety, and environmental systems. • Suggested instructional activity: Case studies
Engineering Drawing (10:10 hrs)	• Demonstrate sketching • Demonstrate isometric/multi-dimensional drawing • Use lines/angles/dimensioning in a drawing • Demonstrate CAD (e.g. Solidworks, 3D Fusion or similar) up to and including 3D sketching, exploded views. • Produce prototypes by interfacing CAD with fabrication tools (e.g. 3D printers)
Professionalism/Ethics Social/Professional Responsibility (2:2 hrs)	• Describe the CEAB core competencies • Apply continuous improvement • Describe the engineering code of ethics • Apply ethical conflict resolution • Suggested instructional activity: Case studies
Team work	• Understand group dynamics theory (e.g., Tuckman model) • Describe models for building successful teams • Apply conflict resolution techniques • Give/receive feedback effectively
Project Work (included as 10:10 workload within the topics above)	Students, working in teams, follow a structured process to design a sophisticated system comprising of multi-disciplinary subsystems

(e.g., electrical, mechanical, and software) and include the following characteristics:

- Demonstrate progress at several milestone stages with associated technical reporting
- Client-based (e.g., the client prescribes the scope and constraints and verifies delivery)
- Consider regulatory constraints, the business case, stakeholder interests and environmental considerations as part of an iterative project design
- Develop a project consisting of the following structure:



LALG I

Linear Algebra is required by all receiving institutions although it can be numbered as either a 1st or 2nd year course. It is *suggested* that MATLAB (or equivalent tool) and its application be introduced to students as part of the course content, preferably as a lab component. A typical syllabus includes:

Recommended Learning Topics:

- Systems of linear equations and matrices
- Matrix algebra
- Determinants
- Linear independence and bases in R^n
- Linear transformations
- Eigenvalues and eigenvectors
- Applications of linear algebra

PHYS I/II

Collectively, these topics shown below typically comprise of what is equivalent to the first-year physics requirements for a BSc program at most institutions. Although the actual order of topics may vary from institution to institution, all topics must be covered to fulfill the CFYEC requirements. Recommended additional topics include RLC, LC circuits, Relativity, Gravitation, or Thermodynamics (if not covered in PHYS III). Estimated coverage time for each topic is indicated in brackets in terms of instruction lecture and lab hours (lecture:lab).

Recommended Learning Topics:
Kinematics and Vectors (~8:6 hrs)

- Vectors
- Projectile Motion
- Circular Motion

Dynamics (Mechanics) (~24:18 - 32:24 hrs)

- Newton's Laws and Free Body Diagrams
- Friction
- Work and Energy
- Conservation Forces, Potential Energy, Work-Energy Theorem
- Rotational Kinetics, Moment of Inertia, Torque
- Rotational Dynamics
- Angular Momentum and Rolling Bodies

Waves and Optics (~24:18 - 32:24 hrs)

- Physical Optics - Reflection, Refraction, and Lenses
- Simple Harmonic Motion and Pendulums
- Waves, Sound, Interference, and Standing Waves, Doppler Effect
- Wave Optics - Superposition, Interference, Reflection
- Properties of EM waves, Light, and Polarization

Electronics (~12:9 hrs)

- DC Circuits: Ohm's Law, Kirchoff's Law
- RC Circuits
- AC Circuits

Quantum Physics (~4:3 hrs)

APPENDIX B: Requirements - University of British Columbia (Vancouver and Okanagan Campus)

Curriculum

The University of British Columbia requires the following curriculum content, nominally captured in the course package entitled PHYS III:

Thermodynamics
- Zeroth Law and Heat Capacity
- Kinetic Theory, First Law of Thermodynamics
- Heat Engines

Mechanics[10]
- Chpt 1.1-1.6 General Principles
- Chpt 2.1-2.9 (excl. 2.4) Force Vectors
- Chpt 3.1-3.4 Equilibrium of a Particle
- Chpt 4.1-4.10 Moments
- Chpt 5.1-5.7 Rigid Body
- Chpt 6.1-6.6 Structural Analysis
- Chpt 7.1-7.3 Internal Forces
- Chpt 8.1-8.4 Friction
- Chpt 12.1-12.8 Kinematics
- Chpt 13.1-13.6 Kinetics

Minimum AU/GA Delivery Requirements

Course	Cred.	Lec (hr/wk)	Lab/Tut (hr/wk)	Total AU	M	NS	M+NS	CS	ES	ED	ES+ED
PHYS III	3	4	-	48		24	24	-	24	-	24
Total				**579**	**144**	**213**	**357**	**89**	**99**	**34**	**133**

Transfer Pathway

For the following institutions,

Capilano University
College of New Caledonia
Kwantlen Polytechnic University
Langara College
Selkirk College
Thompson Rivers University
University of the Fraser Valley
Vancouver Island University

[10]Mechanics material drawn from Hibbler, R.C., *Statics and Dynamics*, 13th Edition (2013)

The CFYEC provides a seamless transfer into second year engineering at UBC. This formal agreement is based both on individual course equivalencies established in the BC Transfer Guide as well as recognition of course groupings specific to the CFYEC.

- Students completing the entire CFYEC within two terms (typically eight months), no later than 30-Jun, and with a minimum CGPA[11] or higher will be guaranteed placement at UBC.
- Students completing the terms of this agreement will compete on an equal footing with UBC students for placement in their first choice of engineering program in second year at UBC.
- For the purposes of this agreement, ENGL II will be considered as a complementary elective towards later engineering studies at UBC.

For all remaining institutions, this agreement guarantees that a student completing the full CFYEC will be considered as completing the first-year engineering curriculum at UBC. Admission into second year is not, however, guaranteed, and will be approved based on CGPA and available seats.

Course-to-Course Transfer - UBC-Okanagan (BCCAT[12])

Course	UBC-O
CALC I	APSC 172
CALC II	APSC 173
CHEM I* PHYS I PHYS III	APSC 180 APSC 181 APSC 182 APSC 183
CSCI I	APSC 177

Course	UBC-O
ENGL I	APSC 176
ENGL II	N/A
ENGR I ENGR II	APSC 169 APSC 171
LALG I	APSC 179
PHYS II	APSC 178

Course-to-Course Transfer - UBC Vancouver (BCCAT)

Course	UBC-V
CALC I	MATH 100
CALC II	MATH 101
CHEM I*	CHEM 154
CSCI I	APSC 160
ENGL I	ENGL 112
ENGL II	CS I
ENGR I ENGR II	APSC 100 APSC 101

Course	UBC-V
LALG I	MATH 152
PHYS I PHYS II	PHYS 157 PHYS 158 PHYS 159
PHYS III	PHYS 170

[11]Minimum CGPA will be reviewed annually and reported at the BCCAT Engineering articulation committee meeting in the year prior to the expected UBC start date.
[12]Shade indicates that contained course units transfer as a block

APPENDIX C: Requirements - University of Victoria

Curriculum

The University of Victoria requires the following curriculum content, nominally captured in the course package entitled PHYS III:

Thermodynamics

- Zeroth Law and Heat Capacity
- Kinetic Theory, First Law of Thermodynamics
- Heat Engines

Mechanics[13]

- Chpt 1.1-1.6 General Principles
- Chpt 2.1-2.9 (excl. 2.4) Force Vectors
- Chpt 3.1-3.4 Equilibrium of a Particle
- Chpt 4.1-4.10 Moments
- Chpt 5.1-5.7 Rigid Body
- Chpt 6.1-6.6 Structural Analysis
- Chpt 7.1-7.3 Internal Forces
- Chpt 8.1-8.4 Friction
- Chpt 12.1-12.8 Kinematics
- Chpt 13.1-13.6 Kinetics

Minimum AU/GA Delivery Requirements

Course	Cred.	Lec (hr/wk)	Lab/Tut (hr/wk)	Total AU	M	NS	M+NS	CS	ES	ED	ES+ED
PHYS III	3	4	-	48		24	24	-	24	-	24
Total				**579**	**144**	**213**	**357**	**89**	**99**	**34**	**133**

Transfer Pathway

This transfer agreement provides for a direct transfer into second year Engineering at the University of Victoria. Individual course equivalencies, established in the BC Transfer Guide, form the foundation of this agreement.

- ENGR 130 (Introduction to Professional Practice) must be completed by all students in the program soon after they begin in a UVic Engineering Program
- This transfer agreement features guaranteed admission into second year of one of the Bachelor of Engineering or Bachelor of Software Engineering programs for students who have successfully completed all of the course in the agreement with a *minimum UVIC GPA of C+ (or UVic 3.0)* and who have *no course transferrable to a UVic Engineering program with a grade less than a C.*

[13]Mechanics material drawn from Hibbler, R.C., *Statics and Dynamics*, 13th Edition (2013)

- Students accepted under this agreement will complete on an equal footing with UVic students for placement in their chosen engineering program.

Course-to-Course Transfer - University of Victoria (BCCAT)

Course	UVic
CALC I	MATH 100
CALC II	MATH 101
CHEM I*	CHEM 150
CSCI I	CSC 110
ENGL I **ENGR I**	ENGR 110
ENGL II **ENGR II**	ENGR 120

Course	UVic
LALG I	MATH 110
PHYS I **PHYS II**	PHYS 110 PHYS 111
PHYS III	ENGR 141

APPENDIX D: Definitions

Articulation Unit (AU)	Defined on an hourly basis for an activity which is granted academic credit and for which the associated number of hours corresponds to the actual contact time of that activity between the student and the faculty members, or designated alternate, responsible for delivering the program: • one hour of lecture (corresponding to 50 minutes of activity) = 1 AU • one hour of laboratory or scheduled tutorial = 0.5 AU This definition is applicable to most lectures and periods of laboratory or tutorial work. Classes of other than the nominal 50-minute duration are treated proportionally. In assessing the time assigned to determine the AU of various components of the curriculum, the actual instruction time exclusive of final examinations should be used
Mathematics (M)	Includes appropriate elements of linear algebra, differential and integral calculus, differential equations, probability, statistics, numerical analysis, and discrete mathematics.
Natural Sciences (NS)	Include elements of physics and chemistry; elements of life sciences and earth sciences may also be included in this category. These subjects are intended to impart an understanding of natural phenomena and relationships through the use of analytical and/or experimental techniques.
Engineering Science (ES)	Involves the application of mathematics and natural science to practical problems. This may involve the development of mathematical or numerical techniques, modeling, simulation, and experimental procedures. Such subjects include, among others, the applied aspects of strength of materials, fluid mechanics, thermodynamics, electrical and electronic circuits, soil mechanics, automatic control, aerodynamics, transport phenomena, and elements of materials science, geoscience, computer science, and environmental science. In addition to program-specific engineering science, the curriculum must include engineering science content that imparts an appreciation of the important elements of other engineering disciplines.
Engineering Design (ED)	Integrates mathematics, natural sciences, engineering sciences, and complementary studies in order to develop elements, systems, and processes to meet specific needs. It is a creative, iterative, and open-ended process, subject to

	constraints which may be governed by standards or legislation to varying degrees depending upon the discipline. These constraints may also relate to economic, health, safety, environmental, societal or other interdisciplinary factors.
Complementary Studies (CS)	Includes humanities, social sciences, arts, management, engineering economics and communications that complement the technical content of the curriculum. Examples include: a) Subject matter that deals with the humanities and social sciences b) Oral and written communications c) Professionalism, ethics, equity and law d) The impact of engineering on society e) Health and safety f) Sustainable development and environmental stewardship g) Engineering economics and project management
Graduate Attributes (GA)	The institution must demonstrate that the graduates of a program possess the attributes under the following headings. The attributes will be interpreted in the context of candidates at the time of graduation. It is recognized that graduates will continue to build on the foundations that their engineering education has provided[14]. 1. A knowledge base for engineering: Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program 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. 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. 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

[14]From https://engineerscanada.ca/sites/default/files/Graduate-Attributes.pdf (fetched 04.May.2018)

economic, environmental, cultural and societal considerations.

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.
6. Individual and Team work: An ability to work effectively as a member and leader in teams, preferably in a multidisciplinary setting.
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.
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.
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 sustainability design and development and environmental stewardship.
10. Ethics and Equality: An ability to apply professional ethics, accountability, and equity.
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.
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.

APPENDIX E: REVISION HISTORY

Version	Comments	Date
1.00	Initial Draft	21.Aug.2018
1.10	PHYS III moved to Institution appendix; Wording surrounding institutional approval adjusted	28.Aug.2018
1.11	Minor editing changes; Software Engineering added to University of Victoria assured entry	30.Aug.2018
1.12	Minor editing	04.Sept.2018
1.13	Future steps added addressing the goal of obtaining sign-off of the common agreement by both UNBC and SFU; Future steps added to suggest additional conversations with both BCIT and TRU to evaluate how the common curriculum framework can be used to facilitate transfers into both those institutions; minor editing to address TAC comments.	13.Nov.2018