



**SMITH
ENGINEERING**
Queen's University

Chemical
Engineering

Designing Change

Reimagining Chemical
Engineering Education

December 2025

A Message from the Department Head



Robin Hutchinson
*Head, Department of
Chemical Engineering
Smith Engineering at
Queen's University*

The Department of Chemical Engineering is entering an exciting period of transformation. Our strategic plan, “**Designing Change**,” focuses on strengthening technical foundations, broadening design perspectives, cultivating leadership and self-directed learning, and embedding humanity into engineering practice. Your input is vital. Please take a few minutes to review this document and provide feedback through the Reimagining Chemical Engineering Education Survey. Together, we can ensure that Chemical Engineering graduates at Queen’s are equipped to lead in an ever-changing world.

A Message from the Associate Dean



Kevin Mumford
*Associate Dean
(Interdisciplinary
Programs)
Smith Engineering at
Queen's University*

Engineering education must evolve in response to a rapidly changing world, adapting what and how we teach to meet society’s emerging needs. What it means to educate an engineer is shifting, shaped by growing expectations that engineers work to help solve the grand challenges facing our local and global communities. These are fundamentally human challenges, demanding that engineers build on their traditional technical expertise to work across disciplines as they define problems and design solutions that matter. At Smith Engineering, we are building an education that is technically rigorous, experientially focused, socially conscious, and creatively inspired; one that prepares students to tackle complex problems, collaborate broadly, and pursue meaningful, future-ready careers. Thank you for helping us as we Reimagine Engineering Education.

Vision

Engineering leaders to advance an ever-changing world

Mission

Our department will guide students to discover and pursue careers that transform society through technically-sound and socially-conscious design.

Strategic Aims for Reimagining Chemical Engineering Education

SA1. Building on program strengths

SA2. Broadening Chem Eng design

SA3. Cultivating leadership and self-directed learning

SA4. Engineering with Humanity

SA1. Building on Program Strengths

While reimagining the future of Chemical Engineering education, we will enhance qualities that define a Smith Engineering experience: technical rigour, unrivalled spirit, and career flexibility.

SA 1.1 Achieving Technical Excellence

Our laboratory program will be fully integrated with coursework to ensure that students have hands-on, practical knowledge of key skills and technologies.



SA 1.2 Strengthening Community Spirit

We will introduce interdisciplinary design teams with students from multiple years and raise funds for a Learning Commons space to bring these groups together.

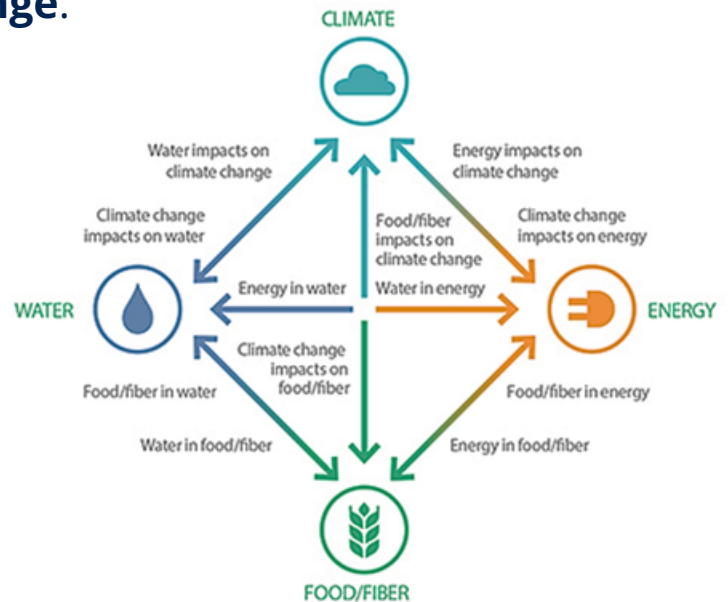
SA 1.3 Enhancing Career Prospects

We will create flexible learning pathways that help students pursue a career of personal interest with the requisite technical and professional skills.

SA2. Broadening Chemical Engineering Design

Although chemical plant design remains a central competence of Chemical Engineering, our reimagined programs will focus on a broader definition – **Designing Change**.

Change occurs over all spatial and time scales and affects every element of our world. As such, Engineers that can affect the transformation of natural, engineered, and social systems are uniquely qualified to advance society's priorities in areas such as environmental protection, global sustainability, and human health.



SA 2.1 Systems Thinking Tools

Process systems expertise will be extended to systems thinking analyses of complex socio-economic behaviour. By discovering causal connections that can be distant in time and space, students will make better informed design decisions.

SA 2.2 Design Project Flexibility

Teams will have opportunities to define projects in areas of personal interest that will include systems-level analysis of potential technical, social and economic consequences of design solutions.

SA3. Leadership and Self-Directed Learning

Equipped with broad foundational knowledge and a systems-focused approach to design, Chemical Engineers have always been natural leaders.

However, modern graduates must contend with a global economy that is increasingly variable, multifaceted and interconnected. As such, engineering programs must extend beyond the transmission of traditional content to include the intentional development of leadership, inquiry and analysis skills.

SA 3.1 Systems Leadership

Students will learn to analyze the operational structure of an organization / industry and identify opportunities to leverage their expertise. This systems-oriented approach to leadership training is designed to accelerate early career development by encouraging graduates to discover and pursue impactful, collaborative efforts.



Systems Leadership



Self-directed Learning



Chemical Eng Science



Process Systems / Systems-thinking



Creative Design



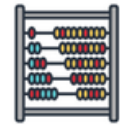
Chemistry



Biology



Physics



Mathematics

SA 3.2 Self-directed Learning

In preparation for careers that value life-long learning, students will become proficient in diagnosing gaps in their skills / knowledge, drawing upon appropriate learning resources, and sharing acquired information with others.

SA3. Engineering with Humanity

As regulated professionals with a responsibility for public well-being, engineers are trusted to generate design solutions that are both technically-sound and socially-conscious.

The complexity of modern technical issues, coupled with rapid shifts in how information is accessed and applied through artificial intelligence, are affecting how engineering programs prepare graduates for this role.

Our response to this challenge centers on the intentional development of critical thinking skills and the cultivation of an interdisciplinary mindset.

SA 4.1 Critical Thinking

Students will develop an instinctive ability to (1) identify the assumptions that frame their thinking, (2) assess the validity of information sources and methodologies, (3) examine ideas from different perspectives, and (4) make informed decisions that minimize the risk of unintended social, economic and technical outcomes.

SA 4.2 Interdisciplinarity

Students will learn to engage people with different backgrounds, disciplinary expertise and perspectives. Formulating and addressing design problems with students in other programs will introduce complexity and authenticity to design work, giving our graduates an appreciation for the importance of diversity in the design process.

Achieving our Goals

The program proposals outlined in Appendices A-D address the strategic aims while improving the student experience by balancing overall workload, deepening command of engineering science, and providing a scaffolded progression of self-directed learning opportunities.

Strengthening our Community

The tight-knit nature of individual classes can be expanded by building relationships between cohorts. Vertically-integrated activities encourage peer-to-peer learning, increase mentoring prospects and accelerate career development. Additional opportunities arise from working with departments such as environmental studies and health sciences, with interdisciplinary teams working on problems of common interest.

This multi-cohort approach can be extended through research-client design work in which fourth year teams are embedded in department research groups. Working in conjunction with graduate students, postdoctoral fellows and research faculty will expose students to leading-edge technology, infrastructure and subject matter expertise.

These community-building initiatives will benefit from the creation of a Learning Commons in Dupuis Hall, where students, faculty, and staff can connect and collaborate. This flexible, collaborative facility will combine group study spaces, physical and digital resources, multi-media technology, and academic support services.



The Experiential Learning Core (ELC)

Experiential Learning Core								
Fall 1	Winter 1	Fall 2	Winter 2	Fall 3	Winter 3	QUIP	Fall 4	Winter 4
APSC 101/2 Design + Labs	APSC 103 Design Project	ELC 1 CHEE 272 Systems Thinking	ELC 2 CHEE 270 ChemEtronics [multi-cohort]	ELC 3 CHEE 372 Modelling	ELC 4 CHEE 373 Process Design [multi-cohort]		ELC 5 CHEE 472 Research-client Design	ELC 6 CHEE 473 Multi-disciplinary design [multi-cohort]

The ELC is a sequence of design courses that dovetail with an optional 12–16-month Queen’s Undergraduate Internship Program (QUIP).

- Experiential learning builds skills and knowledge by engaging in authentic engineering tasks. By navigating real challenges with peers, mentors, and stakeholders, students build the competence in critical thinking, systems leadership and creative design that cannot be gained through instruction alone.
- Teams in Winter-term ELC courses will be interdisciplinary and multi-cohort, with students self-directing their learning by defining and executing projects of common interest.



What are the benefits of the multi-cohort ELC approach?

- Students who engage in experiential learning graduate with a clearer sense of career goals, stronger resumes, and smoother transitions into their first jobs.
- Embedding systems leadership and critical thinking experiences within ELC design activities builds the professional skills demanded by collaborative, interdisciplinary engineering work.

Integrated Laboratory Stream

Recognizing that chemical engineering science is the foundation of applied chemistry/biology design, our reimagined curriculum must deepen student mastery of thermodynamics, transport phenomena, reaction kinetics and process control.

This will be achieved by creating a sequence of integrated laboratory courses that are synchronized with lecture-based exercises.

- These activity-based learning opportunities will provide hands-on reinforcement of learning through direct observation, data analysis and modelling of real systems.
- Each laboratory exercise will engrain a specific foundational concept to ensure that graduates have the technical know-how to succeed in an engineering career.

How can you become involved?

This is an historic time for the department as we redefine the discipline, modernize the curriculum and shift our teaching methodologies.

Input from students, alumni, industry leaders, and educators is needed to discover structural gaps in our plan and identify further opportunities.

Email ideas / comments to: parent@queensu.ca

Complete the Reimagining Chemical Engineering Education Survey:

<https://www.cognitofrms.com/SmithEngineering1/REESurvey>



Chem Eng – Process Option

Current Chemical Engineering Process Option (CHE-1)								
Fall 1	Winter 1	Fall 2	Winter 2	Fall 3	Winter 3	Optional Queen's University Internship Program (QUIP)	Fall 4	Winter 4
APSC 101/2 [Design + Labs]	APSC 103 [Design Project]	CHEE 209 Analysis of Process Data	CHEE 210 Thermodynamics of Energy Conversion	CHEE 321 Chemical Reaction Engineering	CHEE 319 Process Dynamics and Control		CHEE 472 Chemical Process Design I	CHEE 473 Chemical Process Design II
APSC 151 [Geology]	APSC 174 [Linear Algebra]	CHEE 221 Chemical Processes and Systems	CHEE 222 Process Dynamics and Numerical Methods	CHEE 330 Heat and Mass Transfer	CHEE 315 Laboratory Projects II		CHEE 418 Strategies for Process Investigation	CHEE 412 Transport Phenomena
APSC 111 [Physics 1]	APSC 112 [Physics 2]	CHEE 224 Transport Fundamentals	CHEE 223 Fluid Mechanics	CHEE 311 Phase and Reaction Equilibrium	CHEE 331/361 Design of Unit Operations		Tech A Elective	Tech A Elective
APSC 171 [Calculus 1]	APSC 172 [Calculus 2]	MTHE 225 Differential Equations	CHEE 218 Laboratory Projects	CHEE 380 Biochemical Engineering	CHEE 371 Mitigation of Pollution		Technical Elective	Technical Elective
APSC 162 Graphics	APSC 182 [Mechanics]	ENCH 211 Main Group Chemistry	APSC 200/293 Engineering Design & Practice II	Technical Elective	Technical Elective		TEAM / Multidisciplinary Design / Research Project / Lab Projects / Entrepreneurship	
APSC 141 Coding								
APSC 131 [Chemistry 1]	APSC 132 [Chemistry 2]	ENCH 212 Principles of Chemical Reactivity	ENCH 245 Applied Organic Chemistry I	Comp Studies Elective	APSC 221 Economics & Business Practices in Engineering		Comp Studies Elective	Technical Elective

Proposed Chemical Engineering (Process Option CHE-1)								
Fall 1	Winter 1	Fall 2	Winter 2	Fall 3	Winter 3	Optional Queen's University Internship Program (QUIP)	Fall 4	Winter 4
APSC 101/2 Design + Labs	APSC 103 Design Project	ELC 1 CHEE 272 Systems Thinking	ELC 2 CHEE 273 Electronic Systems [multi-cohort]	ELC 3 CHEE 372 Modelling	ELC 4 CHEE 373 Process Design [multi-cohort]		ELC 5 CHEE 472 Research-client Design	ELC 6 CHEE 473 Multi-disciplinary design [multi-cohort]
APSC 111 Physics 1	APSC 112 Physics 2	CHEE 210 Thermodynamics of Energy Conversion	CHEE 209 Data Analytics and Machine Learning	Integrated Lab 1	Integrated Lab 2		Integrated Lab 3	Integrated Lab 4
APSC 171 Calculus 1	APSC 172 Calculus 2	CHEE 221 Process Systems Engineering 1	CHEE 222 Process Systems Engineering 2	CHEE 321 Chemical Reaction Engineering	CHEE 319 Process Dynamics and Control		CHEE 418 Strategies for Process Investigation	Technical Elective
APSC 162 Graphics	APSC 174 Linear Algebra	MTHE 225 Differential Equations	CHEE 225 Transport Phenomena 1	CHEE 3XX Transport Phenomena 2	Technical Elective		Technical Elective	Technical Elective
APSC 141 Coding								
APSC 151 Geology	APSC 182 Mechanics	ENCH 211 Main Group Chemistry	APSC 221 Economics & Business Practices in Engineering	CHEE 33X Thermodynamics of Separations	Technical Elective		TEAM / Multidisciplinary Design / Research Project / Entrepreneurship	
APSC 131 Chemistry 1	APSC 132 Chemistry 2	ENCH 212 Principles of Chemical Reactivity	ENCH 245 Applied Organic Chemistry I	Comp Studies Elective	Comp Studies Elective		Technical Elective	Technical Elective

Chem Eng – Biochemical Option

Current Chemical Engineering Biochemical Option (CHE-2)								
Fall 1	Winter 1	Fall 2	Winter 2	Fall 3	Winter 3	Optional Queen's University Internship Program (QUIP)	Fall 4	Winter 4
APSC 101/2 [Design + Labs]	APSC 103 [Design Project]	CHEE 209 Analysis of Process Data	CHEE 210 Thermodynamics of Energy Conversion	CHEE 321 Chemical Reaction Engineering	CHEE 319 Process Dynamics and Control		CHEE 472 Chemical Process Design I	CHEE 473 Chemical Process Design II
APSC 151 [Geology]	APSC 174 [Linear Algebra]	CHEE 221 Chemical Processes and Systems	CHEE 222 Process Dynamics and Numerical Methods	CHEE 330 Heat and Mass Transfer	CHEE 315 Laboratory Projects II		CHEE 418 Strategies for Process Investigation	CHEE 452 Transport Phenomena in Physiological Systems
APSC 111 [Physics 1]	APSC 112 [Physics 2]	CHEE 229 Cell based Engineering Principles	CHEE 223 Fluid Mechanics	CHEE 311 Phase and Reaction Equilibrium	CHEE 331/361 Design of Unit Operations		Tech A Elective	Tech A Elective
APSC 171 [Calculus 1]	APSC 172 [Calculus 2]	MTHE 225 Differential Equations	CHEE 218 Laboratory Projects	Technical Elective	CHEE 371 Mitigation of Pollution		Technical Elective	Technical Elective
APSC 162 Graphics	APSC 182 [Mechanics]	ENCH 211 Main Group Chemistry	APSC 200/293 Engineering Design & Practice II	CHEE 380 Biochemical Engineering	CHEE 340 Biomedical Engineering		TEAM / Multidisciplinary Design / Research Project / Lab Projects / Entrepreneurship	
APSC 141 Coding							ENCH 212 Principles of Chemical Reactivity	ENCH 245 Applied Organic Chemistry I
APSC 131 [Chemistry 1]	APSC 132 [Chemistry 2]							

Proposed Chemical Engineering Biochemical Option (CHE-2)								
Fall 1	Winter 1	Fall 2	Winter 2	Fall 3	Winter 3	Optional Queen's University Internship Program (QUIP)	Fall 4	Winter 4
APSC 101/2 Design + Labs	APSC 103 Design Project	ELC 1 CHEE 272 Systems Thinking	ELC 2 CHEE 273 Electronic Systems [multi-cohort]	ELC 3 CHEE 372 Modelling	ELC 4 CHEE 373 Process Design [multi-cohort]		ELC 5 CHEE 472 Research-client Design	ELC 6 CHEE 473 Multi-disciplinary design [multi-cohort]
APSC 111 Physics 1	APSC 112 Physics 2	MTHE 225 Differential Equations	CHEE 209 Data Analytics and Machine Learning	Integrated Lab 1	Integrated Lab 2		Integrated Lab 3	Integrated Lab 4
APSC 171 Calculus 1	APSC 172 Calculus 2	CHEE 221 Process Systems Engineering 1	CHEE 222 Process Systems Engineering 2	CHEE 321 Chemical Reaction Engineering	CHEE 319 Process Dynamics and Control		CHEE 418 Strategies for Process Investigation	Technical Elective
APSC 162 Graphics	APSC 174 Linear Algebra	CHEE 210 Thermodynamics	CHEE 225 Transport Phenomena 1	CHEE 3XX Transport Phenomena 2	APSC 221 Economics & Business Practices in Engineering		Technical Elective	Technical Elective
APSC 141 Coding							ENCH 212 Principles of Chemical Reactivity	ENCH 245 Applied Organic Chemistry I
APSC 131 Chemistry 1	APSC 132 Chemistry 2							
APSC 151 Geology	APSC 182 Mechanics	BIOL 102 Molecular and Cell Biology	CHEE 229 Cell based Engineering Principles	CHEE 380 Biochemical Engineering	CHEE 340 Biomedical Engineering		Comp Studies Elective	Comp Studies Elective

Engineering Chemistry

Current Engineering Chemistry								
Fall 1	Winter 1	Fall 2	Winter 2	Fall 3	Winter 3	Optional Queen's University Internship Program (QUIP)	Fall 4	Winter 4
APSC 101/2 [Design + Labs]	APSC 103 [Design Project]	CHEE 209 Analysis of Process Data	CHEE 210 Thermodynamics of Energy Conversion	CHEE 321 Chemical Reaction Engineering	CHEE 324 Organic Process Development		CHEE 472 Chemical Process Design I	CHEE 473 Chemical Process Design II
APSC 151 [Geology]	APSC 182 [Mechanics]	CHEE 221 Chemical Processes and Systems	CHEE 222 Process Dynamics and Numerical Methods	CHEE 330 Heat and Mass Transfer	CHEE 363 Electrochemical Engineering		CHEE 460 Surface and Colloid Science	CHEE 463 Electrochemical Energy Systems
APSC 111 [Physics 1]	APSC 112 [Physics 2]	CHEE 270 ChemEtronics	CHEE 223 Fluid Mechanics	CHEE 311 Phase and Reaction Equilibrium	CHEE 331/361 Design of Unit Operations		Tech A Elective	Tech A Elective
APSC 171 [Calculus 1]	APSC 172 [Calculus 2]	MTHE 225 Differential Equations	APSC 200/293 Engineering Design & Practice II	CHEE 380 Biochemical Engineering	ENCH 321 Instrumental Analytical Chemistry		ENCH 313 Quantum Mechanics	Tech B Elective
APSC 162 [Graphics]	APSC 174 [Linear Algebra]	ENCH 211 Main Group Chemistry	ENCH 222 Methods of Structure Determination	ENCH 312 Transition Metal Chemistry	ENCH 399 Experimental Chemistry II		ENCH 417 Research Thesis	
APSC 141 [Coding]							Tech A Elective	
APSC 131 [Chemistry 1]	APSC 132 [Chemistry 2]	ENCH 212 Principles of Chemical Reactivity	ENCH 245 Applied Organic Chemistry I	Comp Studies Elective	APSC 221 Economics & Business Practices in Engineering			

Proposed Engineering Chemistry								
Fall 1	Winter 1	Fall 2	Winter 2	Fall 3	Winter 3	Optional Queen's University Internship Program (QUIP)	Fall 4	Winter 4
APSC 101/2 Design + Labs	APSC 103 Design Project	ELC 1 CHEE 272 Systems Thinking	ELC 2 CHEE 273 Electronic Systems [multi-cohort]	ELC 3 CHEE 372 Modelling	ELC 4 CHEE 373 Process Design [multi-cohort]		ELC 5 CHEE 472 Research-client Design	ELC 6 CHEE 473 Multi-disciplinary design [multi-cohort]
APSC 151 Geology	APSC 182 Mechanics	CHEE 210 Thermodynamics of Energy Conversion	CHEE 209 Data Analytics and Machine Learning	Integrated Lab 1 [ENCH 398]	Integrated Lab 2 [ENCH 399]		ENCH 417 Research Thesis	
APSC 111 Physics 1	APSC 112 Physics 2	CHEE 221 Process Systems Engineering 1	CHEE 222 Process Systems Engineering 2	CHEE 321 Chemical Reaction Engineering	CHEE 319 Process Dynamics and Control		Technical Elective	Technical Elective
APSC 171 Calculus 1	APSC 172 Calculus 2	MTHE 225 Differential Equations	CHEE 225 Transport Phenomena 1	CHEE 3XX Transport Phenomena 2	CHEE 324 Organic Process Development		Technical Elective	Technical Elective
APSC 162 Graphics	APSC 174 Linear Algebra	ENCH 211 Main Group Chemistry	ENCH 222 Methods of Structure Determination	CHEE 3XX Thermodynamics of Separations	CHEE 363 Electrochemical Engineering		ENCH 312 Transition Metal Chemistry	CSC Biology Elective
APSC 141 Coding							ENCH 313 Quantum Mechanics	ENCH 321 Instrumental Analytical Chemistry
APSC 131 Chemistry 1	APSC 132 Chemistry 2	ENCH 212 Principles of Chemical Reactivity	ENCH 245 Applied Organic Chemistry I	Comp Studies Elective	APSC 221 Economics & Business Practices in Engineering			

Potential Departmental Technical Electives

CHEE 324 – Organic Process Development

CHEE 340 – Biomedical Engineering

CHEE 363 – Electrochemical Engineering

CHEE 371 – Mitigation of Industrial Pollution

CHEE 380 – Biochemical Engineering

CHEE 418 – Strategies for Process Investigation

CHEE 434 – Advanced Control of Multivariable Linear Systems

CHEE 440 – Pharmaceutical Technology

CHEE 460 – Surface and Colloid Science

CHEE 463 – Electrochemical Energy Systems

CHEE 4XX – Transport Phenomena 3

CHEE 490 – Polymer Formulations and Processing Technology



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