ENGINEERING CHEMISTRY

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The Engineering Chemistry program is offered by the Department of Chemical Engineering with the close cooperation of the Department of Chemistry. The academic program is accredited by the Canadian Engineering Accreditation Board as an engineering discipline and the Canadian Society for Chemistry as a chemistry program. The curriculum integrates a core of chemistry with a body of engineering in a manner that allows chemical knowledge to be put into practice. Beginning with a concentration on basic engineering principles, science, and mathematics, students can gain specialization in areas such as process chemistry, materials science, biosciences and pharmaceuticals, through selection of electives and thesis project. They also work on group design projects throughout the design spine. In their fourth year students work on a year-long research thesis project, under the supervision of academic staff. All students have access to a computing facility, equipped with software programs and simulators.

Ancillary Fees

Chemical Engineering and Engineering Chemistry students may be required to pay ancillary fees for course related learning materials, safety equipment and field trips.

Programs

- Engineering Chemistry, B.A.Sc. (Class of 2024) (https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/engineering-chemistry/engineering-chemistry-basc-class-2023/)
- Engineering Chemistry, B.A.Sc. (Class of 2025) (https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/engineering-chemistry/engineering-chemistry-basc-class-2024/)
- Engineering Chemistry, B.A.Sc. (Class of 2026) (https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/engineering-chemistry/engineering-chemistry-basc-class-2026/)
- Engineering Chemistry: Technical Electives (https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/engineering-chemistry/engineering-chemistry-technical-electives/)

Courses

ENCH 211 Main Group Chemistry Units: 4.75
An introduction to chemistry of main group inorganic and organic compounds with the use of fundamental quantum mechanics, molecular orbital diagrams and Lewis structures to describe the structure and bonding. The stereochemistry and chirality of organic compounds, solid-state inorganic chemistry, and descriptive chemistry of compounds of the main group elements will be covered. The laboratory will introduce skills in inorganic and organic synthesis.
(Lec: 3, Lab: 1.5, Tut: 0.25)
Requirements: Prerequisites: APSC 131, APSC 132 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 58
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 212 Princip Of Chem Reactivity Units: 4.00
An introduction to the kinetics and mechanisms of reactions in gaseous and condensed phases, including acid-base and nucleophilic substitution reactions at carbon and other main group centers. Other topics will include molecular dynamics and reactions in solution. The laboratory illustrates measurement techniques and develops laboratory skills
(Lec: 3, Lab: 0.75, Tut: 0.25)
Requirements: Prerequisites: APSC 111, APSC 112, APSC 131, APSC 132 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 49
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 213 Intro To Chemical Analysis Units: 4.75
Introduction to analytical chemical methods and science. Topics include statistical analysis of data, titrations and equilibrium theory, spectrophotometry and instrumental elemental analysis.
(Lec: 3, Lab: 1.5, Tut: 0.25)
Requirements: Prerequisites: APSC 131, APSC 132 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 43
Complementary Studies 0
Engineering Science 15
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 222 Meth Struct Determination Units: 3.75
A survey of practical spectroscopic and spectrometric methods for the determination of the structures of organic and inorganic compounds. Methods will include nuclear magnetic resonance, electronic, infrared/ Raman spectroscopy, and mass spectrometry. Tutorials will involve solving compound structures using spectroscopic data, and include an introduction to computational methods in spectroscopy.
(Lec: 3, Lab: 0, Tut: 0.75)
Requirements: Prerequisites: (APSC 131 and APSC 132) or CHEM 112. Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 45
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 245 Applied Organic Chemistry I Units: 4.75
A survey of organic functional group reactivity from a mechanistic perspective, including substitution, addition, elimination, rearrangement and redox reactions; extensive use of examples from industrial process chemistry. The laboratory provides experience in organic synthesis, including the preparation, purification and characterization of organic compounds.
(Lec: 3, Lab: 1.5, Tut: 0.25)
Requirements: Prerequisites: ENCH 211 (CHEM 211), ENCH 212 (CHEM 212) Corequisites: Exclusions: CHEM 223
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 16
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 311 Mechanistic Organic Chem Units: 3.50
Fundamental mechanistic concepts of organic reactions, structure activity relationships, solvent effects and catalysis. Mechanistic aspects of substitution, addition, elimination and pericyclic reactions.
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: ENCH 245 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 312 Transition Metal Chem Units: 3.50
Introduction to the chemistry, bonding and structures of coordination compounds of the transition metals; transition metals in the solid state and in biological systems; industrial and environmental aspects of transition metal chemistry.
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: ENCH 211 (CHEM 211) Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 313 Quantum Mechanics Units: 3.50
Elementary principles and applications of wave mechanics with special reference to molecular orbitals and chemical bonding.
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: CHEE 210, MTHE 225 (MATH 225) Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 21
Complementary Studies 0
Engineering Science 21
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 321 Instrumental Chemical Analysis Units: 3.00
Overview of instrumental methods of chemical analysis. Topics include gas and liquid chromatography, mass spectrometric detection, new separations methods, electrochemical analysis, inductively coupled plasma-based elemental analysis.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ENCH 213 (CHEM 213) Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 322 Chem Bond: Comp & Spectro. Units: 3.50
The application of quantum mechanics to the structures and internal motions of molecules. The foundations of electronic, vibrational, rotational and NMR spectroscopy will be discussed together with their applications.
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: ENCH 313 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 323 Biological Chemistry Units: 3.00
Introduction to the chemical basis of biological systems and biomolecules; protein structure and synthesis, enzyme catalysis, nucleic acids (DNA, RNA), carbohydrates, membranes, cell signalling, biosynthetic and metabolic pathways.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: CHEE 342 or CHEE 324 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 326 Environmental&Green Chemistry Units: 3.00
The first part examines chemical contaminants in the atmosphere, water, soils and sediments, including sources, behaviour, transport, and distribution among these environments. The second part introduces Green chemistry, examining industrial sources of contaminants and the modification of industrial processes in order to minimize environmental impact.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ENCH 211 (CHEM 211), ENCH 212 (CHEM 212), ENCH 245 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Science 12
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 345 Applied Organic Chemistry II Units: 3.00
A detailed study of organic reactions and processes of industrial and economic importance, with application of the principles developed in ENCH 245 (CHEM 245). Case studies involving process development in the pharmaceutical industry are used extensively.
COURSE DELETED 2018-2019
(Lec: 3, Lab: 0, Tut: 0)
Requirements: ENCH 245 or permission of the instructor.
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Science 12
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 397 Experimental Chemistry Units: 7.00
Laboratory course introducing modern experimental methods in chemistry, including synthesis, analytical instrumentation and computational methods. The integration of several methods will be emphasized in the synthesis and characterization of molecules.
(Lec: 3, Lab: 0.5, Tut: 0)
Requirements: Prerequisites: At least 6 units at the 200-level in ENCH/CHEM or permission of the Department. Corequisites: At least 3 units at the 300-level in ENCH/CHEM or permission of the Department. Exclusions:
Offering Term: FW
CEAB Units:
Mathematics 0
Natural Sciences 84
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Smith Engineering

ENCH 398 Experimental Chemistry I Units: 3.50
Laboratory course. In consultation with the course coordinator, and subject to availability, students may select experiments as are relevant to their degree program including synthesis, analytical instrumentation and computational methods. The integration of several methods will be emphasized in the design and characterization of molecules.
(Lec: 0, Lab: 3, Tut: 0.5)
Requirements: Prerequisites: (ENCH 211 or ENCH 212), ENCH 222, ENCH 245 Corequisites: At least 3 units at the 300-level in ENCH/CHEM or permission of the Department. Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 399 Experimental Chemistry II Units: 3.50
Laboratory course. In consultation with the course coordinator, and subject to availability, students may select experiments as are relevant to their degree program including synthesis, analytical instrumentation and computational methods. The integration of several methods will be emphasized in the design and characterization of molecules.
(Lec: 0, Lab: 3, Tut: 0.5)
Requirements: Prerequisites: (ENCH 211 or ENCH 212), ENCH 222, ENCH 245. Corequisites: At least 3 units at the 300-level in ENCH/CHEM Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 411 Adv. Analytical Chem Units: 3.00
A discussion of recent advances in analytical chemistry and its applications to the environmental, materials and biomedical fields. At least four topics will be covered from sample preparation, separation methods, multidimensional chromatography, elemental spectroscopy, mass spectroscopy, and surface analysis methods. Additional topics will be selected from the current literature.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ENCH 213 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 412 Statistical Mechanics Units: 3.00
The fundamentals of statistical mechanics with applications to thermodynamic properties of gases, liquids and solids and to chemical equilibrium in dilute gases.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ENCH 313 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 413 Computational Chemistry Units: 3.00
The application of quantum mechanics to chemical structures, energetics, internal motions of molecules, and chemical reactions. An introduction to the use of modern electronic structure software in chemistry.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ENCH 313 (CHEM 313) Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 414 Catalysis Units: 3.00
An advanced treatment of the concepts and applications of catalysis, including the kinetics of catalysis and topics selected from the areas of homogeneous, heterogeneous, and biocatalysis.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ENCH 245 and ENCH 312 (CHEM 312) Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 415 Electrochemistry and Electrocatalysis Units: 3.00
The course covers concepts of equilibrium electrochemistry and examines the structure of the electrode-solution interface. It discusses the basics of electron transfer and derives electrochemical kinetics equations. It shows examples of several electrochemical reactions and overviews experimental methods used to study electrochemical phenomena.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: CHEE 210 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 417 Research Project Units: 9.00
In this course, projects will be assigned requiring design and synthesis in the solution of problems in engineering chemistry, using principles and concepts discussed in previous courses. Originality and innovation are encouraged. Students are required to significantly contribute to the design of original experiments, and independently analyze, interpret and communicate the results, both orally and in writing.
Requirements: Prerequisites: ENCH 397 or ENCH 398 or ENCH 399 Corequisites: Exclusions:
CEAB Units:
Mathematics 0
Natural Sciences 53
Complementary Studies 27
Engineering Science 28
Engineering Design 0
Course Equivalencies: ENCH 417; ENCH 417B
Offering Faculty: Faculty of Arts and Science

ENCH 421 Adv. Meth. Physical Chem. Units: 3.00
Modern spectroscopic methods for the structural and electronic characterization
of molecules will be discussed, including: NMR, X-ray and synchrontron-based spectroscopies, laser spectroscopy, surface spectroscopic methods, and
scanning probe methods.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ENCH 313 (CHEM 313) Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 422 Synthetic Organic Chem Units: 3.50
Modern synthetic methods in organic chemistry. Principles of strategy in
planning organic syntheses based on simple classifications of reagents and reactions, and on the control of stereochemistry.
(Lec: 3, Lab: 0, Tut: 0.5)
Requirements: Prerequisites: CHEE 324 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 423 Topics In Inorg/Organomet Chem Units: 3.00
An examination of aspects of modern inorganic and organometallic chemistry. Topics will include metal-ligand bonding in organometallic complexes, applications of organometallics in organic synthesis, metal-metal bonding in dinuclear and polynuclear metal complexes, and may include reaction mechanisms of transition metal complexes, bioinorganic chemistry and symmetry.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: ENCH 312 (CHEM 312) Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 424 Polymer Chemistry Units: 3.00
Specific properties of polymers (glass transition, crystallinity, polydispersity, etc) and their dependence on macromolecular structure and isomerism. Polymer synthesis overview: step and chain polymerization (free-radical, ionic and insertion mechanisms) and reactions on polymers. Examples of polymers and their uses.
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: CHEM 223 or ENCH 245 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science

ENCH 425 Self Assembly & Materials Units: 3.00
Four topics covering a range of self-assembled molecular systems will be discussed: monolayers and bilayers, block co-polymers, nanoparticles,
and liquid crystals. Material properties, synthetic methods and application
of these systems in current and emerging technologies, including nanotechnologies, will be covered.
NOT OFFERED 2023-2024
(Lec: 3, Lab: 0, Tut: 0)
Requirements: Prerequisites: CHEE 210 and ENCH 245 or CHEM 221 and CHEM 223 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0
Offering Faculty: Faculty of Arts and Science